Junzo Watada · Bing Xu
Berlin Wu *Editors*

Innovative Management in Information and Production

Springer

Innovative Management in Information and Production

Junzo Watada • Bing Xu • Berlin Wu
Editors

Innovative Management in Information and Production

Springer

Editors
Junzo Watada
Waseda University
Fukuoka, Japan

Berlin Wu
Department of Mathematical Sciences
National Chengchi University
Taipei City, Taiwan R.O.C.

Bing Xu
Research Institute of Quantitative Economics
Zhejiang Gongshang University
Zhejiang Province, China, People's Republic

ISBN 978-1-4614-4856-3 ISBN 978-1-4614-4857-0 (eBook)
DOI 10.1007/978-1-4614-4857-0
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2013937288

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Today many corporations and governments face hard days because of economic recession, and their most concerns are with innovations and locomotives, which can forward their organizations to obtain more profits even in the hard days. All the people know it looks impossible. On the other hand some corporations and governments are successfully enjoying their management of the organization.

How could they succeed such a miracle? We can point various reasons including innovation, successful management of technology and engineering, successful customer-oriented affective marketing, customer's emotion-based design and manufacturing, human-centered computation, and human-centered problem solving. But we can say it is not possible in narrow and conventional framework to solve such issues.

Another direction is to change our profit-oriented management. Some societies are is very much successful in living on their own quality of life. This means we have to work more on human-centered management than on human centered manufacturing.

Our most concerns are interdisciplinary research studies. Especially we emphasize on the collaboration among innovative management, information, and production. Three years ago, we started this symposium to work on such issues together starting from a small group of research scholars. Some are joining here from management, marketing, social science, mathematics, econometrics, economics, accounting, or engineering as well as from psychology and politics.

This edited book is published in the IMIP2012 proceedings. In IMIP2012, we selected about four keynotes and 40 papers out of those submissions. We believe the papers included in the proceedings book will give some suggestion to solve or mitigate our difficult issues. Since our concerns cover wide ranges, the accepted papers are related to various problems. But the focal concern is the one that will solve our fierce issues we are facing today.

Our research studies are very much related to social and humanity sciences even though we are greatly concerned with engineering. The production cannot only be discussed from the perspective of production engineering but also should be decided from the scope of management, marketing, economy, etc. Many research topics are multidirectional. This conference perspective should influence production engineering from the perspective of the management and information as same as management and information should not be self-contained and self-absorbed science. All the fields are interrelated. Therefore, we have to work on interdisciplinary fields proposed in this IMIP symposium.

At the end I express our sincere appreciation to the USSH—VNU-HCMC, Vietnam, that provides this chance of opening the symposium in the university. We should send many appraisals to Professor Hung T. Nguyen, New Mexico State University, Professor Vladik Kreinovich, University of Texa at El Paso, Professor Kun-huang Huarng, Feng Chia University, Renshou Zhang, Zhejiang Gongshang University, and other committee members who initiated the start of the conference. I hope this small step will be the start of our wide strides of big progresses by this international conference.

Fukuoka, Japan — Junzo Watada
Hangzhou, China — Bing Xu
Taipei, Taiwan — Berlin Wu

Editors

Professor Junzo Watada received his B.Sc. and M.Sc. degrees in electrical engineering from Osaka City University and Dr. of engineering degree from Osaka Prefecture University, Japan. He is currently a professor of Knowledge Engineering, Soft Computing and Management Engineering at the Graduate School of Information, Production and Systems, Waseda University. He was a professor of Human Informatics and Knowledge Engineering at the Osaka Institute of Technology, Japan, and was with Ryukoku University, Kyoto, for about 10 years each. Before moving to Academia, he was with Fujitsu Co. Ltd. for about 10 years. His research interests include decision making tehnologies and management of technology. Dr. Watada is currently the president of the International Society of Management Engineers.

Professor Bing Xu received his Ph.D. in information, production and systems engineering from Waseda University in Japan. Dr. Xu is currently a professor of statistics and econometrics and director of Research Institute of Quantitative Economics in Zhejiang Gongshang University in China. He is an executive editor for International Journal of Innovative Management, Information and Production. His research interests include risk management, statistical model identification, business decision analysis, and system intelligent control.

Professor Berlin Wu received his B.Sc at National Chengchi University, Taiwan (1979) and Ph.D. degree in statistics from Indiana University, Bloomington, Indiana (1988). Dr. Wu is currently a professor in the Department of Mathematical Sciences, National Chengchi University, Taiwan. He was award, by Fulbright Scholarship 1997, and was a Distinguished Research Professor Prizes of National Chengchi University, 2002 and 2004. He is the editor-in-chief for the International Journal of Intelligent Technologies and Applied Statistics. His current research interests include nonlinear time series analysis, fuzzy statistical analysis, and discovering various forecasting techniques with soft computing methods.

Contents

On Uncertainty Analysis Using Random Sets in Science and Engineering

Hung T. Nguyen

Abstract In information management systems in particular, and in science and engineering in general, uncertainty is a norm rather than an exception. Uncertainty can take on various different forms, ranging from randomness to imprecision modeled by probabilities and fuzzy sets, respectively. In view of current interests in using the so-called theory of belief functions in engineering applications, we address here a general unified framework for analyzing uncertainties. The building block of our approach is the concept of random sets.

1 Random Sets in Statistical Analysis

Intuitively, a set obtained at random is called a random set. Such random sets appear often in applications, and yet, their formal treatment seems lacking until quite recently.

In fact random sets appear at the very beginning of statistics! Collecting data in survey studies is the starting point for empirical analysis. If U denotes a physical (finite) population of individuals or objects of interest, then a sample from it is a subset of it. To obtain a subset $A \subseteq U$ containing enough information about some characteristics under investigation, which will be used to conduct inductive logic (inference) towards the whole population, we create a man-made random mechanism to select samples. Thus, an observed sample A is obtained at random and hence a random set.

In standard statistical practice, point estimates are often accompanied by confidence region estimates which are sets depending on a random sample and hence a random set.

H.T. Nguyen (✉)
New Mexico State University, Las Cruces, NM 88003, USA
Chiang Mai University, Chiang Mai, Thailand
e-mail: hunguyen@math.nmsu.edu

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_1,

In statistical estimation of probability density functions in high dimensions, it is more convenient to first estimate cross sections as in the excess mass approach of Hartigan (1987). Specifically, let $f : R^d \to R^+$ be the unknown density of a random vector X;then for each $\alpha > 0$, the α-level set of f is

$$A_\alpha(f) = \{x \in R^d : f(x) \geq \alpha\}. \tag{1}$$

From the knowledge of all level sets, f is recovered as

$$f(x) = \int_0^\infty 1_{A_\alpha}(x)\mathrm{d}\alpha. \tag{2}$$

Thus, an estimation strategy is first estimate the sets A_α from, say, a random sample $X_1, X_2, \ldots, X_n$ drawn from X, by a random set $A_{\alpha,n}(X_1, X_2, \ldots, X_n)$, then use the plug-in estimator

$$f_n(x) = \int_0^\infty 1_{A_{\alpha,n}}(x)\mathrm{d}\alpha \tag{3}$$

to estimate (pointwise) $f(x)$.

Without going into details how to construct a random set estimator, we merely say that set estimators like $A_{\alpha,n}(X_1, X_2, \ldots, X_n)$ are random sets.

In a somewhat "hidden" way, random sets appear in robust Bayesian statistics or in incomplete model specifications. The situation is this. The model is a probability measure P_o on $(\Omega, \mathscr{A})$ which is known only to belong to some known set $\mathscr{P}$ of probability measures on $(\Omega, \mathscr{A})$. Without knowing P_o, statisticians are forced to work with $F = \inf\{P : P \in \mathscr{P}\}$ or its dual $\sup\{P : P \in \mathscr{P}\}$. While clearly, the set function F is not necessarily additive (i.e., not a probability measure), it satisfies a weaker condition, namely,

$$F(\cup_{i=1}^n A_i) \geq \sum_{\varnothing \neq I \subseteq \{1,2,\ldots,n\}} (-1)^{|I|+1} F(\cap_{j \in I} A_j). \tag{4}$$

There are situations (such as when Ω is finite) where we can "inverse" F to obtain

$$f(A) = \sum_{B \subseteq A} (-1)^{|A \setminus B|} F(B) \tag{5}$$

which is nonnegative and $\sum_A f(A) = 1$. As such, the set function f is qualified as a bona fide probability density function, taking values, not as points in Ω, but as subsets of Ω, i.e., f is the probability density of a random set.

Another important situation concerns *coarse data* (low quality). Data can happen to be imprecise, e.g., due to the imperfection of the data acquiring procedure (inaccuracy of measurement instruments), and as such they are rather sets than points in the sample space. In such cases, rather than trying to ascribe unique values to the imprecise observations, it is preferable to represent the outcomes of the random experience or phenomenon as subsets containing the "true" values. For example, missing data, censored or grouped data belong to the category of coarse data.

At another level when we use natural languages in intelligent systems, the imprecision is described by fuzzy sets which generalize ordinary sets. We are talking about random fuzzy sets.

2 The Belief Function Approach to Combining Evidence

Generalizing Bayesian statistics, Dempster (1967) and Shafer (1976) considered an approach to quantify evidence by using uncertainty measures under the name of belief functions. The framework is this.

A "true state of nature" u_o is known to be in some *finite* set U, although it is not known which element of U is that true state. For each subset $A \subseteq U$, we express our "belief" that A contains u_o by a number, denoted as $F(A)$. Such a number $F(A)$ could come from some "evidence." We are talking about modeling/quantifying information provided by evidence, i.e., some mathematical theory of evidence.

A belief function on a finite set U is a set function $F : 2^U \to [0,1]$ such that

(i) $F(\varnothing) = 0$, $F(U) = 1$
(ii) For any $n \geq 2$, and any $A_1, A_2, \ldots, A_n \in 2^U$,

$$F(\cup_{i=1}^n A_i) \geq \sum_{\varnothing \neq I \subseteq \{1,2,\ldots,n\}} (-1)^{|I|+1} F(\cap_{j \in I} A_j), \tag{6}$$

where $|I|$ denotes the cardinality of the set I.

Example [belief functions as distributions of random sets, see Nguyen (1978, 2012)]

Let $(\Omega, \mathscr{A}, P)$ be a probability space and $(V, \mathscr{V})$ be an arbitrary measurable space. A map $X : \Omega \to V$ is called a random element if $X^{-1}(\mathscr{V}) \subseteq \mathscr{A}$, and its probability law is the probability measure $P_X = PX^{-1}$ on $\mathscr{V}$. For U a finite set, and $V = 2^U$, $\mathscr{V}$ being the power set of 2^U, $X : \Omega \to 2^U$ is called a *nonempty* random set whose probability law is completely determined by its *distribution function* $F : 2^U \to [0,1]$, defined by

$$F(A) = P(X \subseteq A). \tag{7}$$

Now, clearly $F(\varnothing) = 0$ and $F(U) = 1$. Moreover, $F(.)$ is infinitely monotone. Indeed, for $B \in 2^U$, and $A_i \in 2^U$, $i = 1, 2, \ldots, n$, let

$$J(B) = \{i : \quad \text{such that} \;\; B \subseteq A_i\}. \tag{8}$$

We have

$$F(\cup_{i=1}^n A_i) = \sum_{B \subseteq \cup_{i=1}^n A_i} F(B) \geq \sum_{B \subseteq U, J(B) \neq \varnothing} F(B). \tag{9}$$

Now observe that, when $J(B) \neq \varnothing$, $\sum_{B \subseteq J(B)} (-1)^{|B|+1} = 1$, we can write

$$\sum_{B \subseteq U, J(B) \neq \varnothing} F(B) = \sum_{B \subseteq U, J(B) \neq \varnothing} \left[\sum_{\varnothing \neq I \subseteq J(B)} (-1)^{|I|+1} \right] F(B) \tag{10}$$

$$= \sum_{\varnothing \neq I \subseteq J(B)} (-1)^{|I|+1} \sum_{B \subseteq U, I \subseteq J(B)} F(B) \tag{11}$$

$$= \sum_{\varnothing \neq I \subseteq \{1,2,\ldots,n\}} (-1)^{|I|+1} \sum_{B \subseteq \cap_{j \in I} A_j} F(B) = \sum_{\varnothing \neq I \subseteq \{1,2,\ldots,n\}} (-1)^{|I|+1} F(\cap_{j \in I} A_j). \tag{12}$$

As expected, as in the case of random vectors, the properties of belief functions can be used as axioms for distribution functions of (finite) random sets: if F is a belief function on a finite set U, then it must be the distribution of some nonempty random set, i.e., there exist a probability space $(\Omega, \mathscr{A}, P)$ and a nonempty random set $X : \Omega \to 2^U$ such that $F(A) = P(X \subseteq A)$. For that, it suffices to show that there exists a function $f : 2^U \to [0,1]$ with $\sum_{A \subseteq U} f(A) = 1$ (called the *density function* of the random set X) such that $F(A) = \sum_{B \subseteq A} f(B)$.

For that purpose, define

$$f(A) = \sum_{B \subseteq A} (-1)^{|A \setminus B|} F(B), \tag{13}$$

where $A \setminus B = A \cap B^c$.

$f(.)$ is nonnegative, indeed, $f(\varnothing) = F(\varnothing) = 0$, and by construction, $f(\{u\}) = F(\{u\}) \geq 0$. For $A \in 2^U$ with $|A| \geq 2$, say, $A = \{u_1, u_2, \ldots, u_k\}$, let $A_i = A \setminus \{u_i\}$, $i = 1, 2, \ldots, k$. Then,

$$f(A) = F(A) - \sum_{i=1}^{k} F(A_i) + \sum_{i<j} F(A_i \cap A_j) + \cdots + (-1)^{k-1} \sum_{i=1}^{k} F(\cap_{j \neq i} A_j) \geq 0 \tag{14}$$

by infinite monotonicity of F, noting that $\cap_{i=1}^{k} A_i = \varnothing$ and $A = \cup_{i=1}^{k} A_i$.

Next,

$$\sum_{B \subseteq A} f(B) = \sum_{B \subseteq A} \sum_{C \subseteq B} (-1)^{|B \setminus C|} F(C) = \sum_{C \subseteq B \subseteq A} (-1)^{|B \setminus C|} F(C). \tag{15}$$

If $C = A$, the last term is $F(A)$. If $C \neq A$, then $A \setminus C$ has $2^{|A \setminus C|}$ subsets, so there are an even number of subsets B with $C \subseteq B \subseteq A$, exactly half of which have an even number of elements. The half of the numbers $(-1)^{|B \setminus C|}$ are 1 and half are -1. Thus, for each $C \neq A$, we have

$$\sum_{C \subseteq B \subseteq A} (-1)^{|B \setminus C|} F(C) = 0 \tag{16}$$

with the summation taken over B. Hence, $\sum_{B\subseteq A} f(B) = F(A)$. In particular,

$$1 = F(U) = \sum_{B\subseteq U} f(B). \tag{17}$$

Remark. A quantitative concept of degrees of belief can be also justified in the context of *coarse data* in statistics. If $Y : \Omega \to U$ is a random variable, then a *coarsening* of Y is a nonempty random set $X : \Omega \to 2^U$ such that $P(Y \in X) = 1$, i.e., Y is an almost sure selector of X. Without observing the (latent) random variable of interest Y, we rely on the observable X to conduct statistical inference. The distribution F of X is a belief function, and any possible probability law Q of Y on U should be compatible with F, i.e., $Q \geq F$, i.e., is in the *core* of F, namely, $\mathscr{C}(F) = \{Q : Q \geq F\}$. This is so, since, for any $A \in 2^U$, $\{\omega \in \Omega : X(\omega) \subseteq A\} \subseteq \{\omega \in \Omega : Y(\omega) \in A\}$ and hence

$$F(A) = P(X \subseteq A) \leq P(Y \in A) = PY^{-1}(A). \tag{18}$$

It is interesting to note that humans often use *coarsening schemes* in decision-making, a fact which can be attributed to "intelligence." I have once "argued" with Professor Zadeh that fuzziness in perception information appears as consequences of using fuzzy coarsening schemes, i.e., fuzzy partitions, in order to make decisions. When facing a decision, or a question, with not enough information to act, humans use a coarsening of the domain, such as in if–then rules in fuzzy control (see, e.g., Nguyen and Walker 2006).

The theory of belief functions was introduced as a mathematical theory of evidence. Since in a given problem, there might exist several sources of evidence, each represented by a belief function, there is a need to combine them. In random set language, if we have two random sets X and Y on the same finite set U, then the random set $X \cap Y$ is a natural candidate for a combined evidence. Clearly, the distribution of $X \cap Y$ depends on the joint distribution of (X,Y). From the knowledge of the marginal distributions, say, F_X, F_Y, we seek some possible joint distribution H for (X,Y). This sounds like an old problem of Maurice Frechet! If X and Y are random *vectors*, then the problem is solved by Sklar (1959) via the concept of *copulae* [see also, Nelsen (1999)]. However, here, not only we are facing discrete variables, but also these variables are not random vectors, they are random sets. The extension of Sklar's work from random vectors to multivariate random sets (random sets in n dimensions) is *an open problem.*

While X and Y are nonempty random sets, $X \cap Y$ might not be a nonempty random set, i.e., $P(X \cap Y = \varnothing) > 0$. However, the "conditional random set" $X \cap Y | (X \cap Y \neq \varnothing)$ is a nonempty random set. Indeed, its density is

$$\psi(A) = P(X \cap Y = A | X \cap Y \neq \varnothing) = \frac{P(X \cap Y = A, X \cap Y \neq \varnothing)}{P(X \cap Y \neq \varnothing)} \tag{19}$$

from which we see that $\psi(\varnothing) = 0$ (since then $(X \cap Y = \varnothing, X \cap Y \neq \varnothing) = \varnothing$).

The approach to combination of evidence, known as the Dempster's rule of combination, assumes in addition that the random sets X and Y are independent, i.e., $P(X = A, Y = B) = P(X = A)P(Y = B)$, for any A, B in 2^U, so that $\psi(.)$ is reduced to, for $A \neq \varnothing$,

$$\psi(A) = \frac{\sum_{C \cap D = A} P(X = C)P(Y = D)}{\sum_{S \cap T = \varnothing} P(X = S)P(Y = T)}. \tag{20}$$

We refer the reader to discussions concerning the independence assumption of X, Y in this rule of combination and its incompatibility with the condition $X \cap Y \neq \varnothing$. But if we drop the independence assumption on X, Y, then we face Frechet's problem: how to specify a joint distribution from its marginals? (here in the context of random sets!). Using *maximum entropy principle?*

3 Formal Treatment of Random Sets

With the above motivation for applications in a variety of diverse fields, ranging from engineering to social sciences, let us say few words about the formal theory of random sets and random fuzzy sets. For more details see Nguyen (2006) and Nguyen and Tran (2007).

A random set is a random element of a special form. To cover all possible situations where the outcomes are obtained at random, the theory of probability provides us with the following notion.

Let $(\Omega, \mathscr{A}, P)$ be a probability space. Let U be an *arbitrary set*, equipped with a σ-field $\mathscr{U}$. Then a random element is a measurable map $X : \Omega \to U$ such that $X^{-1}(\mathscr{U}) \subseteq \mathscr{A}$. Its probability law is the probability on $\mathscr{U}$ defined by $P_X = PX^{-1}$.

When U is a collection of subsets of some base set T, then X is called a random set to emphasize the fact that the "values" of X are sets.

In standard uncertainty analysis, we encounter random vectors (where $U = R^d$) and random functions (where U is a function space such as $C[0,1]$). The case of sets is delicate since it is non-euclidean.

The pioneering work of random sets is Matheron (1975). Extension to random fuzzy sets is in Nguyen and Tran (2007).

References

A.P. Dempster, Upper and lower probabilities induced by a multivalued mapping. Ann. Probab. **38**, 325–339 (1967)

G. Gierz, K.H. Hofmann, K. Keimel, J.D. Lawson, M. Mislove, D.S. Scott, *A Compendium of Continuous Lattices* (Springer, Heidelberg, 1980)

J.A. Hartigan, Estimation of a convex density contour in two dimensions. J. Am. Statist. Assoc. **82**, 267–270 (1987)

G. Matheron, *Random Sets and Integral Geometry* (Wiley, New York, 1975)

R.B. Nelsen, *An Introduction to Copulas*. Lecture Notes in Computer Science (Springer, Berlin, 1999)

H.T. Nguyen, On random sets and belief functions. J. Math. Anal. Appl. **65**, 531–542 (1978), reprinted in *Classical Works of the Dempster-Shafer Theory of belief Functions*, ed. by R. Yager, L. Liu. (Springer, Berlin, 2008), pp. 105–116

H.T. Nguyen, *An Introduction to Random Sets* (Chapman and Hall/CRC, Boca Raton, 2006)

H.T. Nguyen, On belief functions and random sets. In *Belief Functions: Theory and Applications*, ed. by T. Denoeux, M.H. Masson. (Springer, Berlin, 2012), pp. 1–19

H.T. Nguyen, H. Tran, On a continuous lattice approach to modeling of coarse data in system analysis. J. Uncertain Syst. **1**(1), 62–73 (2007)

H.T. Nguyen, E.A. Walker, *A First Course in Fuzzy Logic*, 3rd edn. (Chapman and Hall/CRC, Boca Raton, 2006)

G. Shafer, *A Mathematical Theory of Evidence*. Princeton University Press, Princeton, 1976)

A. Sklar, Fonctions de repartition a n dimensions et leur marges. Publ. Inst. Statist. Univ. Paris **8**, 229–231 (1959)

A Simulation Study of Estimator for the Stable Index

Wararit Panichkitkosolkul

Abstract Stable distributions are applied in several areas such as communications theory, physics, biology, astronomy, finance, economics and sociology. By using the structure of V-statistics, we develop a new estimation of stable index of the stable distribution. Furthermore, we also compare the proposed estimator with a simple and unbiased estimator proposed by Fan (Commun Stat-Theor Methods 35(2): 245–255, 2006). Our estimator is constructed by using the linear relation between U-statistics and V-statistics. In simulation study, we show that proposed estimator is more efficient than the existing estimator developed by Fan (Commun Stat-Theor Methods 35(2):245–255, 2006) in terms of the standard deviation, interquartile range, and mean square error of estimators.

Keywords Stable distributions • Stable index • Estimator • U-statistics • V-statistics

1 Introduction

Stable distributions are a class of probability distributions which have skewness and heavy tails (Rimmer and Nolan 2005). Stable distributions have a wide area of applications: probability theory, communications theory, physics, biology, astronomy, finance, economics, sociology, and so forth (Bolov 2005). The parameter estimation of stable distributions was first studied by Fama and Roll (1971). Press (1972) proposed several methods for estimating parameters of stable distributions. His methods are based on the sample characteristic functions and depend on

W. Panichkitkosolkul (✉)
Thammasat University, 99 Moo 18 Paholyothin Road, Klong Luang, Rangsit, Pathumthani 12120, Thailand
e-mail: wararit@mathstat.sci.tu.ac.th

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_2,

different choices of the arguments of the characteristic functions of the underlying stable distribution. The regression-type estimator was proposed by Kouttrouvelis (1980). Zolotarev (1986) established an estimator of the stable index α based on special transformations in the case of strictly stable distributions. McCulloch (1986) suggested using a quantile-based estimator. Ma and Nikias (1995) and Tsihrintzis and Nikias (1996) presented the estimators based on moment properties of stable random variables. In addition, Meerschaert and Scheffer (1998) constructed a robust estimator based on the weak convergence of the distributions of partial sums. Estimators based on the method of point process were introduced by Marohn (1999). Nolan (2001) proposed the maximum likelihood estimation for stable parameters.

Recent work by Fan (2006) proposed an estimator for the stable index by using the structure of U-statistics. His estimator is not only unbiased but is also consistent. Additionally, this estimator is simple and easy-to-compute. It is well known that V-statistics is a linear combination of U-statistics (see, for example, Lee 1990; Nomachi and Yamato 2001). Furthermore, in some cases, V-statistics has a mean square error (MSE) smaller than U-statistics (Shao 2003). The asymptotic normality of V-statistics is discussed in Chap. 6 of Serfling (1980). Therefore, we have developed a new estimator of stable index by extending the concepts of Fan (2006), by using the structure of V-statistics.

The paper is structured as follows. In Sect. 2, we describe stable distributions. The parameter estimations for the stable index are shown in Sect. 3. Section 4 presents the results of simulations. Conclusions are presented in the final section.

2 Stable Distributions

A nondegenerate distribution is a stable distribution if it satisfies the following property: Suppose X_1 and X_2 are independent copies of a random variable X. Then X is said to be stable if for any constants $a > 0$ and $b > 0$, the random variable $aX_1 + bX_2$ has the same distribution as $cX + d$ for the constants $c > 0$ and d. The distribution is said to be strictly stable if this holds with $d = 0$ (Nolan 2009). In general, a stable distribution does not have closed-form expressions for its density and distribution function. However, this distribution can be described easily by its characteristic function. A random variable X is said to have a stable distribution if the probability density has the following form:

$$f(x) = \frac{1}{2\pi}\int_{-\infty}^{\infty}\phi(t)\mathrm{e}^{-ixt}\mathrm{d}t, \tag{1}$$

where

$$\phi(t) = \begin{cases} \exp(i\mu t - \sigma^{\alpha}|t|^{\alpha}[1 - i\beta\,\mathrm{sgn}(t)\tan(\pi\alpha/2)]), & \text{if } \alpha \neq 1, \\ \exp(i\mu t - \sigma|t|[1 - i\beta\,\mathrm{sgn}(t)\frac{2}{\pi}\log|t|), & \text{if } \alpha = 1, \end{cases} \tag{2}$$

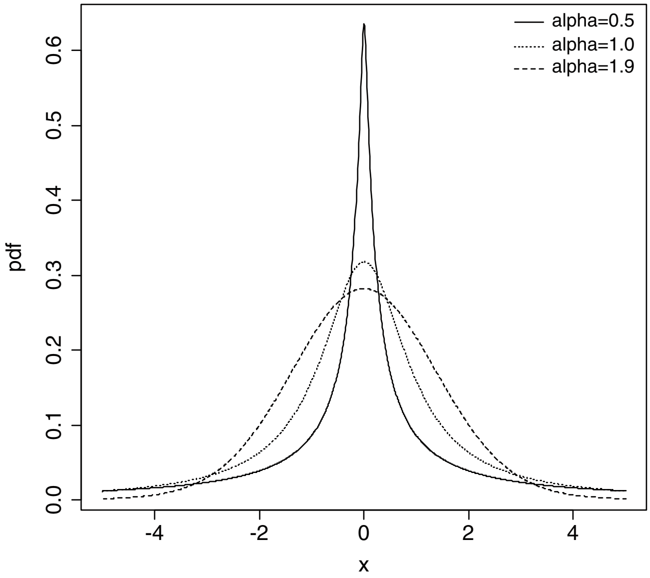


Fig. 1 Stable densities $S_\alpha(1,0,0)$, for $\alpha = 0.5, 1$, and 1.9

with $\alpha \in (0,2)$, $\beta \in [-1,1]$, $\sigma > 0$, $\mu \in R$, and $\operatorname{sgn}(t)$ is the sign function of t. Since Eq. (2) is characterized by four parameters, we will denote stable distributions by $S_\alpha(\sigma,\beta,\mu)$. The parameter α is referred to as the stable index or characteristic exponent of the stable distribution, σ is the scale parameter, β is the skewness parameter, and μ is the location parameter. There are three special cases of stable distribution which one can write down in closed form for the probability density function. First, the case where $\alpha = 2$ yields a normal distribution. Second, the case where $\alpha = 1$ and $\beta = 0$ yields a Cauchy distribution. The last special case is obtained for $\alpha = 1/2$ and $\beta = 1$. For this case, we have a Lévy distribution (Nolan 2009). Figure 1 displays the probability densities of stable distribution where $\sigma = 1$, $\beta = 0$, $\mu = 0$, and $\alpha = 0.5, 1, 1.9$.

When the parameter β is zero, the distribution is symmetric around μ. Stable distribution allows for skewed distributions when $\beta \neq 0$ and the distribution is fat-tailed (Rachev et al. 2005). Two conditions yield a strictly stable distribution: when (i) $\alpha \neq 1$, $\mu = 0$ and (ii) $\alpha = 1$, $\beta = 0$.

3 Parameter Estimations for the Stable Index

Fan (2006) proposed an unbiased estimator for the stable index α based on U-statistics first introduced by Hoeffding (1948). In what follows, we review this estimator which proposed by Fan (2006) and then we augment his estimator by using V-statistics.

Suppose $X_1,\ldots,X_n$ are independent and identically distributed (iid) random variables with strictly stable distribution. Based on the sum-preserving property of stable random variables [see Definition 2.2 in Fan (2006)], we have

$$X_1+X_2 \overset{d}{=} 2^{1/\alpha}\cdot X_1. \tag{3}$$

Further,

$$E[\log|X_1+X_2|]=\frac{1}{\alpha}\log 2+E[\log|X_1|],$$

that is,

$$\frac{1}{\alpha}=\frac{E[\log|X_1+X_2|]-E[\log|X_1|]}{\log 2}. \tag{4}$$

Let the kernel h be a real function given by

$$h(x_1,x_2)=\frac{\left(\log|x_1+x_2|-\frac{1}{2}(\log|x_1|+\log|x_2|)\right)}{\log 2}.$$

By using the kernel h, we define U-statistics (Lee 1990; Serfling 1980)

$$U_n(h)=\binom{n}{2}^{-1}\sum_{1\le i<j\le n}h(X_i,X_j). \tag{5}$$

Fan (2006) also has shown that $U_n(h)$ defined in Eq. (5) is an unbiased estimator of parameter α^{-1}. Consequently, the unbiased estimator for stable index α is $U_n^{-1}(h)$. The asymptotic normality of the estimator of α^{-1} was also discussed in Theorem 2.1 of Fan (2006). Compared with the estimator of Press (1972) via simulations, his estimator yields smaller MSE. Apart from U-statistics, there is a closely related V-statistics defined by

$$V_n(h)=\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n}h(X_i,X_j). \tag{6}$$

Although V-statistics is biased, the bias is small asymptotically. However, $V_n(h)$ may be better than $U_n(h)$ in terms of their MSE (Shao 2003). In case where the kernel h is not degenerate, V-statistics has asymptotic normality (Nomachi and Yamato 2001). Therefore, in this paper we will examine the efficiency of the estimator of α based on V-statistics via simulations. In addition, the formula given in Eq. (6) can be written as a linear combination of U-statistics (Shao 2003):

$$V_n(h)=n^2\binom{n}{2}^{-1}U_n(h)+\frac{1}{n}. \tag{7}$$

Hence,

$$V_n(h) = \frac{n-1}{n} U_n(h) + \frac{1}{n}. \tag{8}$$

The alternative estimator for stable index α is therefore $V_n^{-1}(h)$ defined in Eqs. (7) and (8).

4 Simulation Results

In this section, we present the simulation results in order to examine the efficiency of the estimators, $U_n^{-1}(h)$ and $V_n^{-1}(h)$, of the stable index α. Simulation experiments are conducted with a fix location parameter $\mu = 0$, the skewness parameter $\beta = 0$, the scale parameter $\sigma = 1$, and the stable parameter ranging from 0.1 to 1.9. All data were simulated by using R statistical software (Ihaka and Gentleman 1996). The number of simulation trials was set to 1,000 and the sample sizes simulated were 200 and 500. We used a function `rstable` from package Basics so as to generate samples from corresponding stable distributions. Simulation results which are shown in Tables 1 and 2 consist of mean, standard deviation, interquartile range (IQR), and MSE of the estimators. As can be seen from Table 1 and Fig. 2, the standard deviation and IQR of our estimator $V_n^{-1}(h)$ are smaller than those of the estimator $U_n^{-1}(h)$ when $\alpha \geq 0.5$ and the MSE of the estimator $V_n^{-1}(h)$ are smaller than that of the estimator $U_n^{-1}(h)$ when $\alpha \geq 0.6$. When $\alpha < 0.5$, the two estimators have very similar standard deviation, IQR, and MSE. These values decrease as sample sizes get larger. As it is seen from Fig. 2, the standard deviations, IQRs, and MSEs of estimators increase when the values of α increase. Additionally, the standard deviation, IQR, and MSE of the estimator $V_n^{-1}(h)$ are less than those of the estimator $U_n^{-1}(h)$ (about 0.01–1.6 %, 0.004–1.4 %, and 0.03–3.8 %, respectively). The simulation results for $n = 500$ shown in Table 2 are similar to those reported in Table 1. Our empirical evidence indicates that the estimator $V_n^{-1}(h)$ performs better than the estimator $U_n^{-1}(h)$ in terms of the standard deviation, IQR, and MSE for almost all scenarios that we considered.

5 Conclusions

In this paper, we propose a new estimator of stable index for the stable distribution based on the structure of V-statistics. The proposed estimator, $V_n^{-1}(h)$, and the existing estimator based on U-statistics, $U_n^{-1}(h)$, were compared through a simulation study. Simulation results show that the estimator $V_n^{-1}(h)$ is more efficient than the estimator $U_n^{-1}(h)$ in terms of standard deviation, IQR, and MSE in almost all situations. In addition, the comparative efficiency increases as α approaches 2.

Table 1 Mean, standard deviation, interquartile range (IQR), and mean square error (MSE) of the estimators, $U_n^{-1}(h)$ and $V_n^{-1}(h)$, for $\sigma = 1$, $\beta = 0$, $\mu = 0$, and $n = 200$.

	Mean		SD		IQR		MSE	
α	$U_n^{-1}(h)$	$V_n^{-1}(h)$	$U_n^{-1}(h)$	$V_n^{-1}(h)$	$U_n^{-1}(h)$	$V_n^{-1}(h)$	$U_n^{-1}(h)$	$V_n^{-1}(h)$
0.1	0.100579	0.101033	0.006443	0.006469	0.008651	0.008686	0.000042	0.000043
0.2	0.200636	0.201440	0.013469	0.013509	0.017845	0.017898	0.000182	0.000184
0.3	0.301656	0.302711	0.019636	0.019675	0.025692	0.025743	0.000388	0.000394
0.4	0.401909	0.403111	0.027904	0.027930	0.034395	0.034429	0.000781	0.000789
0.5	0.504032	0.505279	0.034494	0.034491	0.045016	0.045014	0.001205	0.001216
0.6	0.602492	0.603681	0.045540	0.045490	0.062675	0.062612	0.002078	0.002081
0.7	0.705608	0.706633	0.055668	0.055545	0.074115	0.073963	0.003127	0.003126
0.8	0.807845	0.808600	0.066230	0.066015	0.084690	0.084431	0.004444	0.004428
0.9	0.909207	0.909588	0.080426	0.080082	0.107821	0.107382	0.006547	0.006499
1.0	1.009948	1.009849	0.098945	0.098411	0.130921	0.130261	0.009879	0.009772
1.1	1.113674	1.112975	0.115950	0.115201	0.148961	0.148057	0.013618	0.013426
1.2	1.210653	1.209296	0.130080	0.129110	0.166483	0.165315	0.017017	0.016739
1.3	1.318187	1.315982	0.149491	0.148208	0.186852	0.185345	0.022656	0.022199
1.4	1.419255	1.416137	0.173567	0.171816	0.213939	0.212000	0.030466	0.029752
1.5	1.530400	1.526159	0.198003	0.195823	0.251425	0.248875	0.040090	0.038993
1.6	1.629719	1.624369	0.218095	0.215437	0.259941	0.257073	0.048401	0.046961
1.7	1.733057	1.726444	0.240818	0.237662	0.317627	0.313755	0.059028	0.057126
1.8	1.846848	1.838681	0.278300	0.274185	0.338095	0.333645	0.079568	0.076598
1.9	1.933576	1.924167	0.294562	0.289974	0.342784	0.337970	0.087807	0.084585

Table 2 Mean, standard deviation, IQR, and MSE of the estimators, $U_n^{-1}(h)$ and $V_n^{-1}(h)$, for $\sigma = 1$, $\beta = 0$, $\mu = 0$, and $n = 500$.

	Mean		SD		IQR		MSE	
α	$U_n^{-1}(h)$	$V_n^{-1}(h)$	$U_n^{-1}(h)$	$V_n^{-1}(h)$	$U_n^{-1}(h)$	$V_n^{-1}(h)$	$U_n^{-1}(h)$	$V_n^{-1}(h)$
0.1	0.100374	0.100555	0.004047	0.004054	0.005237	0.005245	0.000017	0.000017
0.2	0.200446	0.200767	0.008344	0.008354	0.011198	0.011212	0.000070	0.000070
0.3	0.300160	0.300580	0.012006	0.012015	0.016533	0.016546	0.000144	0.000145
0.4	0.401539	0.402020	0.017545	0.017552	0.023886	0.023896	0.000310	0.000312
0.5	0.501578	0.502077	0.021801	0.021801	0.028535	0.028535	0.000477	0.000479
0.6	0.601366	0.601844	0.028358	0.028347	0.039688	0.039672	0.000805	0.000806
0.7	0.702359	0.702775	0.035760	0.035730	0.050453	0.050412	0.001283	0.001283
0.8	0.803794	0.804106	0.041776	0.041724	0.053557	0.053492	0.001758	0.001756
0.9	0.899466	0.899642	0.050445	0.050363	0.071487	0.071373	0.002542	0.002534
1.0	1.003364	1.003350	0.061392	0.061266	0.078753	0.078595	0.003777	0.003761
1.1	1.107929	1.107679	0.070982	0.070806	0.095988	0.095755	0.005096	0.005067
1.2	1.208184	1.207668	0.082205	0.081968	0.116721	0.116392	0.006818	0.006771
1.3	1.306992	1.306174	0.089768	0.089473	0.125018	0.124616	0.008099	0.008036
1.4	1.411178	1.409996	0.104594	0.104205	0.142889	0.142372	0.011054	0.010948
1.5	1.512135	1.510560	0.117441	0.116956	0.158893	0.158252	0.013926	0.013777
1.6	1.614115	1.612097	0.137522	0.136892	0.183344	0.182535	0.019093	0.018867
1.7	1.717724	1.715219	0.145857	0.145132	0.197456	0.196501	0.021567	0.021274
1.8	1.807584	1.804616	0.164886	0.163993	0.213842	0.212733	0.027218	0.026888
1.9	1.918509	1.914928	0.178370	0.177328	0.233693	0.232380	0.032127	0.031637

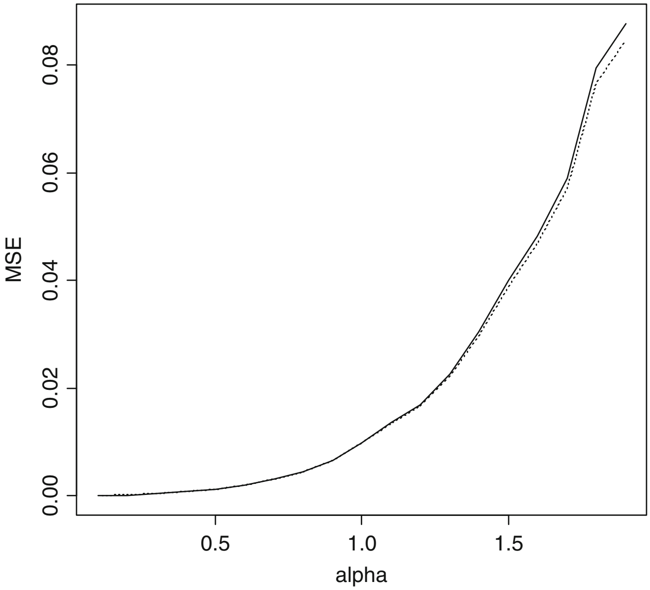


Fig. 2 The MSE of the estimators, $U_n^{-1}(h)$ and $V_n^{-1}(h)$, for $\sigma = 1$, $\beta = 0$, $\mu = 0$, and $n = 200$

Our estimator is not only very easy to compute, but also has asymptotic normality property.

Acknowledgements The author sincerely thanks anonymous referees for helpful comments and suggestions, leading to many improvements in the paper.

References

I.A. Bolov, On the computation of the probability density function of α-stable distributions. In: *Mathematical Modelling and Analysis Proceedings of the 10th International Conference MMA2005 and CMAM2*, Trakai, pp. 333–341, 2005

Z. Fan, Parameter estimation of stable distributions. Commun. Stat. Theor. Methods **35**, 245–255 (2006)

E.F. Fama, R. Roll, Parameter estimates for symmetric stable distribution. J. Am. Stat. Assoc. **66**, 331–338 (1971)

W. Hoeffding, A class of statistics with asymptotically normal distribution. Ann. Math. Stat. **19**, 293–325 (1948)

R. Ihaka, R. Gentleman, R: A language for data analysis and graphics. J. Comput. Graph. Stat. **5**, 299–314 (1996)

I.A. Kouttrouvelis, Regression-type estimation of the parameters of stable laws. J. Am. Stat. Assoc. **75**, 918–928 (1980)

A.J. Lee, *U-Statistics: Theory and Practice* (Marcel Dekker, New York, 1990)

F. Marohn, Estimating the index of a stable laws via the POT-method. Stat. Probab. Lett. **41**, 413–423 (1999)

J.H. McCulloch, Simple consistent estimators of stable distribution parameters. Commun. Stat-Simulat Comput **15**, 1109–1136 (1986)
X. Ma, C.L. Nikias, Parameter estimation and blind channel identification in impulsive signal environments. IEEE Trans. Signal Process **43**, 2884–2897 (1995)
M.M. Meerschaert, H. Scheffer, A simple robust estimation method for the thickness of heavy tails. J. Stat. Plann. Infer. **71**, 19–34 (1998)
J.P. Nolan, Maximum likelihood estimation of stable parameters. In: *Lévy Processes: Theory and Applications*, ed. by O.E. Barndorff-Nielsen, T. Mikosch, I. Resnick. (Birkhäuser, Boston, 2001). Accessed 3 Sep 2010
J.P. Nolan, Stable distributions: models for heavy tailed data (2009), http://academic2.american.edu/jpnolan/stable/chap1.pdf
T. Nomachi, H. Yamato, Asymptotic comparisons of U-statistics, V-statistics and limits of Bayes estimates by deficiencies. J. Jpn. Stat. Soc. **31**, 85–98 (2001)
S.J. Press, Estimation in univariate and multivariate stable distributions. J. Am. Stat. Assoc. **67**, 842–846 (1972)
R.H. Rimmer, J.P. Nolan, Stable distributions in Mathematica. Math. J. **9**, 776–789 (2005)
S.T. Rachev, C. Menn, F.J. Fabozzi, *Fat-Tailed and Skewed Asset Return Distributions: Implications for Risk Management, Portfolio Selection, and Option Pricing* (Wiely, New York, 2005)
R.J. Serfling, *Approximation Theorems of Mathematical and Statistics* (Wiely, New York, 1980)
J. Shao, *Mathematical Statistics* (Springer, New York, 2003)
G.A. Tsihrintzis, C.L. Nikias, Fast estimation of the parameters of alpha-stable impulsive interference. IEEE Trans. Signal Process **44**, 1492–1503 (1996)
V.M. Zolotarev, *One-dimensional Stable Distributions* (American Mathematical Society, Rhode Island, 1986)

Overcome the Sort Problem of Low Discrimination by Interval Fuzzy Number

Wentsung Lai and Berlin Wu

Abstract Purposes: to explore the sort problem if student scores discrimination was too low or the arithmetic average was equal. In advance to explore how to test nonparametric analysis by interval fuzzy scores. **Procedures:** empirical study samples had three groups which each had eight scores and arithmetic average was equal. **Methods:** to use the fuzzy theory application to create a new model to solve research purposes. **Results:** the defuzzification value of interval fuzzy scores could solve the problem of research purposes. The key technologies were the new Definition 2.1 of the interval fuzzy scores as (a, b). In advance to calculate three levels defuzzification sort analysis by Definition 2.2. **Therefore,** results could apply for the sort problem of the same scores or low discrimination. The key technologies could also solve the sort problem of application for admission when 12-year compulsory education is implemented in Taiwan.

Keywords Interval fuzzy number • 12-year compulsory education • Sort • Low discrimination

W. Lai
Department of Educational Policy and Administration, National Chi Nan University, No. 10, Alley 1, Lane 452, Shuiyuan Road, Dajia District, Taichung City 43742, Taiwan (R.O.C.)
e-mail: s100407904@mail1.ncnu.edu.tw

B. Wu (✉)
Department of Math Sciences, National Cheng Chi University, No. 64, Sec. 2, Zhinan Road, Wenshan District, Taipei City 116, Taiwan (R.O.C.)
e-mail: berlin@nccu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_3,

1 Introduction

Since the implementation of 12-year compulsory education in Taiwan, students have used sorted scores to apply for admission to further education. A comparison between students is difficult if the sort lacks discrimination. This study presents a comparison of sorted scores by using a novel Definition 2.1 of interval fuzzy scores to calculate a defuzzification value Harloff (2011). This effectively overcomes the problem of sorted-score comparison. Definition 2.1 was used to discriminate between student performances. Student interval fuzzy scores were defined as (a,b), where a and b are two different test scores for the same student and ab. Interval fuzzy scores were also transformed to defuzzification scores Harloff (2011). This strategy allowed the defuzzification value to compare the sorted scores and to compare sorted scores with the same mean. It also enabled nonparametric analysis of the defuzzification value. Thus, medians and variance between groups could be tested. The relevant literature is divided into three parts. The first is the development of fuzzy statistical theory. Zadeh's fuzzy theory explained several phenomena, and since its inception, the theory has been well developed. Recent research has developed many fuzzy theory statistical analysis methods and concepts (Wu and Lin 2002; Dubois et al. 2005; Sun and Wu 2007; Wang and Chen 2010; Hsu et al. 2009; Wu and Lin 2002; Dubois et al. 2005; Sun and Wu 2007; Wang and Chen 2010; Hsu et al. 2009). The second part of the literature consists of research on the interval fuzzy number. This research has enhanced the level and methods of fuzzy theory (Suleman and Suleman 2012; Liu et al. 2008; Harloff 2011; Yager et al. 2001; Fan 2010). The third part of the literature consists of research on sorting fuzzy numbers. This research has resulted in many proposed methods (Sengupta and Pal 2000; Lin and Chen 2004; Nguyen and Wu 2006; Lee and Lee 2001; Hung et al. 2011; Ravi et al. 2010; Chu and Lin 2009; Lin et al. 2006). This study proposes a novel model for comparing student scores using interval fuzzy scores that transform the defuzzification value to enable sorting. This study solves the problem of sorting equal averages. Therefore, this paper proposes a defuzzification method to discriminate between student scores when they have equal averages.

2 Novel Model

2.1 Interval Fuzzy Number

Definition 2.1 (of interval fuzzy scores). Definition 2.1 is the novel definition of the interval fuzzy scores. It is used for discrimination analysis of student scores. We defined student performance interval fuzzy scores as (a,b), where a and b are two different test scores for one student and ab.

Definition 2.2 (defines the defuzzification of interval fuzzy scores Harloff (2011)). Let $X = (a, b)$ be an interval fuzzy number; c is the range center; and $l = |b - a|$ is the whole distance. The defuzzification value of the interval fuzzy number is

$$x_f = c + 1 - \frac{ln(1 + |x|)}{|x|} \tag{1}$$

$$1 - \frac{ln(1 + |x|)}{|x|}. \tag{2}$$

Formula 2.2 is the defuzzification function of the interval length. If $a \to b$, then x_f approaches the range center value $a + b/2$.

2.2 Calculating the Domain of x_f Using Formula 2.1

The domain of x_f is calculated using Formula 2.1 because Formula 2.2 has a maximal value of 1 and a minimal value of 0. The domain is calculated using the following process: $\lim_{x\to 0} \frac{ln(1+|x|)}{|x|} = \lim_{x\to 0} \frac{D_x ln(1+|x|)}{D_x|x|} = \lim_{x\to 0} \frac{1}{1+|x|} = 1$

$$\lim_{x\to\infty} \frac{ln(1 + |x|)}{|x|} = \lim_{x\to\infty} \frac{D_x ln(1 + |x|)}{D_x|x|} = \lim_{x\to\infty} \frac{1}{1 + |x|} = 0.$$

Formula 2.2 has a minimal value of 0 and a maximal value of 1. Formula 2.1 has a minimal value of c and a maximal value of $c + 1$. If test scores are expressed as percentages, then their maximal value is min $(100, c + 1)$ and their minimal value is 0. The domain of x_f matches with educational requirements and habits.

2.3 Controlled Defuzzification Domain of Interval Fuzzy Scores within the Smallest Unit

If student scores are expressed as percentages, the maximal score is 100 and the minimal score is 0. Formula 2.1 was used to transform the defuzzification value of the interval fuzzy number because the defuzzification value of Formula 2.2 controls the domain from 0 to 1. Thus, sorting the defuzzification values is the same as sorting center value c.

3 Research Method

3.1 Study Flow Chart

Figure 1 is a flow chart of the steps followed by the study.

3.2 Software

MINITAB16.0 software was used to statistically analyze the questionnaire using nonparametric analysis. Nonparametric analysis was used because the sample was not normally distributed. Because sample 8 was small, nonparametric analysis was better suited to this situation (Harloff 2011; Sun and Wu 2007).

4 Empirical Study

Example 4.1. A 12-year compulsory education exists in Taiwan. Students apply for high school using their junior high school accounting math scores. Several students achieve the same math scores, which presents sorting problems.

4.1 Comparing Three Classes with the Same Means

For example, if there are three classes (1, 2, and 3) with first and second mean math scores of 75, how can we compare the three class scores? This study uses the novel model to compare the scores to produce an effective distribution analysis for the three classes. This solves the comparative difficulty of identical means. Tables 1–3 show the results for classes 1, 2, and 3, respectively.

4.2 Fuzzy Nonparametric Analysis

This section focuses on nonparametric analysis. The interval fuzzy number was transformed to the defuzzification value. A fuzzy Wilcoxon rank-sum test was conducted to compare class-medians. Tables 4–6 show these results. A fuzzy mood median test was conducted to compare variance between classes. These results are shown in Tables 7–9. A fuzzy Kruskal–Wallis test was conducted to calculate and compare variance among the three classes. Table 10 shows these results. Conducting a nonparametric fuzzy test produces three types of data. The first-type tests center

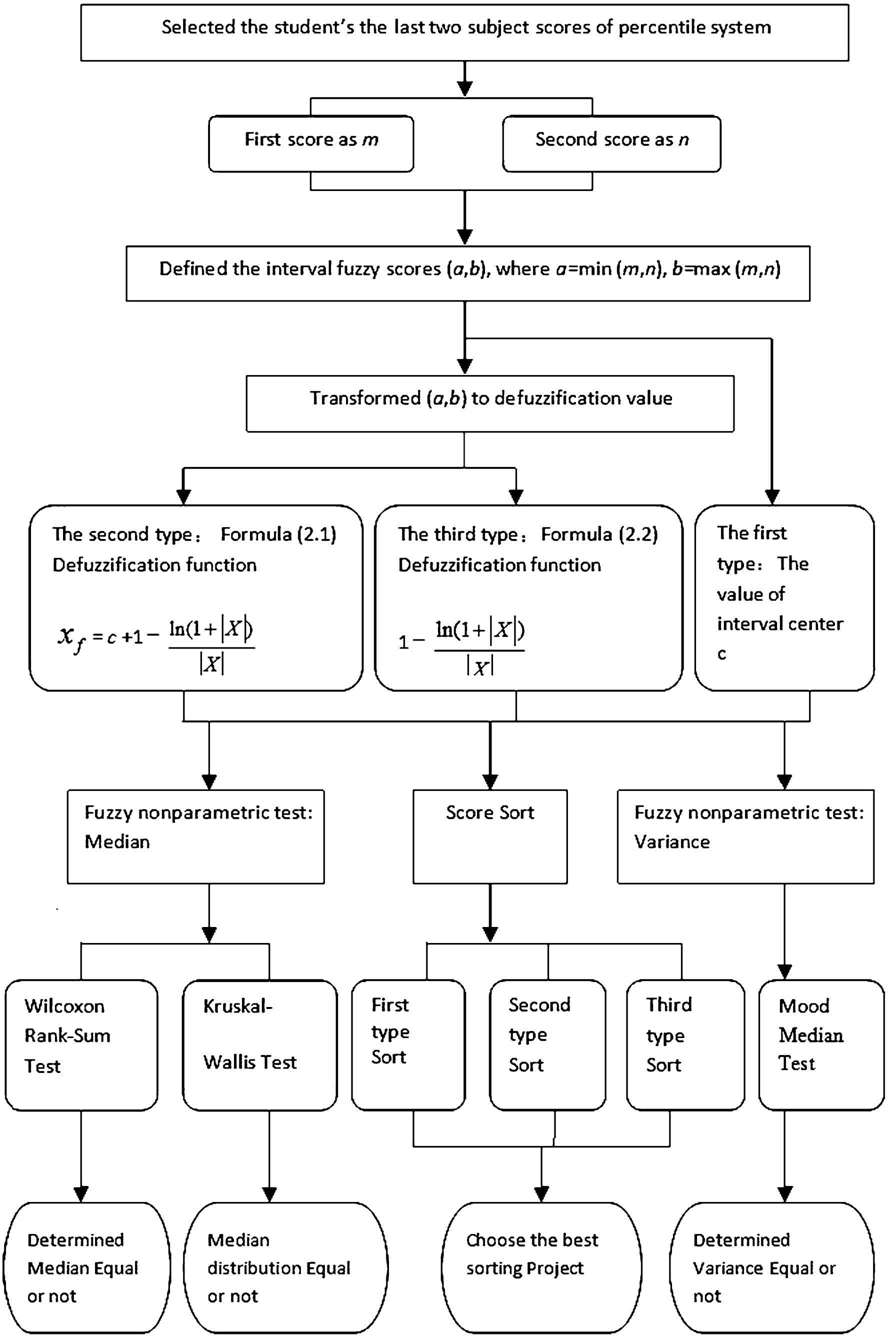


Fig. 1 Flow chart of the study process

Table 1 Class 1 (eight students)—mean math score of 75. Solving the sorting problem using defuzzification scores

Student code	First math score a	Second math score b	$\frac{a+b}{2}$	Sort by c	Interval fuzzy score (a,b)	Interval length $\lvert X\rvert$	Defuzzification scores x_f	Sort by x_f	$\lvert X\rvert$ Defuzzification
1	74	74	74	2	(74,74)	0	74.0000	8	0.0000
2	65	83	74	2	(65,83)	18	74.8364	7	0.8364
3	84	64	74	2	(64,84)	20	74.8478	6	0.8478
4	63	85	74	2	(63,85)	22	74.8575	5	0.8575
5	64	88	76	1	(64,88)	24	76.8659	4	0.8659
6	89	63	76	1	(63,89)	26	76.8732	3	0.8732
7	62	90	76	1	(62,90)	28	76.8797	2	0.8797
8	61	91	76	1	(61,91)	30	76.8855	1	0.8855

Table 2 Class 2 (eight students)—mean math score of 75. Solving the sorting problem using defuzzification scores

Student code	First math score a	Second math score b	$\frac{a+b}{2}$	Sort by c	Interval fuzzy score (a,b)	Interval length $\lvert X\rvert$	Defuzzification scores x_f	Sort by x_f	$\lvert X\rvert$ Defuzzification
1	79	77	78	1	(77,79)	2	78.4507	4	0.4507
2	76	80	78	1	(76,80)	4	78.5976	3	0.5976
3	75	81	78	1	(75,81)	6	78.6757	2	0.6757
4	82	74	78	1	(74,82)	8	78.7253	1	0.7253
5	67	77	72	2	(67,77)	10	72.7602	8	0.7602
6	66	78	72	2	(66,78)	12	72.7863	7	0.7863
7	79	65	72	2	(65,79)	14	72.8066	6	0.8066
8	64	80	72	2	(64,80)	16	72.8229	5	0.8229

Table 3 Class 3 (eight students)—mean math score of 75. Solving the sorting problem using defuzzification scores

Student code	First math score a	Second math score b	$\frac{a+b}{2}$	Sort by c	Interval fuzzy score (a,b)	Interval length $\lvert X\rvert$	Defuzzification scores x_f	Sort by x_f	$\lvert X\rvert$ Defuzzification
1	61	99	80	1	(61,99)	38	80.9036	1	0.903590
2	98	62	80	1	(62,98)	36	80.8997	2	0.899697
3	63	97	80	1	(63,97)	34	80.8954	3	0.895431
4	64	96	80	1	(64,96)	32	80.8907	4	0.890734
5	93	47	70	2	(47,93)	46	70.9163	5	0.916301
6	48	92	70	2	(48,92)	44	70.9135	6	0.913485
7	49	91	70	2	(49,91)	42	70.9104	7	0.910448
8	90	50	70	2	(50,90)	40	70.9072	8	0.907161

Table 4 Class 1 and Class 2—fuzzy Wilcoxon rank-sum test

Type	N	Median	Estimate	95.9 % CI	W	Significant	Adjusted
A :	8	75.000	0.000	(−3.998,3.998)	68.0	1.0000	1.0000
First type	8	75.000					
B :	8	75.862	−0.194	(−3.741,4.058)	68.0	1.0000	
Second type	8	75.637					
C :	8	0.8617	0.1025	(0.041,0.250)	92.0	0.0136	
Third type	8	0.7428					

Table 5 Class 2 and Class 3—fuzzy Wilcoxon rank-sum test

Type	N	Median	Estimate	95.9 % CI	W	Significant	Adjusted
A :	8	75.000	0.000	(−8.001,8.001)	68.0	1.0000	1.0000
First type	8	75.000					
B :	8	75.637	−0.161	(−8.080,7.545)	68.0	1.0000	
Second type	8	75.904					
C :	8	0.7428	−0.1607	(−0.306, −0.101)	36.0	0.0009	
Third type	8	0.9054					

Table 6 Class 1 and Class 3—fuzzy Wilcoxon rank-sum test

Type	N	Median	Estimate	95.9 % CI	W	Significant	Adjusted
A :	8	75.000	0.000	(−6.000,6.000)	68.0	1.0000	1.0000
First type	8	75.000					
B :	8	75.862	−0.461	(−6.044,5.956)	68.0	1.0000	
Second type	8	75.904					
C :	8	0.8617	−0.0430	(−0.069, −0.025)	36.0	0.0009	
Third type	8	0.9054					

Table 7 Class 1 and Class 2—fuzzy mood median test

	Type	Overall median	Chi-Square	DF	P
A	By the center value c of the fuzzy number	75.00	32.00	1	0.000
B	Used Formula 2.1 to defuzzification value	75.86	32.00	7	0.000
C	Used Formula 2.2 to defuzzification value	0.862	32.00	7	0.000

Table 8 Class 2 and Class 3—fuzzy mood median test

	Type	Overall median	Chi-Square	DF	P
A	By the center value c of the fuzzy number	75.00	32.00	1	0.000
B	Used Formula 2.1 to defuzzification value	75.64	32.00	7	0.000
C	Used Formula 2.2 to defuzzification value	0.743	32.00	7	0.000

Table 9 Class 1 and Class 3—fuzzy mood median test

	Type	Overall median	Chi-Square	*DF*	*P*
A	By the center value *c* of the fuzzy number	75.00	32.00	1	0.000
B	Used Formula 2.1 to defuzzification value	75.86	32.00	7	0.000
C	Used Formula 2.2 to defuzzification value	0.862	32.00	7	0.000

Table 10 Classes 1, 2, and 3—fuzzy Kruskal–Wallis test

	N	Median	Ave rank	*Z*	Overall all	Overall rank	*H*	*DF*	*P*
A	8	75.00	12.5	0.00	24	12.5	0.00	2	1.00
	8	75.00	12.5	0.00					
	8	75.00	12.5	0.00					
B	8	75.86	12.5	0.00	24	12.5	0.00	2	1.00
	8	75.64	12.5	0.00					
	8	75.90	12.5	0.00					
C	8	0.8617	11.5	−0.49	24	12.5	18.24	2	0.00
	8	0.7428	5.5	−3.43					
	8	0.9054	20.5	3.92					

value c of the fuzzy number and uses Formula 2.1 to transform the second-type test using the defuzzification value of the fuzzy number value. If the first- and second-type information is the same, Formula 2.2 must be used to calculate the third-type test using the defuzzification value of the interval length. By comparing the three types, subtle differences become apparent. Tables 4–10 show these results. The last row of the tables shows significant differences when comparing the third-type test.

4.3 Fuzzy Wilcoxon Rank-Sum Test

4.3.1 Class 1 and Class 2

Row A shows the first-type test using center value *c* of the fuzzy number; the results of median analysis do not show significant differences. Row B shows the results of using Formula 2.1 to calculate the second-type test using the defuzzification value of the fuzzy number value; the results of median analysis do not show significant differences. Row C shows the results of using Formula 2.2 to calculate the third-type test using the defuzzification value of the interval length; the results of median analysis showed significant differences. Table 4 shows these results.

4.3.2 Class 2 and Class 3

Row A shows that the results of median analysis were not significantly different. Row B shows that the results of median analysis were not significantly different. Row C shows that the results of median analysis were significantly different. Table 5 shows these results.

4.3.3 Class 1 and Class 3

Row A shows that the results of median analysis were not significantly different. Row B shows that the results of median analysis were not significantly different. Row C shows that the results of median analysis were significantly different. Table 6 shows these results.

4.4 Fuzzy Mood Median Test

4.4.1 Class 1 and Class 2

Row A shows the results of the first-type test of center value c of the fuzzy number; the results of variance analysis are significantly different. Row B shows the results of using Formula 2.1 to calculate the second-type test using the defuzzification value of the fuzzy number value; the results of variance analysis are significantly different. Row C shows the results of using Formula 2.2 to calculate the third-type test using the defuzzification value of the interval length; the results of variance analysis are significantly different. Table 7 shows these results.

4.4.2 Class 2 and Class 3

Row A shows that the results of variance analysis are significantly different. Row B shows that the results of variance analysis are significantly different. Row C shows that the results of variance analysis are significantly different. Table 8 shows these results.

4.4.3 Class 1 and Class 3

Row A shows that the results of variance analysis are significantly different. Row B shows that the results of variance analysis are significantly different. Row C shows that the results of variance analysis are significantly different. Table 9 shows these results.

4.5 Fuzzy Kruskal-Wallis Test

Row A shows the first-type test using center value c of the fuzzy number; the results of median analysis are not significantly different. Row B shows the results of using Formula 2.1 to calculate the second-type test using the defuzzification value of the fuzzy number value; the results of median analysis are not significantly different. Row C shows the results of using Formula 2.2 to calculate the third-type test using the defuzzification value of the interval length; the results of median analysis are significantly different. Table 10 shows these results.

5 Conclusions

This study solved two research problems. The first is the problem of sorting scores when discrimination is low or means are equal. The second is the problem of testing nonparametric analysis using interval fuzzy scores. The defuzzification value of the interval fuzzy scores solves these research problems. The novel interval fuzzy score definition, Definition 2.1, defines the interval fuzzy score as (a,b). Definition 2.2 is used to conduct three-type defuzzification-sorting analysis. Therefore, the results could solve the problem of sorting identical scores or scores with low discrimination. The results could also solve admission-sorting problems for 12-year compulsory education in Taiwan. The results could improve the efficiency of sorting student scores.

References

T.C. Chu, Y.C. Lin, Interval arithmetic based fuzzy TOPSIS mode. Expert Syst. Appl. **36**, 10870–10876 (2009)

D. Dubois, H. Fargier, J. Fortin, The empirical variance of a set of fuzzy intervals. *Proceedings of the International Conference on Fuzzy Systems*, Reno, Nevada, pp. 22–25. (IEEE Press, 2005), pp. 885–890

Z.P. Fan, An approach to solve group-decision-making problems with ordinal interval numbers. IEEE Trans. Syst. Man Cybern. B **40**(5), 1413–1423 (2010)

J. Harloff, Extracting cover sets from free fuzzy sorting data. Qual. Quan. **45**, 1445–1457 (2011). doi: 10.1007/s11135-011-9497-y

T.H. Hsu, T.N.Tsai, P.L.Chiang, Selection of the optimum promotion mix by integrating, a fuzzy linguistic decision model with genetic algorithms. Inform. Sci. **179**(1–2), 41–52 (2009)

N. Hung, K. Vladik, B. Wu, X. Gang, Computing statistics under interval and fuzzy uncertainty. *Studies in Computational Intelligence* (Springer, Berlin, 2011)

J. Lee, H. Lee, Comparison of fuzzy values on a continuous domain. Fuzzy Sets Syst. **118**, 419 (2001)

C.C. Lin, A.P. Chen, Fuzzy discriminate analysis with outlier detection by genetic algorithm. Comput. Oper. Res. **31**(6), 877 (2004)

Y. Lin, M. Yi, B. Wu, Fuzzy classification analysis of rules usage on probability reasoning test with multiple raw rule score. Educ. Tech. **2**, 54–59 (2006)

H. Liu, B. Wu, M. Liu, Investors preference order of fuzzy numbers. Comput. Math. Appl. **55**, 2623–2630 (2008)

H. Nguyen, B. Wu, *Fundamentals of Statistics with Fuzzy Data* (Springer, Heidelberg, 2006)

N. Ravi, V. Shankar, K. Sireesha, S. Rao, N. Vani, Fuzzy Critical Path method based on metric distance ranking of fuzzy numbers. Int. J. Math. Anal. **4**(20), 995–1006 (2010)

A.Sengupta, T.K. Pal, On comparing interval numbers. Eur. J. Oper. Res. **127**, 28 (2000)

A. Suleman, F. Suleman, Ranking by competence using a fuzzy approach. Qual. Quant. **46**, 323–339 (2012). doi: 10.1007/s11135-010-9357-1

M. Sun, B. Wu, New statistical approaches for fuzzy data. Int. J. Uncertain. Fuzz. Knowledge-based Syst. **15**(2), 89–106 (2007)

T.C. Wang, Y.H. Chen, Incomplete fuzzy Linguistic preference relations under uncertain environments. Inform. Fusion 11(2), 201–207 (2010)

B.L. Wu, Y.H. Lin, The introduction of fuzzy mode and its applications. Inform. Stat. Meas. **47**, 23–27 (2002)

R.R. Yager, M. Detyniecki, B. Bouchon-Meunier, A context-dependent method for ordering fuzzy numbers using probabilities. Inf. Sci. **138**, 237 (2001)

Beyond Mars and Venus: An Examination of Gender Differences in Academic Performance of High School Students

Mingchuan Hsieh

Abstract In the field of education, the existence of gender differences in verbal and math abilities is the essential research question and continues to be one of the most important issues. The present study examined the equivalence of the measurement structure for the male and female group using data from a statewide assessment program. The sample used was randomly drawn from the whole test population, consisting of 151,077 males and 196,074 females. Four different structured models were tested to examine innate gender differences in academic performance. The results of confirmatory factor analysis show that the difference in the factor structures across groups is quite large. Therefore, it is reasonable to conclude that the factor structure of the math and English ability is not invariant across the gender groups. Limitations and implications are presented at the end of this study.

Keywords Gender difference • Confirmatory factor analysis • Group invariance

1 Introduction

> Once upon a time, Martians and Venusians met, fell in love, and had happy relationships together because they respected and accepted their differences. Then they came to Earth and amnesia set in: they forgot they were from different planets
>
> From John Gray (2003)

Gray (2003) is an expert in investigating the differences between men and women the field of self-help psychology. Gray (2003) suggested that males and females can

M. Hsieh (✉)
National Academy for Educational Research, New Taipei City, Taiwan
e-mail: hm7523@hotmail.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_4,

respect each other and enhance their personal and professional relationships through understanding their differences in nature. Meanwhile in the field of education, the existence of gender differences in verbal and math abilities has been one of the most important issues, particularly when designing and validating high-stake standardized assessment programs. Anastasi (1958) in her classic text on differential psychology stated that females are superior to males in verbal and linguistic functions from infancy through adulthood, whereas males excel in mathematical ability over females from the elementary school years. Since then, gender differences in academic aptitude have been extensively studied, and the results have been mixed.

Of particular relevance to the present study is the meta-analysis by Stanley et al. (1987) which investigated the existence of gender differences on 82 nationally standardized tests in USA. Fairly large effect sizes (0.5–0.9) were found for aptitude tests and for advanced achievement tests such as GRE exams, which tend to corroborate the gender-based differential ability stereotypes initiated by Anastasi (1958). However, the effect sizes were smaller for the college admission tests such as the SAT test. The same conclusion has also been made by many researchers (Armstrong 1981; Clark and Grandy 1984; Fennema and Carpenter 1981).

Most studies of the comparative performance of males and females rely on descriptive statistics or statistical tests of mean differences in subtests. There are relatively few studies that have been done using factor analytic approaches to assess the equity of the two groups. The purpose of this study is to test the equivalence of the measurement structure for the male and female groups using statewide assessment data.

2 Method

2.1 Instrument

There are four major tests with multiple-choice items for the statewide assessment used in this study: English, mathematics, reading, and scientific reasoning. In order to simplify this project, only English and mathematics tests were considered. The high school GPA was also included in the analysis as the indication of students' general ability. The mathematics test is a 60-item multiple-choice test that is designed to measure students mathematical reasoning skills. Content areas for the mathematics test include algebra (pre-algebra, elementary, and intermediate algebra), geometry (coordinate and plane geometry), and trigonometry. The English test is a 75-item multiple-choice test that is designed to measure examinees general English ability. Content areas for the English test include mechanics (punctuation, grammar, and usage) and rhetorical skills (sentence structure, strategy, organization, and style).

The tests were designed for Grade 12 students. The sample used in this study was randomly drawn from the whole test population, and it consisted of 151,077 males and 196,074 females. Individuals who have missing scores on any content area subtests were deleted from this analysis.

2.2 Procedures

There were several steps performed across two phases to complete the study. First, exploratory factor analysis (EFA) was conducted using SAS to produce the correlation and covariance matrices for the response data, and the EFA was conducted as the preliminary analysis to ascertain a plausible number of factors and the factor loadings for each latent variable for males and females. Based on the rule of thumb, the number of eigenvalues greater than 1 was used as the reference to decide the number of factors in the dataset. EFA analysis suggested models of two or three latent variables as parsimonious explanations of gender variance.

Subsequent to EFA via SAS, confirmatory factor analysis (CFA) via LISREL 8 (Joreskog and Sorbom 1993) was used to examine the goodness of fit for the models. Four models were considered for CFA tests of fit based on the EFA results and suggestions from extant literature. The first model is a simple one-factor model suggested by Jensen (1998); he mentioned that tests of mental ability typically reflect a single factor, usually abbreviated as "g" for "general intelligence." This model was also suggested by Klein (1981) to use as a baseline to compare results. Model 2 was a two factor model, with one English factor indicated by all the subtests in the English test and one math factor indicated by all the subtests in the mathematics test. GPA was loaded onto both factors in this model. Model 3 was a three-factor model, similar to the second model, but with the GPA treated as a third factor since the scale for GPA is different from the scale of the test scores. Model 4 was also very similar to model 2, but GPA was treated as an exogenous variable instead of an endogenous variable (Fig. 1).

After choosing the model that fits best, a multi-sample LISREL analysis was carried out to test the factor pattern invariance of groups with regard to gender. The statistical analyses conducted were based on the suggestion from Joreskog and Sorbom (1993), which involved testing a sequence of hypotheses including testing the invariance of covariance matrices, invariance of factor patterns, and invariance of pattern coefficients. Follow-up studies would be implemented if there were any difference in factor structures between two groups.

In order to assess the model fit, both inferential chi-square test and descriptive goodness-of-fit indices were utilized. Because chi-square test is very sensitive to the sample size, the hypothesized model is likely to be rejected when the sample size is large, even if the discrepancies of the covariance matrix between the two samples are very small (Fan and Wang 1998). For this reason, other indices were also consulted, including goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (RMR).

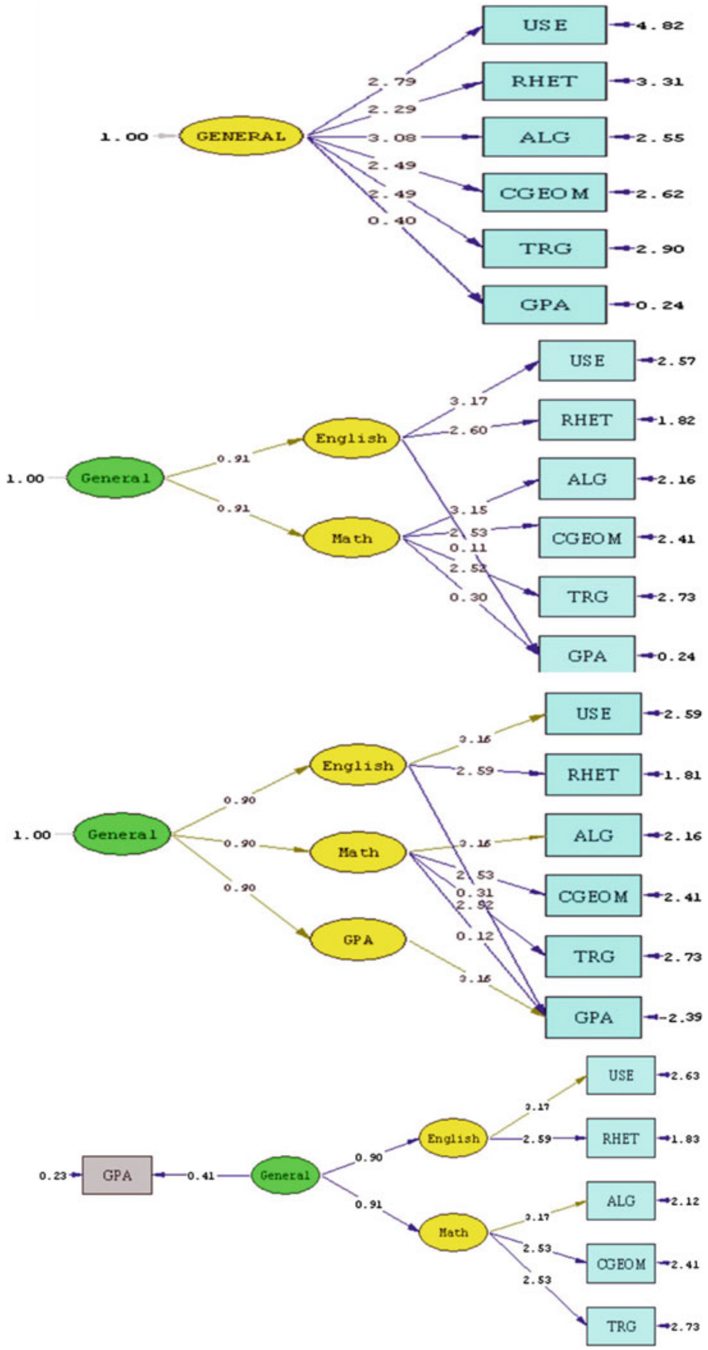


Fig. 1 Path diagrams of the four models USE-usage/mechanics, ALG-algebra CGEOM-intermediate algebra/coordinate geometry, TRG geometry/trigonometry, RHET-rhetorical skills, GPA-high school GPA

3 Results

The correlation matrices for males and females for each variable are presented in Tables 1 and 2, respectively. It can be seen that the variables exhibit moderate to high correlations with each other except for GPA (Tables 1 and 2). In addition, the typical English/math disparity between males and females is present with males scoring higher in the math content areas of algebra, geometry, and trigonometry, and females scoring higher in the English areas of grammar and rhetorical skills. Table 3 provides the effect sizes to examine the magnitude of differences between the gender groups. The results also show that females outperformed males in the English areas, and males outperformed females in the mathematics areas.

Because the multiple-group analysis in LISREL requires the use of covariance matrices, all the analyses in the following part were based on the covariance matrices instead of correlation matrices.

Table 1 Correlation, mean, and standard deviation of five subtests and GPA for males

	USE	RHET	ALG	CGEOM	TRG	GPA	Mean	SD
USE	1.000						10.088	3.554
RHET	0.792	1.000					10.539	2.927
ALG	0.655	0.662	1.000				11.357	3.473
CGEOM	0.616	0.611	0.771	1.000			10.670	2.966
TRG	0.697	0.606	0.756	0.717	1.000		10.950	3.014
GPA	0.501	0.494	0.555	0.527	0.514	1.000	3.148	0.631

USE—usage/mechanics, ALG—algebra
CGEOM—intermediate algebra/coordinate geometry, TRG—geometry/trigonometry
RHET—rhetorical skills, GPA—high school GPA

Table 2 Correlation, mean, and standard deviation of five subtests and GPA for females

	USE	RHET	ALG	CGEOM	TRG	GPA	Mean	SD
USE	1.000						10.689	3.562
RHET	0.798	1.000					10.795	2.931
ALG	0.661	0.659	1.000				10.749	3.245
CGEOM	0.591	0.587	0.732	1.000			10.175	2.759
TRG	0.594	0.593	0.721	0.667	1.000		10.157	2.932
GPA	0.513	0.507	0.550	0.510	0.501	1.000	3.297	0.570

Table 3 Correlation, mean, and standard deviation of five subtests and GPA for females

	English			Math		
	USE	RHET	ALG	CGEOM	TRG	GPA
ES*	0.17	0.09	−0.18	−0.17	−0.26	0.25

* Effect size = (female–male)/pooled standard deviation.

Table 4 Summary statistics of fit for four models

Model	x^2 (p value)	Std RMR	GFI	AGFI	NFI	
Model 1	4697.85 ($df = 9$)	0.045 (0.000)	0.903	0.773	0.923	0.190
Model 2	3697.4 ($df = 6$)	0.12 (0.000)	0.979	0.926	1.000	0.093
Model 3	2162.1 ($df = 8$)	0.041 (0.000)	0.996	0.992	0.977	0.0407
Model 4	1824.80 ($df = 8$)	0.012 (0.000)	0.997	0.992	0.971	0.0327

Table 5 Test of invariance for males and females

Hypothesis	x^2	Δx^2	P value	RMSEA	GFI	NFI
A:H_{Σ}	1502	0.000	0.05	0.90	0.95	
B:$H_{n=2}$	1896	394 0.000	0.23	0.75	0.84	

3.1 Model Fit

Table 4 shows the statistics for testing the fit of the four models. For each of the models, chi-square values were large, with the one-factor model being the largest. Because of the large sample size used in this analysis, all of the chi-square tests were highly significant. The descriptive indices show that in general, all models fit reasonably well. But it appears that models 3 and 4 provide better fit than the other two models. In order to improve the model fit, the modification indices were examined for each model. Unfortunately, most of the modification indices suggested do not make much sense from a substantive point of view, and some of the estimated values of the parameters cannot be easily interpreted. Even if some of the modification indices seem to make sense, there exists the identification problem given there are only six variables included in this study. Thus, no model refinement was made, and model 4 was chosen as the baseline model to do the group comparison.

3.2 Testing Invariance

Table 5 shows the results for the test of group invariance across genders. Although the chi-square statistic for testing the invariance of covariance matrices was significant, two of the descriptive model-fit indices, GFI and NFI, indicate that two

Table 6 Common metric completely standardized solution for model 4

	English		Math	
	Male	Female	Male	Female
USE	0.86	0.83		
RHET	0.91	0.95		
ALG			0.90	0.90
CGEOM			0.83	0.86
TRG			0.80	0.83

Table 7 Estimates of unique variance for males and females

	USE	RHET	ALG	CGEOM	TRG	GPA
Male	0.23	0.18	0.19	0.27	0.30	0.51
Female	0.19	0.21	0.21	0.32	0.34	0.61

Table 8 Covariance between math, reading, and general ability

	English		Math		General	
	Male	Female	Male	Female	Male	Female
Math	1.00	0.99				
English	0.82	0.78	1.00	0.99		
General	0.89	0.85	0.92	0.91	1.03	1.02

groups have similar covariance matrices. The test of hypothesis B shows that the invariance of factor patterns does not hold very well because RMSEA, GFI, and NFI show poor fit. There seems to exist some degree of difference for two groups in terms of factor structures. Estimates of pattern coefficients, unique variance, and the covariance of solutions standardized to a common metric were examined to ascertain the sources of differences. Table 6 shows the result of the standardized solutions for the factor pattern coefficients of males and females. After comparing these coefficients with males and females, it seems that the relationship between latent variables and their indicators was similar for the two groups.

Table 7 shows the estimates of unique variances for the two groups. The errors of measurement factors were larger for females than for males in all cases except for the English subtest of grammar/usage. Unique variances are high for GPA indicator for both groups; the possible reason could be that the scale for GPA is different from the other variables. Finally, the covariances between the latent variables were examined, and the results are shown in Table 8. This table shows that the factor variance and covariance are larger for the males than for females.

4 Discussion

This study examines the structural equivalence of a statewide test for males and females. The sample used for this study was randomly selected from all the examinees of a statewide test in 2004. Several analyses were performed which included the selection of best-fitting models as well as the examination of structural invariance for males and females.

The results of this study show that the two-factor model with GPA as an exogenous variable provides the best fit. It is because the scale for GPA is quite different from the scale score used in the statewide tests. Although treating GPA as a third variable might also be a possible solution, the fit indices suggest that treating GPA as an exogenous variable is the best way to describe the data.

Based on CFA tests of invariance of the factor structure across groups, the factor patterns were found to be not invariant across the gender groups. Because of limitations of the chi-square tests of model fit with large sample sizes, other descriptive model-fit indices were also utilized. Those descriptive indices suggested that the covariance for the two groups generally holds, but not for the factor patterns. Since the lack of invariance in the factor structures across groups is sufficiently large, it is reasonable to conclude that the factor structure of the math and English ability is not invariant across the gender groups.

There are several explanations that could explain the difference in factor structures of math and English ability for males and females. First, male and female students typically have different experiences that may be relevant to the development of math and English skills. Male students typically receive more and higher levels of mathematics instruction than females. And females are more often encouraged to take courses related to literature or reading (Femmema and Sherman 1977). In addition, the social and cultural assumption and stereotypes about the difference in male and female abilities could also be the cause of the differences in their interests and performance. The other possible reason could be the incorporation of GPA as an indicator that the scale for GPA being much smaller than the scale for other subtests could be problematic. In addition, the unique variances of GPA are quite large for both groups. This implies that the error variance of GPA could be very large. There are two limitations in this study. First, this study only considered six variables, and each factor only has two or three indicators. Given the large sample size, more variables should be incorporated to lessen the chances of the improper estimation of parameters (Anderson and Gerbing 1984). It would be desirable to add more academic subject areas and examine the equivalence of factor structure across genders further. Second, the methods used to estimate the free and constrained parameters in the model are only based on the maximum likelihood estimation (MLE) method. Other estimation methods, such as generalized least-square, and unweighted least square methods should also be examined as a comparison to test the consistency of the results estimated by MLE.

References

A. Anatasi, *Differential psychology: individual and group differences in behavior* (Macmillan, NY, 1958)

J. Anderson, D. Gerbing, The effects of sampling error on convergence, improper solutions and goodness of fit indices for maximum likelihood confirmatory factor analysis. Psychometrika **49**, 155–173 (1984)

J. Armstrong, Achievement and participation of women in mathematics: results of two national surveys. J. Res. Math. Educ. **12**, 356–372 (1981)

M. Clark, J. Grandy, *Sex Differences in the Academic Performance of Scholastic Aptitude Tests takers* (College Entrance Examination Board Report, pp. 8–84; ETS Research bulletin, pp. 43–84). (College Entrance Examination Board, New York, 1984)

X. Fan, L. Wang, Effect of potential confounding factors on fit indices and parameter estimates for true and misspecified SEM models. Educational and Psychological Measurement **58**, 699–733 (1988)

E. Femmema, J. Sherman, Sex-related differences in mathematics achievement, spatial visualization and affective factors. Am. Educ. Res. J. **14**, 51–71 (1977)

E. Fennema, T.P. Carpenter, Sex-related differences in mathematics: Results from national assesment. The Mathematics Teacher **74**, 554–559 (1981)

J. Gray, *Men Are From Mars, Women Are From Venus* (Harper Collins Publishers, NY, 2003)

L. Joreskog, K. Sorbom, *LISREL 8 User Reference Guide* (Scientific Software International Inc., Chicago, 1993)

A.R. Jensen, The g factor and the design of education. In R. J. Sternberg & W.M. Williams (Eds.), *Intelligence, instruction, and assessment: Theory into practice.* 111–131 (Mahwah, NJ: Lawrence Erlbaum, 1998)

A. Klein, Redundancy in the iowa testing of basic skills. Educ. Psychol. Meas. **41**, 537–544 (1981)

J.C. Stanley, L.E. Brody, S.L. Dauber, A.E. Lupkowski, C.P. Benbow, Sex difference in cognitive abilities and achivement. A Symposium presented at the annual meeting of the American Educational Research Association. Washington, D.C. (1987)

Evaluating Co-movements with the Total Value of Import and Export with Exchange Rate in Yunnan Province

Xinyu Yuan, Songsak Sriboonditta, Berlin Wu, and Jiechen Tang

Abstract The copulas provide a greater flexible method of constructing multivariate distributions. Our study will use dynamic copula-based GARCH models to evaluate the dependence structure between the monthly total value of import and export in Yunnan Province with exchange rates. We find that the Clayton copula exhibits greater economic benefits than other dynamic strategies. From the empirical studies, we can see a sharply decreased in 2005 (China deepening reform of RMB exchange rate) and 2009 (the World Financial Crisis) with the dependence structure in Gaussian copula, Student-*t* copula, and Clayton copula, respectively. The results showed that, the latest return information is a meaningful measure between the monthly total value of import and export with exchange rate in Yunnan Province.

Keywords The total value of import and export • Exchange Rate • Yunnan • Dynamic copula

1 Introduction

According to the statistical data from Department of Commerce of Yunnan Province and General Administration of Customs of the People's Republic of China, from 2001 to 2011, the international trade of Yunnan development was rapid. The total value of import and export rose from approximately $1.989 billion to approximately $16.5 billion. As a result of the worldwide influence of the American financial crisis,

X. Yuan (✉) • S. Sriboonditta • J. Tang
ChiangMai University, Suthep, A.Mueang, ChiangMai, 2397, Thailand
e-mail: ynandre@hotmail.com

B. Wu
Department of Mathematic, National ChengChi University, No. 64, Sec. 2, ZhiNan Rd., Wenshan District, Taipei City, Taiwan
e-mail: berlin@nccu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_5,

in 2008, the total value of import and export in Yunnan dropped to approximately \$9.599 billion; in 2009, financial crisis' influence further appears in this year, the import and export value of Yunnan approximately \$8.019 billion. In 2005, a new reform plan was announced by the People's Bank of China that would reform the exchange rate regime by moving into a managed floating exchange rate regime based on market supply and demand with reference to a basket of currencies. RMB would no longer be pegged to the US dollar.[1] With unceasingly economic developments of Yunnan Province, the Yunnan's Enterprises have great challenge, both the scope and depth, and participate in the international economy activities; to circumvent exchange rate, risk becomes inevitable.

The purpose of our study was to investigate the dependence structure between the total value of import and export with exchange rate. We attempted to use the dynamic copula-GARCH model to analyze the dynamic dependence structure between the total value of import and export with exchange rate based on monthly data. It focused on the application of the research finding to demand analysis in government policy-making.

The paper is organized as follows. Section 2 provides a literature review. Section 3 describes the econometrics models used in the paper Sect. 4 discusses date and empirical result. The last section provides some concluding remarks.

2 Literature Review

This paper uses the value of international trade between China and ASEAN countries to test the relationship of pricing to market and consequent local currency price stability. They find no evidence that RMB appreciation makes a larger impact on price adjustment than RMB depreciation. Feng (2007); the trade value between Yunnan Province and ASEAN is about the inverse proportion with the distance of each other. They also use the Trade Competitiveness Index to examine the value of trade between Yunnan and ASEAN products in the degree of comparative advantage. We also find that Yunnan and Guangxi Provinces within the region should increase cooperation and interaction TU (2010), Xu (2004), Ding and Pang (2005).

The Chinese monetary authority's capability controls the exchange rate of the RMB through reviewing of key features of Chinese currency exchange regime that not only allows the monetary authority to affect the exchange rate fluctuation by open market operations but also to influence the supply and demand in the foreign exchange market. The impacts of the real exchange rates between the RMB and the US dollar on the trade from the estimation of co-integrating vectors, 1% depreciation of the RMB, raise the Chinese exports to the USA by 1.7% Lu (2004), Baak (2008).

[1]Public Announcement of the People's Bank of China on Reforming the RMB Exchange Rate Regime (July 21, 2005).

3 Econometrics Models

In this paper, we used the dynamic copula-based GARCH models. The analysis of copulas has two advantages. First, copulas provide a greater flexible method of constructing multivariate distributions, given the marginal distributions and the dependence structures separately. We can connect k (such as the normal distribution, the marginal distribution of the lognormal distribution) through any copula function. Second, linear correlation and Granger causality analysis method are the commonly used correlation analysis method, but there are still many limitations, this kind of method can only analyze linear situation of correlated variables, linear correlation coefficient, and the corresponding elliptical distribution that can only describe the linear correlation degree between variables and symmetrical correlation model. When meeting the question which is nonlinear, it cannot get accurate results. We briefly review the basic properties of a bivariate copula ($K = 2$) below.

3.1 The Marginal Distribution of the Model and the Joint Distribution of Copula Model

The GARCH (1,1) model can be described as follows:

$$y_{i,t} = x_0 + x_1 y_{i,t-1} + x_2 e_{i,t-1} + e_{i,t} \tag{1}$$

$$e_{i,t} = \sqrt{p_{i,t}} k_{i,t}, k_{i,t} \sim SkT\left(k_i \middle| \eta_i, \lambda_i\right) \tag{2}$$

$$p_{i,t} = \omega_{i,t} + \alpha_i e^2{}_{i,t-1} + \beta_i p_{i,t-1} e_{i,t} \tag{3}$$

x_1 captures the impact of nonsynchronous effects. When model the GARCH, it needs to satisfy the condition is (1) $\omega_i > 0$; (2) $\alpha_i, \beta_i \geq 0$; (3) $\alpha + \beta_i < 1$. The error term of $e_{i,t}$ is assumed to be a skewed-t distribution, which can be used to capture the possible asymmetric and heavy-tailed characteristics. The Hansen density function (1994) is used in this research:

$$\text{skewed} - t\left(k \middle| \eta, \lambda\right) \begin{cases} qc\left(1 + \frac{1}{\eta-2}\left(\frac{qk+d}{1-\lambda}\right)^2\right)^{-(\eta+1)/2} & , k < -\frac{d}{q} \\ qc\left(1 + \frac{1}{\eta-2}\left(\frac{qk+d}{1+\lambda}\right)^2\right)^{-(\eta+1)/2} & , k \geq -\frac{d}{q} \end{cases} . \tag{4}$$

The value of d, q, and c are defined as

$$d \equiv 4\lambda d \frac{\eta - 2}{\eta - 1}, q^2 \equiv 1 + 2\lambda^2 - d^2 \text{ and } c \equiv \frac{\daleth(\eta + 1/2)}{\sqrt{\pi(\eta - 2)}\daleth(\eta/2)} \tag{5}$$

the asymmetry kurtosis parameters and the degrees-of-freedom parameter, respectively. λ is restricted within $(-1,1)$. When $\lambda < 0$ that skewed to the left. When $\lambda > 0$, it implies skewed to the right. η is restricted within $(2,+\infty)$. If $\lambda = 0$, it implies the skewed-t distribution will turn toward the Student-t distribution.

Here we employed two families of copula model to describe the dependence structure between the total value of import and export with exchange rate. Gaussian, Student-t, Gumbel, and Clayton copula were used to capture different dependence structure.[2] The advantage of Gaussian and Student-t copulas is that one can specify different levels of correlation between the marginals. In contrast to elliptical copulas, Archimedean copula can capture the right tail dependence and left tail dependence. These copula models are briefly discussed below.

The dynamic Gaussian copula is the density of the joint standard uniform variables (m_t, w_t), with a time-varying correlation, ρ_t. The density of the time-varying Gaussian copula is then

$$C_t^{\text{Gau}}(m_t, w_t|\rho_t) = \frac{1}{\sqrt{1-\rho_t}} \exp\left\{ \frac{2\rho_t x_t y_t - x_t^2 - y_t^2}{2(1-\rho_t^2)} + \frac{x_t^2 + y_t^2}{2} \right\}. \tag{6}$$

The density of the time-varying Student-t copula is

$$C_T^t(m_t, w_t|\rho_t, n) = \frac{1}{\sqrt{1-\rho_t}} \left\{ 1 + \frac{-2\rho_t x_t y_t + x_t^2 + y_t^2}{n\left(1-\rho_t^2\right)} \right\}^{-\frac{n+2}{2}}. \tag{7}$$

The density of the time-varying Gumbel copula is

$$C_t^{\text{Gum}}(m_t, w_t|\tau_t) = \frac{x^{\tau_t-1} y^{\tau_t-1}}{a_t b_t} \exp\left\{ -\left[x^{\tau_t-1} + y^{\tau_t-1}\right]^{\frac{1}{\tau_t}} \right\} \tag{8}$$

$$\left\{ -\left[x^{\tau_t-1} + (y)^{\tau_t-1}\right]^{\left(\frac{1-\tau_t}{\tau_t}\right)^2} + (\delta_t - 1)\left[(x)^{\tau_t-1} + (y)^{\tau_t-1}\right]^{\frac{1-2\tau_t}{\tau_t}} \right\}. \tag{9}$$

The density of the time-varying Clayton copula is

$$C_t^{\text{Glay}}(m_t, v_t|\tau_t) = (\tau_t + 1)\left(a_t^{-\tau_t} - b_t^{-\tau_t}\right)^{-\frac{2\tau_t+1}{\tau_t}} a_t^{-\tau_t-1} b_t^{-\tau_t-1}. \tag{10}$$

[2] Gaussian and Student-t copula belong to family of elliptical copula. And Gumbel and Clayton copula are Archimedeans copula.

3.2 The Time-Varying Copula for Dependence Parameters

We commonly use Pearson's correlation coefficient ρ_t to describe the dependence structure in the dynamic Gaussian copula and dynamic Student-t copula. On the other hand, we often use the Kendall's τ_t on the Gumbel and Clayton copulas. We assumed that the dependence parameters rely on past dependence and historical information $(m_{t-1}-0.5)(w_{t-1}-0.5)$. The dependence process of the Gaussian and Student-t are, therefore,

$$\rho_t = \Lambda\left(\alpha_c + \beta_c\rho_{t-1} + \gamma_c(m_{t-1}-0.5)(w_{t-1}-0.5)\right). \tag{11}$$

The dependence process of the Gumbel is

$$\tau_t = \Lambda\left(\alpha_c + \beta_c\tau_{t-1} + \gamma_c(m_{t-1}-0.5)(w_{t-1}-0.5)\right). \tag{12}$$

In the conditional dependence, we assumed that ρ_t and τ_t determined from its past level, $\rho_(t-1)$ and $\tau_(t-1)$. The parameter of β_c captures the persistent effect and γ_c can captures historical information. $\Lambda = -\ln[(1-x_t)/(1+x_t)]$, denotes the logistic transformation, which is used to ensure the dependence parameters fall within the interval $(-1,1)$.

While we change the historical information $(m_{0,t-1}-0.5)(w_{e,t-1}-0.5)$ to $\frac{1}{10}\sum_{i=1}^{10}|m_{t-1}-w_{t-1}|$, captures the variability of the dependence.

We proposed time-varying dependence processes for Clayton copula as

$$\tau_t = \Pi\left(\alpha_c + \beta_c\tau_{t-1} + \gamma_c\frac{1}{10}\sum_{i=1}^{10}|w_{t-1}-m_{t-1}|\right) \tag{13}$$

$\Pi = (1+e^{-x})^{-1}$ denotes the logistic transformation.

3.3 The Estimation and Calibration of the Copula

IFM method is used to estimate copula-based GARCH mode and get the parameters. The method function is

$$\hat{\theta}_{it} = \arg\max\sum_{t=1}^{T}\ln f_{it}\left(k_{i,t},\theta_{it}\right) \tag{14}$$

$$\hat{\theta}_{ct} = \arg\max\sum_{t=1}^{T}\ln C_{it}\left(F_{it}\left(k_{1,t}\right),\ldots,F_{\mathrm{nt}}\left(k_{n,t}\right),\theta_{ct},\hat{\theta}_{it}\right). \tag{15}$$

4 Date and Empirical Result

To explore the dependent structure between the total value of import and export with exchange rate. This paper will collect the monthly total value of import and export which comes from Department of Commerce of Yunnan Province and General Administration of Customs of the People's Republic of China (sample period from January 2001 to December 2011). The Chinese Yuan/US dollar monthly average exchange rates come from International Financial Statistics of the International Monetary Fund and Financial Statistics of the Federal Reserve Board (sample period from January 2001 to December 2011) and yielding a total of 132 observations. The monthly total value of import and export of Yunnan with exchange rate is plotted in Fig. 1, which exhibits a permanent deterministic pattern of the long-term upward trend, although sharply around the time of the global financial crisis (2008 and 2009).

Because the GARCH model was used to estimate the conditional correlation between the monthly total value of import and export with exchange rate. The data should be stationary. Thus, the first difference of the monthly total value of import and export with exchange rate was taken to make series stationary, $y_{\mathrm{IE},t}, y_{\mathrm{EX},t}$, as incremental rate between the monthly total value of import and export with exchange rate, respectively. The monthly total value of import and export with exchange rate incremental rates is plotted in Fig. 2, which show, that there is a conditional variance processes in the data. It implies that we selected GARCH model as appropriate for modeling the monthly total value of import and export with exchange rate.

The descriptive statistics for the incremental rate between the total value of import and export with exchange rate are reported in Table 1, which show that the standard deviation of $y_{\mathrm{IE},t}$ is higher than $y_{\mathrm{EX},t}$. The skewness statistics for the total value of import and export with exchange rate is negative; the null hypotheses of $y_{\mathrm{IE},t}$ and $y_{\mathrm{EX},t}$ are rejected at the 0.001% significance level, i.e., there is a significantly normal distribution. Kurtoses of the value of imports and exports and exchange rate are close to 3, and therefore, leptokurtosis and the Jarque and Bera statistics for exchange rate are much higher.

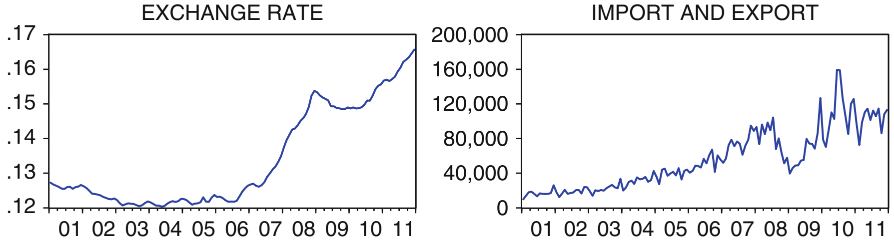


Fig. 1 The monthly total value of import and export in Yunnan with exchange rates

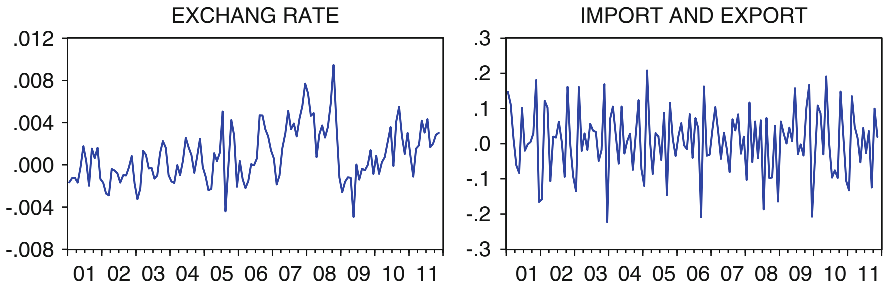


Fig. 2 The incremental rate for the monthly total value of import and export with exchange rate

Table 1 Summary statistics for the value of imports and exports and exchange rate

	Exchange rate	Import and export
Mean (%)	0.000875	0.008085
SD (%)	0.002530	0.091245
Skewness	0.571722	−0.199908
Excess Kurtosis	3.247830	2.762848
Max (%)	0.009450	0.208290
Min (%)	−0.004960	−0.223460
JB	7.471814	1.179514

Table 2 Tests of hypotheses of unit-root

	ADF		PP	
Variables	Level	Log of first difference	Level	Log of first difference
Exchange rate	−1.308496	−5.851011**	−1.308496	−5.857011**
Import and export	−5.466175**	−14.37424**	−5.466175**	−14.37424**

Note: The ADF, the log of first difference ADF, PP, and the log of first difference PP tests should be compared. The critical values for the rejection of the null hypothesis of a unit-root are −4.0295 and −3.444 for 1% and 5%, respectively. The log of first difference series is at the 1% significance level. The symbols ** and * denote rejection of the null hypothesis at the 1% and 5% significance levels, respectively.

The total value of import and export with exchange rate should be stationary for modeling the time series, thus testing for unit roots is essential for the time series analysis with multivariate GARCH models. ADF and PP test can perform the test for unit-root; Table 2 shows the results of strong support of the null hypothesis 8 of unit-root for the first difference of log-transformed.

Table 3 reports the maximum likelihood estimates of the GARCH model. The ARMA (1.0)–GARCH (1.1) specification is the best model for exchange rate, while export and import are appropriate of ARMA (1.1)–GARCH (1.1) All autoregressive coefficients β are highly significant. All the positive values of x_1 imply that it is positive related to the previous one. The result of the conditional variance equations is $\hat{\alpha} + \hat{\beta} = 0.993$, 0.999 for the monthly total value of import and export with exchange rates, respectively. As can be seen in the variance equation, the asymmetry parameters, λ_i, are significant and positive and skewed to the right.

Table 3 Result for GARCH model

	Exchange rate	Import and export
x_0	0.000964	0.006149**
	(0.000602)	(0.002701)
x_1	0.638161***	0.148361
	(0.070929)	(0.108222)
ω_i	0.000000	0.000018
	(0.000000)	(0.000194)
α_i	0.016463	0.000000
	(0.062142)	(0.009295)
β_i	0.977535***	0.999000***
	−0.060618	−0.028028
v_i	7.434065	5.255410
	(4.897542)	(2.789163)
λ_i	1.097979***	0.812306***
	(0.175906)	(0.094664)
x_2		−0.684393***
		(0.087467)

Note that ***, **, and * denote rejection of the null hypothesis at the 1%, 5%, and 10% significance levels, respectively.

Table 4 Result for dynamic Copula—GARCH

Exchange rate-import and export (Copula—GARCH)				
	Gaussian	Student-*t*	Gumbel	Clayton
α_c	0.33023*	0.12198	−0.01679	0.039829
	(0.15761)	(0.24149)		(0.126319)
β_c	−0.20774	−0.29527	0.99500	−0.321341
	(0.33605)	(0.28426)		(0.126319)
r_c	−0.76634*	4.79412**	−19.19543***	2.296919***
	(0.32399)	(1.85965)	(7.17238)	(0.848985)
n		26.7586***		
		(1.21385)		
Ln(L)	2.778109	3.603159	1.876237	3.843579
AIC	0.443781	0.7936814	2.247526	−1.687158

Note that ***, **, and * denote rejection of the null hypothesis at the 1%, 5%, and 10% significance levels, respectively.

Table 4 reports the parameter estimates for different copula function based on the GARCH model; four parts estimation are the Gaussian dependence structure, the Student-*t* dependence structure, the Gumbel dependence structure, and the Clayton dependence structure, respectively. In terms of the values of AIC, the Clayton dependence structure exhibits better explanatory ability than other dependence structures despite the marginal models employed, while the Gumbel copulas have worse explanatory ability. In Table 4, the autoregressive parameter β_c is negative and the latent parameter γ_c is significant and displaying that the latest return information is a meaningful measure between the monthly value of imports and exports with

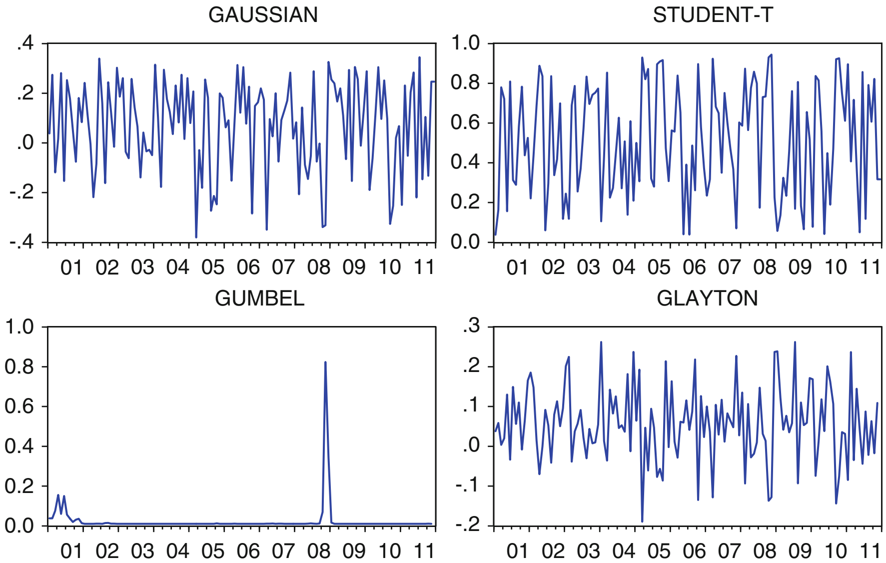


Fig. 3 Conditional dependence estimates between the monthly total value of import and export with exchange rate with four different copula function based on the GARCH model

Table 5 Goodness-of-fit tests for the copula model

	Guassian	Student-*t*	Gumbel	Clayton
Exchange rate and import and export	0.0824	0.1483	0.0585	0.2772

Note: We report the *p*-value from the goodness-of-fit tests. A *p*-value less than 0.05 indicates a rejection of the null hypothesis that the model is well specified

exchange rate. Specially, γ_c in the Student-*t* copula is much larger than others, which means it has a greater short-run response than other copula functions.

The dependence parameter estimates between the monthly total value of import and export with exchange rate, over the sample period generated from GARCH-copula model, are plotted in Fig. 3. We can observe that different copula generates different dependence structure. The Gumbel copula has worse explanatory ability. We can observe that the dependence structure in Gaussian copula, Student-*t* copula, and Clayton copula sharply decreased in 2005 and 2009, respectively. This may be due to China deepening reform of RMB exchange rate (2005) and the World Financial Crisis (2009).

We used Genest and Remillard (2009) method to compute the *P*-values. An estimation method was to be used to estimate the dependence parameter of maximum pseudo-likelihood. Table 5 presents the results of the bivariate goodness of Fit for the copula. These tests revealed that between exchange rate with import and export is hardly significant in the Gumbel copula at the 5% level, and more significant in the Clayton l copula at the 5% level.

5 Conclusions

The results showed that the latent parameter r_t is significant and displaying that the latest return information is a meaningful measure between the monthly total value of import and export in Yunnan Province with exchange rate. Specially, γ_c in the Student-*t* copula is much larger than others, which means it has a greater short-run response than other copula functions. We can observe that the dependence structure decreased in 2005 and 2009, respectively. This may be due to China reform of RMB exchange rate (2005) and the World Financial Crisis (2009). This relationship between the monthly total value of import and export with exchange rate has enabled to serve as useful tool for government policy-making.

In terms of the values of AIC, the Clayton dependence structure exhibits better explanatory ability for the monthly total value of import and export with exchange rate than other dependence structures, while the Gumbel copulas have worse explanatory ability. From the goodness of fit for the copula revealed that between exchange rate with the total value import and export are not significant in the Gumbel-copula at the 5% level, and more significant in the Clayton-copula at 5% the level.

References

S. Baak, The bilateral real exchange rates and trade between China and the US. China Econ. Rev. **19**, 117–127 (2008)

X.B. Feng, Chinese RMB exchange rate and local currency price stability in ASEAN trade. China Econ. Rev. **18**, 417–424 (2007)

D. Lu, China's capability to control its exchange rate. China Econ. Rev. **15**, 343–347 (2004)

K.S Ding and Y.Y Pang, The cooperative interaction of Yunnan and Guangxi of China - Asean free trade area. J. Yunnan Financ. Econ. Univ. **20**(16), 41–43 (2005) 1672-4755 06-0041-03

J.C. Reboredo, Modelling oil price and exchange rate co-movements. J. Policy Model. **34**, 419–440 (2012)

N.S. TU, Analysis on the Goods Trade between Yunnan and ASEAN Nations. Around Southeast Asia, pp. 27–30, 2010

C.C Wu, The economic value of co-movement between oil price and exchange rate using copula-based GARCH models. Energy Econ. **xxx**, 13 (2011)

Y.J. Xu, Comparative advantage and trade structure difference: A positive analysis of Yunnan and Asean five. Acad. Exploration **3**, 120–122 (2004)

K.F. You, A twelve-area model for the equilibrium Chinese Yuan/US dollar nominal exchange rate. Int. Fin. Markets, Inst. Money **22**, 151–170 (2012)

Alliance Capability, Innovative Activity and Evolution

Shenghua Zheng and Wenjing Yuan

Abstract Based on prior researches, we re-conceptualize alliance capability and re-evaluate it from two levels into three categories with nine dimensions. Then in order to examine the relations among alliance capability, network innovative activity, and evolution, we put forward the analysis framework concerning it. The results reveal that alliance capability facilitates the alliance network evolution mainly through the network innovative activity.

Keywords Alliance capability • Innovative activity • Evolution

1 Introduction

Based on prior researches, we re-conceptualize alliance capability and re-evaluate it from two levels into three categories with nine dimensions. We use structure and relation variables to explain alliance network evolution. Then in order to examine the relations among alliance capability, network innovative activity, and evolution, we put forward the analysis framework concerning it.

S. Zheng • W. Yuan (✉)
Zhejiang University of Technology, No. 288 Liuhe Street, Xihu District,
Hangzhou City, Zhejiang Province, P.R. China
e-mail: zheng0210@163.com; hzczywj@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_6, © Springer Science+Business Media New York 2014

2 Reviews and Connotation

2.1 Alliance Capability

In recent years, more and more network scholars pay close attention to a special capability which is embedded into the alliance network, network competence (Ritter and Gemünden 2003, 2004), strategic network capability (Hagedoorn et al. 2006), relational capability (Collins and Hitt 2006), as well as the alliance capability (Kale et al. 2002). Despite the different names, it is all about the capability of enterprises to manage the alliance successfully (Draulans et al. 2003) and also refers to the capability that enterprise actively adapts to the environment, so as to ensure the long-term performance. So here we define it as a kind of dynamic capability which can help the enterprise to recognize alliance value and opportunity, construct alliance network to facilitate its own development, use and maintain the level of network relationship in order to gather enough information and resources to help enterprises to obtain sustainable competitive advantage, and then promote the healthy and orderly development of alliance. We divide alliance capability into three aspects with nine dimensions according to professor Zheng et al. (2007) IDCV-based (integrated dynamic capability view) fundamental framework. Firstly, alliance strategic capability: (1) vision designing, (2) partner screening, and (3) strategic controlling. Secondly, alliance learning capability: (1) knowledge gathering, (2) absorbing and integrating, and (3) compositive innovation. Thirdly, relation bonding capability: (1) communicating, (2) relation optimizing, and (3) relation coordinating and controlling.

2.2 Innovative Activity

More than 85 % of innovative activity among alliances is related to technical innovation (Steensma et al. 2000). Therefore, in this paper, alliance innovative activity mainly refers to technical innovative activity conducted by the core companies, medium and small nodes as well as other institutions, who, integrating internal resources, capabilities as well as external cooperation, exchange to achieve network innovation. And in this paper it will be studied from two variables, innovative intention and innovative behaviours (Hurt et al. 1977). Innovative intention can be understood as innovation motivation and desire. And the enterprises' innovative behaviour is driven directly by the intrinsic requirement and motivation of innovation (Xu and Wang 2003).

2.3 Alliance Network Evolution

From biological evolution theory perspective, evolution is the change in the inherited traits of a population from one generation to the next (Wilson and Hynes 2009). From self-organization theory perspective, evolution is regarded as the outcome of the continuous "nets," which is a self-organizing process with the character of path-dependence. From social network theory perspective, alliance network evolution is driven by the initial conditions and the interaction among the members of the alliance; it is both progressive and path-dependent (Doz 1996). From evolutionary game theory perspective, alliance networks do not only come out from the motivation of sharing in network organizations but also from the attraction between each other. The evolution essentially is the redistribution of interests between the network organizations and a process that the members compete to reach the dynamic equilibrium (Ahuja 2000). In this paper, we define enterprise alliance network evolution as a series of irreversible changes in the consequence of interaction between enterprise and the environment. It's a process of structure-evolution and relation-evolution.

3 Interaction and Propositions

3.1 Interaction Between Alliance Strategic Capability and Innovative Activity

3.1.1 Vision Designing Capability and Innovative Activity

On one hand, it can stimulate enterprise's innovative intention by helping them find the gap between their knowledge reserve and the actual needs, thus arousing their motivation to learn; on the other hand, vision design capability would guarantee the implementation of innovative behaviour. First of all, it helps enterprises better perceive the innovation opportunities and activities which is embedded in alliance networks (Kristian et al. 2005) and discover the existing technology breakthrough. Furthermore, it provides useful knowledge and information for enterprise to innovate. With this capability, enterprise can seek and summon all the invisible innovation resources actively to achieve the goal of innovation.

3.1.2 Partner Screening Capability and Innovative Activity

Partner screening capability helps enterprises to find out the suitable partners for joint innovation. For example, selecting vision-shared, culture-similar partners can reduce the sense of distance and improve the knowledge transfer performance

(Bernard 1999, 2004) and hence stimulate innovation confidence and innovative intention: selecting complementary-resource partners can help enterprises use different thinking methods and obtain a variety of heterogeneous resources and innovative resource and then get more support for innovative behaviour and selecting innovative partners; it can help enterprise to learn the spirit of innovation, knowledge, and skills from partners, then greatly enhance their learning desire and innovative potential via the atmosphere of innovation and hence promote the innovative activities.

3.1.3 Strategic Controlling Capability and Innovative Activity

Through two aspects it affects the network innovative intention and innovative behaviour. Firstly, strategic controlling capability can cultivate the innovation atmosphere. It pays more attention to enterprise continuous improvement, not only setting a certain goal then indulge nothing, thus it provides a more suitable environment for their innovative activities. Secondly, strategic controlling capability can reduce the uncertainty and risk in the process of innovation. It makes timely adjustment to adapt to the changes of external environment and effectively reduce the poor execution, opportunism, and knowledge plagiarism risk, which can stimulate the innovative intention and behaviour. Proposition la: Alliance strategic capability has a positive effect on innovative activity.

3.2 Interaction Between Alliance Learning Capability and Innovative Activity

3.2.1 Knowledge Gathering Capability and Innovative Activity

On one hand, knowledge gathering capability partly decides the stock of enterprise's knowledge gathering. It can expand their knowledge boundary, make the enterprise to have more opportunity to contact, and obtain more extensive information, knowledge, and other tangible and intangible resources, and if the enterprise knowledge basement is more abundant, knowledge structure is more complete, information is more rich, then the enterprise is more conducive to avoid their own thinking "lock" effect and be more innovative. Therefore, the stronger the enterprise knowledge gathering capability is, the more it can stimulate the innovative intention of the enterprise and lead to more innovative behaviour. On the other hand, knowledge gathering capability partly decides the quality of enterprise' knowledge gathering. The current research generally believes that the quality of knowledge (the scope, timeliness, and effectiveness) determines the frequency and efficiency of innovative activities. Thus the stronger the enterprise knowledge gathering capability is, the more high-quality information can be obtained, and more information can be disseminated effectively, which can accelerate the tacit knowledge flow, and then promote the innovative behaviour of the enterprise.

3.2.2 Absorbing and Integrating Capability and Innovative Activity

Absorbing and integrating capability is considered to have been playing an important role in cultivating new knowledge (Lane and Lubarkin 1998), enterprise learning, and especially successful innovation. Through absorbing and integrating capability the enterprise transforms, spreads, applies, and integrates the tacit knowledge and ability of alliance into their own knowledge and skills timely and effectively and improve the innovation in speed, frequency, and intensity.

3.2.3 Compositive Innovation Capability and Innovative Activity

Without innovative capacity, innovation can just be a fantasy, only with the ability to innovate; innovation can be realistic. In alliance network, only possessing the capability of knowledge gathering and absorbing is far from enough; the enterprise may not be attractive to partners and technological innovation can never be achieved without certain comprehensive innovation capability. Generally speaking, with strong compositive innovation capability, enterprise can develop new products and new technology continuously, as well as expand the space for the development and urge enterprises to maintain a strong innovative intention. Furthermore, it cannot only attract more high-quality relations but also benefit from the technical level to conduct effective exchanges and communication. In addition, this interaction can increase the innovation confidence, reduce the innovation risk, and improve the success rate of innovative activities. Proposition lb: Alliance learning capability has a positive effect on innovative activity.

3.3 Interaction Between Relation Bonding Capability and Innovative Activity

3.3.1 Communicating Capability and Innovative Activity

Enterprise's communicating capability mainly influences the innovative intention and behaviour of corporate through three aspects. First, enterprises with high communicating capability can increase the frequency and intensity of effective communication with each other. And the more they communicate with others, the more skills and knowledge can be shared and transferred among the alliance, and the more rapidly can information and resources flow, which is more likely to stimulate enterprise's innovation intention and behaviour and then contribute to the technological innovative activity. Second, enterprises with high communicating capability can choose the best path and methods of communication. Entrepreneurs can be constructed through a variety of networks, such as the establishment of credit, access to market information, management consulting, and capital financing to obtain a wealth of valuable heterogeneity resources. Third, enterprises with high communicating capability can determine the appropriate alliance members as partners. In the process of cooperative innovation, due to the understanding of each other, they believe that the other party will participate in innovation initiative and overcome the problems positively, which would stimulate the enterprise innovative intention and promote to achieve more innovative activities with higher value and quality.

3.3.2 Relation Optimizing Capability and Innovative Activity

Instability of relationship would significantly weaken the output of enterprise innovation. Therefore, in the alliance network, as a capability of maintaining and improving partnership, enterprise's relation optimizing capability in the process of mutual cooperation to complete technical project can guide and standardize the network members' innovative behaviour, avoid the opportunism to reduce the innovation cost and risk, and stimulate their enthusiasm for innovation, which makes both sides not to be overly self-protective due to fear of other's speculation and be willing to strengthen their technical innovation input, and do more innovative practice.

3.3.3 Coordinating and Controlling Capability and Innovative Activity

Relation coordinating and controlling capability mainly has two great mechanisms, the mechanism of trust and the conflict resolution. From the perspective of trust mechanism, it is known to all that trust is the most important antecedent variables that has impact on inter-organizational knowledge communication (Kale et al. 2000). Trust can promote the transfer of tacit knowledge across organizational boundaries and the innovation of alliance members; on the contrary, through lack of trust, enterprise might be too concerned about the loss of their core technology and competitive advantage to overly protect themselves, which will finally inhibit innovation from happening in the alliance. From the other perspective of conflict resolution mechanism, we can predict that when the enterprise and its partner have conflicts, enterprises can have a better understanding of their partners, respect for them, and make corresponding adjustment and correction though the capability of relation coordinating and controlling, and eventually establish a conduct and norms with each other, which can be shared with each other and promote a joint innovation. Proposition lc: Relation bonding capability has a positive effect on innovative activity.

3.4 Interaction Between Alliance Capability and Innovative Activity

Since the three dimensions of alliance capability all have positive effect on innovative activity, we can propose that alliance capability has a positive effect on innovative activity. Proposition 1: Alliance capability has a positive effect on innovative activity.

3.5 Interaction Between Innovative Activity and Alliance Network Evolution

3.5.1 No Innovation No Breakthrough

So does the alliance network, only to maintain a certain degree of innovation, can alliance network be survived and keep moving. There are some reasons contributing to this point.

3.5.2 Innovative Activity and Alliance's Adaptability to the Environment

Since innovative activities though alliance will greatly strengthen the adaptability when alliance network facing the notable environment changes by enhancing the competitiveness and the flexibility of the whole alliance, it will determine the subsequent vitality of alliance.

3.5.3 Innovative Activity and Alliance Members' Survival and Development

It is known to all that technical innovation is connected with the enterprise survival, development, and competitiveness. It is the engine for organization innovation, is the important strategy to reduce the risk and cost, and is the effective way to get exterior knowledges and skills. Strong innovative intentions force enterprises to accelerate the pace of technological innovation, so that all members' competitiveness can be improved effectively and enhance the overall strength of the network.

3.5.4 Innovative Activity and Alliance Relationships Evolution

innovative activity will promote enterprise to try hard to strengthen its original coupling relationships with other members through more intimate and more frequent contact (Gao and Li 2006) with the process of innovative activities, cooperation behaviour among members becomes more standard, partnership comes to be closer, and complementary resource was used more effectively. Therefore, alliance members seek greater development through the complementary advantages and collaborative innovation, which not only further reduces the transaction cost and improves the trading efficiency, but also can be beneficial to the accumulation of social capital, which is conducive to the development of enterprises and evolution of alliance.

3.5.5 Innovative Activity and Alliance Structure Evolution

Gao and Li (2006) say that the network structure in part is the results of all members' technological innovative activities. Since innovative activities occurred, the former network structure will be unable to adapt to technological innovation and changes. On one hand, when innovation occurs inside the alliance, it will require members to consciously follow up which makes enterprise progress, by thus network numbers, types, and relations incline to be diverse; on the other hand, innovative activities have also promoted the alliance expansion. When the enterprise wants to gain innovation resources or, due to its reputation of absorption or, derive a new member of alliance, the network boundary and the scale of the network will expand; when innovation occurs, the network will continue to eliminate the nodes who fall behind others and lack the innovative intentions and behaviours in order to continuously enhance the efficiency of the network. Proposition 2: Innovative activity has a positive effect during the process of alliance network evolution.

4 Conclusion

Since alliance capability affects alliance members' innovative activity remarkably and which has a great effect on alliance network evolution in four aspects, we can conclude that alliance capability has a positive effect on alliance network evolution.

References

G. Ahuja, Collaboration networks, structural holes and innovation: A longitudinal study. Adm. Sci. Q. **45**(3), 425–457 (2000)

L.S. Bernard, Ambiguity and the process of knowledge transfer in strategic alliances. Strateg. Manage. J. **20**, 595–623 (1999)

L.S. Bernard, An empirical investigation of the process of knowledge transfer in international strategic alliances. J. Int. Bus. Studies **35**, 407–427 (2004)

D.J. Collins, A.M. Hitt, Leveraging tacit knowledge in alliances: The importance of using relational capabilities to build and leverage relational capital. J. Eng. Technol Manage. **23**, 147–167 (2006)

Y.L. Doz, The evolution of cooperation in strategic alliances: Initial conditions or learning processes. Strateg. Manage. J. **17**, 55–83 (1996)

J. Draulans, A.P.d Manand, H.W. Volberda, Building alliance capability: Management techniques for superior alliance performance. Long Range Plann. **36**, 151–166 (2003)

Z.J. Gao, Y. Li, Strategic networks and innovations: A structural embeddedness perspective. Studies Sci. Sci. **24**, 474–479 (2006)

J. Hagedoorn, N. Roijakkers, H.V. Kranenburg, Inter-firm R&D networks: The importance of strategic network capabilities for high-tech partnership formation. Br. J. Manage. **17**, 39–53 (2006)

T.H. Hurt, K. Joseph, C.D. Cook, Scales for the measurement of innovativeness. Hum. Commun. Res. **4**(1), 58C65 (1977)

P. Kale, H. Singh, H. Perlmutter, learning and protection of proprietary assets in strategic alliances: Building relational capital. Strateg. Manage. J. **21**(3), 217–237 (2000)

P. Kale, J.H. Dyer, H. Singh, Alliance capability, stock market response, and long-term alliance success: The role of the alliance function. Strateg. Manage. J. **23**, 747C767 (2002)

K.M. Kristian Müller, A. Rajala, S. Svahn, Strategic business nets – their type and management. J. Bus. Res. **58**, 1274–1284 (2005)

P.J. Lane, M. Lubarkin, Relative absorptive capacity and inter-organizational learning. Strateg. Manage. J. **19**(5), 461–478 (1998)

T. Ritter, H.G. Gemünden, Network competence: Its impact on innovation success and its antecedents. J. Bus. Res. **56**(9), 745–755 (2003)

T. Ritter, H.G. Gemünden, The impact of a company's business strategy on its technological competence, network competence and innovation success. J. Bus. Res. **57**(5), 548–556 (2004)

H. K. Steensma, L. Marino, K.M. Weaver, P.H. Dickson, The influence of national culture on the formation of technology alliances by entrepreneurial firms. Acad. Manage. J. **43**, 951–973 (2000)

J. Wilson, N. Hynes, Co-evolution of firms and strategic alliances: Theory and empirical evidence. Technol. Forecast. Soc. Change **76**(5), 620–628 (2009)

X. Xu, Z. Wang, The study on technological innovation's dynamic principle. Sci. Technol. Manage. **05**, 131–133 (2003)

S. Zheng, M. Rui, R. Chi, The fundamental framework of alliance capability and its mechanism of promoting. Alliance Perform. **06**, 122–128 (2007)

Information Technology and Communication in High Schools in Vietnam

Nguyen Loc and Vuong Thanh Huong

Abstract This paper mentions a very important field in which information technology is applied, that is, education. First, the treatise updates important concepts in information technology application that are idiosyncratic in education such as Internet-mediated teaching, website-based teaching, online education, computer-mediated communication, electronic learning, the virtual classroom, and the virtual school. Then the paper analyzes the importance of the teachers as well as the learners in the environment wherein information technology is applied, emphasizing the activeness and the participation of the learners in the new learning environment. Especially, this paper attempts to highlight the unconventional modes of learning, thanks to information technology application such as mobile learning and learning everywhere. The paper also points out nine dimensions of applying information technology that are globally ubiquitous and analyzes five common levels of information technology application in teaching and learning. Finally, the paper analyzes the status quo in applying information technology in Vietnamese schools. Predicated on this, the paper presents some initial evaluations on information technology application in Vietnamese schools from the perspective of the school, the teacher, and the student.

Keywords ICT • High school • Vietnam • Education • Integration

1 The Role of ICT Application in High Schools in Vietnam

Definition of information communication technology (ICT) in its broad meaning presently involves about 20 issues which are described as new technology applications in education such as Internet-mediated teaching, website-based teach-

N. Loc (✉) • V.T. Huong
Vietnam Institute of Educational Sciences, Hanoi, Vietnam
e-mail: dr.nguyenloc@gmail.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_7,

ing, online education, computer-mediated communication, electronic learning, the virtual classroom, the virtual school, communication environment, ICT, online communication via computer, open and distance learning (ODL), distance education, allocation of study support, blended learning, e-learning materials, hybrid courses, digital education, mobile learning, and technology-supported learning.

In fact, when computers were first introduced into schools in late 1970s, we would mention computers in education from the first PC to printer, soft disk, scanner, and digital camera. People started using the term "CNTT"—information technologies to describe the computers and different peripherals. Later, the Internet came up simultaneously with computer network, World Wide Web, email, and search engines. Renovation in education with ICT, the abbreviation of information and communication technologies, consists of many technologies which allow us to receive information, communicate or exchange information with other people (Anderson 2010).

Many scholars think that e-learning and distance education are inhomogeneous definitions. E-learning may include any kind of study using electronic means such as television, radio, CD-ROM, DVD, telephone, and the Internet. Moreover, e-learning is known as a new distinction used for diversifying learning objectives in traditional classes, replacing face-to-face meetings with online encounters. Distance education doesn't require venues, the place where students live and want to study. Distance education is construed as the method of transforming the knowledge rather than educational philosophy. Researches on distance education have been conducted and implemented by many countries since early 1980s, especially by open universities. French Minister of Education stated in a recent report: In this era of globalization, France is rather late compared with other Western countries in providing and approaching online courses or distance education. Right this time, when the ownership of ICT becomes a component of national competitiveness, this delay of ICT application in the digital era causes an obstacle in France's development in the coming years.

In the twenty-first century, people talk more about education for a digital world. Scholars and educational experts believe that digital education can neither devalue the role of schools and institutes nor replace the traditional education system which has always been the invaluable accumulated treasure of the human kind. Actually, it helps to support, perfect, and upgrade the knowledge in order to be a real property of a human. The role of both teachers and students is improved, thanks to the creativeness, communication and collaboration when using the communicative tools in the digital environment of the 2.0 Web version. The way of investing and spending money on developing digital education in each country is a current hot-debated studied matter. Experts believe that the more we approach to the intellectual economy, the more GDP index is related to the educational quality. Thanks to the ICT application, the roles of teachers and students have changed so much (Table 1).

The ICT application in education in the beginning of the twenty-first century is considered as the Third Revolution related to using ICT in receiving and distributing information Table 2.

Table 1 ICT Applications create changes in teachers' role

From		To
Teacher transfers the knowledge from the raw data and information to the students.	⟶	Teacher is the instructor and assistant of students in learning.
Teacher test and steer all aspects of the study.		Teacher gives more opportunities for students and increase their responsibilities in learning.

Source: Resta and Patru (2010)

Table 2 ICT Applications creates changes in learners' role

From		To
Passively receive the information from the teacher.	⟶	Actively participate in the learning process.
Consolidate the knowledge through learning activities.		Consolidate the knowledge through collaboration with other students.

Source: Resta and Patru (2010)

In the second decade of the twenty-first century, will people possibly enter the Fourth Revolution? This interesting question was raised by the Director of the UNESCO Asia-Pacific Regional Bureau in an International Conference held in China in 2009. The network and its services such as Google and email as well as a large number of new products like Wikipedia, Skype, Facebook, and Twitter are penetrating more deeply and comprehensively in the way we are living, learning, and working. With these new ICT applications in education, the study in some countries will be conducted outside traditional classes; hence, there will be some renovation in learning methods such as mobile learning and ubiquitous learning.

Researches on ICT applications in education in many countries at the present aiming at some aspects as followed:

- Email
- OpenCourseWare
- e-Library
- Training programs combined ICT applications and traditional methods in teaching and learning
- The effectiveness in ICT applications in teaching and learning
- ICT as an effective tool in science research
- Human resource and improving capability of ICT application in teaching and learning for staffs, teachers, and lecturers
- Building up online and multimedia resources
- Supporting ICT skills for both teachers and students
- Building up related professional training programs to support for the project of IT integration into practices of teaching and learning in all educational system from early childhood to higher education and postgraduate study (Anderson 2010).

2 Levels of ICT Application in Schools

ICT application in teaching and learning is diversified and various in different levels, depending on the awareness, computer skill of teachers and students, and IT facilities in schools:

- Level 1: Using information technology and communication to assist teachers with some tasks such as making lesson plans by office software (e-teaching plans), printing, collecting materials....
- Level 2: Application of information technology and communication in some session or a particular task in the whole teaching process, for example, using PowerPoint to present the lessons.
- Level 3: Using teaching software to organize a class teaching a chapter, some periods, or some topics of the subject. However, in order to apply ICT in teaching at this level, we need appropriate software compatible with the subject, grade, and well-equipped facilities (e.g., with enough computers, IT room, and specific classroom for different subjects).
- Level 4: Integrating ICT into teaching procedure. Elements of ICT are mentioned in all activities of organizing and managing the teaching procedure in the traditional school, including:
  - Teaching in class time
  - Organize extra time learning activities
  - Testing and assessments
  - Supervise the student learning activities at home
  - Assist professional activities of teachers and supplementary activities for the profession
- Level 5: Deploy intelligent school and e-learning. Intelligent schools are understood as schools with ICT support in training programs in order to reach the goal of personalize teaching and develop the student learning potentiality in the best way and train a human resource which can highly adapt to the information technology era (Dao Thai Lai et al. 2006; Thanh and Nguyen 2008).

3 The Reality of ICT Application in Schools in Vietnam

3.1 Legal Corridor

The Ministry of Education and Training issued the Instruction No. 29/2001/ BGD&?T on reinforcing teaching, training, and applying information technology in the 2001–2005 period. The project of teaching and applying information technology in high schools has been implemented since the end of 2004. All educational institutions have specific guidelines and policies to encourage the ICT application in teaching. In recent years, the Ministry has deployed such actions as:

- Establishing the Information Technology Bureau
- Instructions and directions of implementing Internet connection
- Issuing annual instructions of school years duty on IT application
- Issuing the Circular No. 07/2010/TT-BGD?T laying down regulations in organizing operation and using emails and websites of educational institutions

3.2 Implementing Online Application Systems

- Free email system with domains of the education sector towards the target that each lecturer, teacher, and student has his/her email address based on their educational institutions.
- Establishing education website system from the Ministry and national level to provincial/municipal level and schools, including websites of the Ministry: www.moet.gov.vnandwww.edu.net.vn
- The online manual of examination and enrollment at http://thi.moet.gov.vn. This is the database of all information about universities, colleges, and vocational high schools in Vietnam.
- The library of e-books at http://ebook.moet.gov.vn.
- The educational resource at www.edu.net.vn/media.
- E-learning website running on Moodle operation system.
- The e-lesson plan contest at http://thi-baigiang.moet.gov.vn.
- The legislative system of laws and regulations in education branch at http://vanban.moet.gov.vn.
- Staff, teachers, and educational institutions can search information about all documents related to education branch.
- The system of online meeting and lecture at http://hop.edu.net.vn.
- So far, more than 50 educational offices and 15 departments of education and training have been provided with virtual rooms.
- The system of public service administration at http://www.moet.gov.vn/?page=3.13.
- Many other online databases such as loan for study and list of trained staff.
- Explore the open source-code software in which the current website system of the education branch is designed.
- Begin to implement the website system for online management in schools.
- Having organized training workshops for more than 5,000 teachers in 34 cities and provinces.

In developed countries, the ideal rate is 7–8 students per computer. In Vietnam, this rate is divided into grades as 30 students per computer in primary schools, 25 students per computer in secondary level, and 20 students per computer in high schools. Most of the high schools have Internet connection for teaching and learning; however, the educational sources are still restricted and unequal.

According to statistics of the project of teaching and applying IT in high school education (2006), the rates of schools with computer equipped as followed:

- The number of schools without computer: 21%
- The number of schools with 1–10 computers: 35%
- The number of schools with 11–20 computers: 21%
- The number of schools with more than 20 computers: 23%

The result of the Research No. B2003-49-42TD on minimum equipped condition of facilities in high schools in Hanoi and Ho Chi Minh City shows that the average rate is 75 students per computer. This statistic stated that the situation of least equipped with information technology in high schools in Vietnam is still deficient. Therefore, they need to be invested more, particularly the schools in rural areas.

The teaching and learning software which are currently used are mainly Sketchpad, Cabri Geometry and Maple for mathematics, and Chemsketch and Crocodile for chemistry.

The Thesis No.B2003-49-42TD of the Vietnam Educational Science Institute has conducted a survey on 1,029 high school teachers; only 57 of them know about teaching software (not exceeding 6%). Among them, many people just know about teaching software but are not able to use them in teaching a particular lesson. Therefore, the rate of high school teachers with the ability of using teaching software is very low.

3.3 About the Information Technology Skills and Capacity of Applying ICT in Teaching of the Teachers

According to the statistics of the Ministry of Education and Training, in the school year 2004–2005, among the total number of high school teachers, there are:

- 2,000 teachers with IT diploma (university degree), occupied 1.8%
- 700 teachers with IT diploma (college degree), occupied 0.65%
- 160 teachers with IT diploma (intermediate level), occupied 0.15%
- 1,700 teachers with short-term IT training, occupied 1.59%

So, the total number of teachers with minimum short-term training and above on ICT is 4,560 people, occupied 4.27%.

The result of a survey on 374 teachers in high schools in Hanoi and Ho Chi Minh City conducted within Thesis No. B2003-49-42TD about the situation of ICT application in teaching and learning is shown as in the following table (Table 3).

A preliminary survey through statistics on the Internet about the reality of information technology and communication integration in high schools in Hanoi and Ho Chi Minh City shows that:

Table 3 The result of a survey within Thesis No. B2203-49-42TD about the situation of ICT application in teaching and learning

Total	Being provided with ICT	Be able to draw up documents	Be capable of using Power-Point	Be capable of using Excel	Be capable of using Internet	Know some teaching and learning softwares
100	256	324	190	176	128	24
Percentage (%)	68	86	51	47	34	6

(Source: Dao Thai Lai et al. 2006)

Quick survey done vis internet on ICT application of high schools in Hanoi showed that:

- 47/126 high schools have their own websites
- 12/126 high schools use their internal email system (Outlook)
- 18/126 high schools have online forums on their Websites so that teachers and students can exchange and interact about activities related to teaching and learning (Thanh and Nguyen 2008).

4 ICT Application in Some Subjects

4.1 ICT Application in Teaching History

4.1.1 Building Up an Interactive Multimedia

In teaching history, teachers need to build up an interactive multimedia such as interactive pictures, maps, diagrams, interactive models, documentary, video lectures, audio lectures, and digital databases. Database used by teachers are supported by specialized software.

With the need of word processor, slideshow, and data analysis, we can use MS Office software or Open office.com (free, open source); to deal with graphics, we use Adobe Photoshop (www.adobe.com) or GIMP (http://gimp.org); or for audio processor, the Audacity (http://audacity.sourceforge.net) may help. These are simple and suitable software, meeting the demand of designing, editing, and composing teaching plans of history in high schools.

Using MindMap Software

A mind map is a diagram used to visually outline some specific information in learning. Through mind maps, the overall of the matter is clearly presented, in which objects are linked together by lines. In this way, data are easy to remember quickly. Mind maps are applied in history teaching such as the teachers compose and show the lesson structure, main ideas, and developing ideas as branching diagrams and emphasized by suitable images and symbols. Then, students can improve their skills of taking notes, systematize their knowledge, and analyze, summarize, and give their personal judgments through mind maps.

Building Up e-Lectures

Collecting learning materials are designed with interactive multimedia and organized in data frame which can provide suitable knowledge and skills for learners. With e-lectures, students can self-study with the teachers' instructions. To compose a history e-lecture, the teacher can use the following useful and friendly software: http://exelearning.org, OpenOffice.org, PowerPoint, and Microsoft Office.

Many high school teachers in Hanoi assign homeworks, and students manage to make it with PowerPoint and present in front of the class. In this way, it helps to improve the knowledge-approaching method of students; one good example is the Chu Van An High School in Hanoi.

ICT Application in Testing and Assessment

In history teaching, there are many different kinds of testing and assessment, meanwhile these methods support each other to obtain the highest effectiveness. IT will provide some lessons of recognition and awareness of the history, history practice, and forms of testing as essay or synthesis. With specialized software, teachers can manage exam questions and let students interact in class or extracurriculum activities, or they can integrate directly into their e-lectures.

ICT application can bring some effects in teaching and learning as follows:

- Teachers have a chance to use tools such as written words, sound, static images, and animations to present historical events.
- Teachers have favorable conditions to compose lectures with maps, diagrams, forms, and events lookup tables which help students to practice scientific thinking skills, focus on fundamental and systematic knowledge, and generalize the lessons.
- Teachers have a chance to present about historical characters, combine the theory and practice as well as combine learning and testing the knowledge right at the end of the class.
- Teachers can link many various reference sources together so that the history class is not boring and rigid anymore.
- Students have a chance to collect historical documents from different sources and then make them into photo albums or historical videos for their personal or common reference.
- Teachers can add, edit, and update the teaching plan timely.

4.2 *ICT Application in Teaching Chemistry*

4.2.1 Situations of ICT Application in Teaching Chemistry

- Simulating the structures of chemical molecular and nuclear
- Simulating chemistry formulas
- Simulating reactions in chemistry
- Setting up virtual experiments

Using Chemistry Teaching Softwares

Presentation software is used with chemistry symbols displaying function. With Microsoft Word, we can use self-composing macro with additional fonts to display chemistry symbols, and nuclear formation or create space formation. Such calculating software as HyperChem, Mopac, and Gaussian for Windows help computerize experiment procedures and bring up following benefits:

- Lessening the time for observation, adopting, and analyzing results of experiments.
- Providing ideal environment for experiments. In reality, it is not easy to create chemical environment for experiments in appropriated with the theory, especially dangerous or long-lasting and complicated ones.
- Helping analyze statistics faster and be able to perform a series of calculating operation automatically, find out relationships, and draw diagrams.
- Helping the students conduct micro simulating experiments. This is an advantage of ICT applied in teaching chemistry, thanks to the computer which can perform experiments in molecular size. Therefore, it helps students understand clearly about characteristics of the physical objects at a microlevel.

4.3 *ICT Application in Teaching Biology*

Thanks to the ICT application, teachers can compose e-lectures including multimedia tools such as text, graphics, audio files, and video files. The application of ICT in teaching biology in high schools brings benefits to teachers and students as follows:

- Teachers can show students images and pictures of experiments samples, evolutions, and growth process conveniently and quickly.
- Teachers can use frames, tables, diagrams, and illustrative practical films to teach and test the knowledge of many students in each period as well as correcting mistakes in front of the class without wasting time.

- First, teachers can show students steps, procedures of the experiment, and operation; then students will follow the instructions.
- The biology lessons become more lively and interesting for students.

For the students side:

- They can practice skills, absorbing the knowledge deeper, easy to remember with long memory.
- The students concentration is improved, and students participate more actively in their study in class.

4.4 ICT Application in Teaching Physics

4.4.1 Simulating Research Objects in Physics

Many processes and physical phenomena are difficult to observe with normal eyes such as falling movements, horizontal throwing motion, and radiation. The use of computer in supporting for researching these phenomena brings high efficiency such as the software of objects composition model, wave simulation, the phenomenon of electromagnetic induction, and the simulation of basic optical phenomena.

4.4.2 Using Computer Connected with Measuring Equipments to Support for Students Doing Research on Physical Experiments

The software used for analyzing digital signals are Videopoint, Cuple, Galileo, and Diva. In physics, there are some procedures which happen so fast or in a vast space and difficult to observe in the field; they can record the real physical process in videotapes and decrease the speed, giving a chance to observe the research objects.

5 Conclusion

5.1 For the High schools' Side

The main applications are to build up website, internal email system, information exchange forums, and e-contact list (please see the Appendix). With these applications, the information is exchanged and updated continuously about educational issues and training programs; the communication between parents and the school is precise in details. Therefore, the connection between the school and family will be improved whereas the management of students information becomes easier. By using these applications, the image of a modern and professional education institution has been improved, boosting the modernization and computerization in schools.

5.2 For the Teachers' Side

The main applications are composing the lecture, using software in teaching subjects, searching for information and documents, exploring the Internet, using emails in exchanging knowledge, and teaching experiences. These applications, especially the teaching software, are very meaningful and important because they support effectively for the teaching and learning environment, increasing the effectiveness of using computer (hardware system) in high schools. A good application software in teaching must meet the requirements of technical quality, the possibility, and effectiveness. It is a pity that we do not have many researches on the quality of the application in teaching of current software in high schools in Vietnam.

5.3 For the Students' Side

The main applications include searching for documents and pictures on the Internet, exchanging lessons, and making references from other friends via emails, messages, and forums on the schools' website. Some students can build up their personal blogs on the Internet to promote and share information. However, the application of IT and communication of students is still fragmented and spontaneous and unorganized, so it is difficult to assess its effectiveness in improving the learning quality of students in a particular way.

References

J. Anderson, ICT transforming education, Published by Asia and Pacific Regional Bureau for Education, UNESCO Bangkok (2010)

Dao Thai Lai and his research team, IT application in teaching and learning in Vietnamese schools, B2003-49-42TD, The Vietnam Institute of Educational Sciences (2006)

Ministry of education and training, Final report on the connecting educational network (2010), http://edu.net.vn. Accessed 18 Dec 2010

L. Nguyen, V.K. Phan (chief editor), The educational sciences of Vietnam from the Renovation to the present. The Vietnam National University Ha Noi Publisher, Ha Noi (2012)

P. Resta, M. Patru (eds.), Teacher development in an E-learning age: A policy and planning guide. Paris, UNESCO (2010)

V.H. Thanh, H.T. Nguyen, Report on the research of typical example of the ICT application in secondary schools (in 12 schools in 6 cities/provinces), The second project of educational development for secondary schools (2008)

Analytical Evaluation of Learning Experiences on Problem-Solving Efficacy of Vietnamese College Students

Minh-Quang Duong

Abstract This study was conducted to explore how learning experiences affect problem-solving efficacy of Vietnamese college students. The study used a questionnaire survey with 430 students' technical and scientific areas from three member universities at Vietnam National University of Ho Chi Minh City. Results of this study indicated that Vietnamese college students' problem-solving efficacy was within the range of "average" to "high" response. Various college learning experiences of teaching approach, and learning engagement influenced as significant factors affecting students' problem-solving efficacy.

Keywords Learning experiences • Problem-solving efficacy • Vietnamese college students

1 Introduction

Higher education in Vietnam has greatly expanded in the past two decades. It has gradually improved in terms of size, types of institutions, and forms of training, meeting the demand of the socioeconomic development. However, higher education is facing big challenges: government loses authority controlling higher education institutions and does not facilitate or promote the improvement of training quality of the whole system. According to Thomas and Ben (2008), Vietnamese students and international investors cite the lack of skilled workers and managers as a major barrier to expansion. The proportion of Vietnamese students who acquired other skills is very low, mostly under 30% (Luong 2010).

M.-Q. Duong (✉)
University of Social Sciences and Humanities, Vietnam National University of Ho Chi Minh City, No 10–12, Dinh Tien Hoang Stress, District 1, Ho Chi Minh City, Vietnam
e-mail: flowerfour84_dl@yahoo.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_8,

The literature encouraged that the development of problem-solving efficacy is necessary for career success (Gustin 2001; Zekeri 2004). Problem-solving is such an important efficacy that it focuses on its students becoming effective problem-solvers by applying logical, critical, and creative thinking to a range of problems (Wilson 1993). Problem-solving can provide the site for learning new concepts and for practicing learned skills (Kilpatrick et al. 2001). The development of problem-solving efficacy is therefore an important mission for faculty to develop for their students (Pajares and Kranzler 1995). Sirin and Gzel (2006) showed that it was found that problem-solving efficacy had a positive relationship with reflective observation learning style and a negative relationship with abstract conceptualization learning style. Little and Hefferan (2000) provided clear strategies on how to develop students' development of legal problem-solving efficacy. Effective problem-solving efficacy is best learned in an environment in which the student is free to test thinking skills, explore alternatives, and discover solutions that may or may not match the instructors solution (May and Newman 1980).

Research recognizes that students who frequently practice active learning perceive themselves gaining knowledge and skills from their college education and view their college experiences as rewarding (Braxton et al. 2000). Although college students acquire knowledge and skills primarily through curriculum, learning contributes to college student outcomes (Wu 2012). Breiter, Clements, and Pavesic emphasized the importance of problem-solving efficacy as the key focus of future curriculum (Breiter and Clements 1996; Pavesic 1991), and it is considered as the heart of learning (Schommer-Aikins et al. 2005). As a sequence of learning opportunities, curriculum has several aspects and indications such as plans and intentions, patterns of classroom activities, and textbooks (Schmidt et al. 2001). College recognizes the importance of creating safe and open classroom environments to foster students' learning and development. The curriculum can contribute to valued outcomes of college students (Bowen 1977; Chickering and Riesser 1993). According to Braskamp et al. (2006), curriculum is a fundamental component of a college commitment to holistic student development and what and how students learn which are interdependent. Problem-solving efficacy has become the means to rejoin content and application in a learning environment for basic skills and their application in various contexts. Today, there is a strong movement in education to incorporate problem-solving as a key component of the curriculum (Krikley 2003).

In general, learning experience is a sequence of learning opportunities provided to students in their study and contributes to the development of students' competence. Unfortunately, there is a lack of the literature on college students' problem-solving competence and curriculum learning in Vietnam. Thus, the primary purpose of the present study was to explore how learning experiences affect problem-solving efficacy of Vietnamese college students. In view of the aforesaid points, this study seeks to address the following questions:

1. Do students' technical and scientific areas differ in their problem-solving efficacy? How?

2. How are the students' problem-solving efficacies in technical and scientific areas affected by their college learning experiences?

2 Method

2.1 Sample and Instrument

This study was selected through a random sample from three member universities at Vietnam National University of Ho Chi Minh City (VNU-HCM) including the University of Technology, the University of Science, and the University of Information Technology. According to Thompson's definition, with single random sampling, setting is as follows:

$$n = \frac{1}{\frac{d^2}{z^2\sigma^2} + \frac{1}{N}} = \frac{1}{\frac{1}{n_0} + \frac{1}{N}}. \tag{1}$$

The total population within three universities was 29,326 third-year students (VNU-HCM 2009). Thompson (1987) showed that where α = 0.10, n_0 with d = 0.10 was 403. Thus, this study used formula (1) to compute proper sample size of 398 students. However, to enhance the validity and reliability, this study planned use a sample of 430 third-year students, exceeding Thompson's requirement.

This study uses questionnaire survey to gather data. The survey is the most widely used data gathering in the social sciences (Neuman 2006). The independent variables in this study included three variable blocks: student backgrounds, teaching approach, and learning engagement. The problem-solving efficacy-dependent variable was constructed from four characteristics: (1) data analysis efficacy, (2) critical thinking efficacy, (3) presenting solution efficacy, and (4) generating innovation efficacy. Factor analysis revealed that all four competences had factor loading (0.690 C 0.856) greater than threshold level of 0.6 and Cronbach's coefficient of 0.798, which is significantly higher than the 0.6 principal guideline and indicating satisfactory reliability for this student competence measurement (Hair et al. 2006).

2.2 Data Analysis Method

Descriptive analysis and analysis of variance (ANOVA) were used to answer the first research question of "Do students' technical and scientific areas differ in their problem-solving efficacy? How?" and the multiple regression method was used to answer the second research question of "How are the students' problem-solving efficacies in technical and scientific areas affected by their college learning experiences?".

2.2.1 Mean (M) and Standard Deviation (SD)

For mean (M), Ferguson and Takane (1989) defined the arithmetic mean is the sum of a set of measurements divided by N written as follows:

$$\overline{X} = \frac{X_1 + X_2 + X_3 + \cdots + X_N}{N} = \frac{\sum(X_i)}{N}. \tag{2}$$

For standard deviation (SD), Sirkin (2006) showed that SD is the positive square root of the variance. According to Ferguson and Takane (1989), the standard deviation (SD) in a sample is as follows:

$$s = \sqrt{\frac{\sum((X - \overline{X})^2)}{N - 1}}, \tag{3}$$

where the square$(X - \overline{X})^2$ is in square inches.

2.2.2 Analysis of Variance

To test the significance of the difference between k means using the ANOVA, if the probability of obtaining the observed F value is small, say, less than 0.05 or 0.01, under the null hypothesis, reject the hypothesis (Ferguson and Takane 1989). According to Sirkin (2006), if F is significant and the number of categories is greater than two, calculate the F ratio, where:

$$F = \frac{MS_{\text{Between}}}{MS_{\text{Within}}} = \frac{SS_{\text{Between}}/df_{\text{Between}}}{SS_{\text{Within}}/df_{\text{Within}}}, \tag{4}$$

where $df_{\text{Between}} = $ number of categories $- 1, df_{\text{Within}} = (n_{\text{Total}} - 1)$.

2.2.3 Multiple Regression

According to Ferguson and Takane (1989), a multiple correlation square, R_2, between the dependent variable and the $k - 1$ coded variables may be computed. A test of significant may be applied to R_2 using the formula:

$$F = \frac{R^2/g}{(1 - R^2)(N - g - 1)}, \tag{5}$$

where $R = $ multiple correlation coefficient

N = number of observation

g = number of independent variables or predictors

R^2 is a measure of the strength of association between the dependent and independent variables and is identical with the correlation ration $\eta^2_{y.x}$. If Y denotes the dependent variable and the independent variable is coded as $k-1$ orthogonal variables, then:

$$R^2 = r^2_{y1} + r^2_{y2} + \cdots + r^2_{yk-1}. \tag{6}$$

3 Results and Discussion

3.1 Vietnamese Students' Technical and Scientific Areas in Their Problem-Solving Efficacy

For the first research question, formulas (3) and (4) are used to answer how Vietnamese students' problem-solving efficacy in technical and scientific areas and using the formula (5) to answer "Do students' technical and scientific areas differ in their problem-solving efficacy?" As shown in Table 1, Vietnamese college students' average problem-solving efficacy ($M = 3.41, SD = 0.55$) was located within the range of the response of "average"(point 3) to "high" (point 4) in the five-point Likert's scale employed in the questionnaire.

For students at the three campuses of VNU-HCM, the results of Table 1 exhibited that students at the University of Technology had the highest problem-solving efficacy $(M = 3.51, SD = 0.50)$ and students at the University of Information Technology had the lowest problem-solving efficacy $(M = 3.06, SD = 0.55)$. The results of post hoc comparisons showed that there existed significant differences of problem-solving efficacy of students among the three universities ($F = 18.12, p < 0.001$). Post hoc comparisons indicated that students at the three universities can be categorized into two groups: high level of problem-solving efficacy of students in the Universities of Technology and low level of problem-solving efficacy of students at the University of Information Technology and the University of Science. Within the two groups, there was no significant difference of students' problem-solving efficacy.

Table 1 ANOVA, means and standard deviation results of college students' problem-solving efficacy among three universities

VNU-HCM members	*M*	*SD*	*F*	Sig.	Post hoc
Average of three universities	3.39	0.56			
1. University of technology	3.51	0.50			
2. University of information technology	3.06	0.55	18.12	0.000	$(1) > (2,3)$
3. University of science	3.25	0.60			

The results of this study are different from previous studies of Luong (2010), MOET (2001), Nguyen (2009), and Vallely and Wilkinson (2008) which showed that Vietnamese college students are weak in problem-solving efficacy. These studies were based on large-scale surveys including public and private universities and even employment. The difference between this current study and the previous is probably due to the sample examined in the study is of better students. However, both this study and the previous indicated that the problem-solving efficacy of Vietnamese college students is unsatisfactory. Problem-solving is important for students to become effective problem-solvers in their profession (Hamza and Griffith 2006; Wilson 1993) and for later career success (Froman 2002; Gustin 2001). Thus, Vietnamese government should invest more resources in enhancing problem-solving efficacy of all students in the process of constructing an instructional program.

3.2 Vietnamese Students' Problem-Solving Efficacy Affected by Their College Learning Experiences

For the second research question, we used formula (6) to answer how the students' problem-solving efficacies in technical and scientific areas are affected by their college learning experiences. For the whole sample, the results of Table 2 indicated that the regression model proposed by this study explained 18.1% of Vietnamese college students' problem-solving efficacy ($R_2 = 0.066$–0.405). However, the regression model wielded rather different explanation power for students' problem-solving efficacy among the three universities.

At the University of Technology, the results showed that item of student's backgrounds of class ranking ($\beta = 0.128, p < 0.05$) and levels of involvement in class activities($\beta = 0.206, p < 0.01$), time spent on course work ($\beta = 0.131, p < 0.05$), and skipping class ($\beta = 0.161, p < 0.05$) significantly benefited students' problem-solving efficacy ($R_2 = 0.066$). At the University of Information Technology, teaching approach of employing multimedia ($\beta = -0.417, p < 0.05$) significantly hindered students' problem-solving efficacy ($R_2 = 0.405$). At the University of Science, level of involvement in class activities ($\beta = 0.204, p < 0.05$), time spent on course work ($\beta = 0.164, p < 0.05$), and frequency of consulting teacher ($\beta = 0.220, p < 0.05$) significantly empowered students' problem-solving efficacy ($R_2 = 0.179$). No other independent variable had significant effect on students' problem-solving efficacy.

Vietnamese college students' problem-solving efficacy is significantly influenced by their college learning experiences. There are different affecting variables at different universities. Based on these differences, universities should design interventions to enhance students' problem-solving efficacy. As an example, University of Technology and University of Science may very well consider learning engagement, or University of Information Technology may want to avoid a teaching approach employing multimedia. The only variable across the universities is

Table 2 Regression analysis results among the dependent variable and independent variables at the whole sample and each college

Variable	The whole sample	University of technology		University of information technology	University of science
	Beta(β)				
Student background					
Class ranking	0.114*				
Family income					
Teaching approach					
One-way instruction					
Group discussion					
Multimedia			−0.417*		
Learning engagement					
Levels of involvement in class activities	0.241***	0.206**			0.204*
Frequency of going to library					
Time spent on course work	0.160***	0.131*			0.164*
Frequency of consulting teacher					0.220*
Skipping class	0.108*	0.161*			
Adjusted R_2	0.181	0.066		0.405	0.179

Note.*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

student involvement in class activities. In this study, involvement in class activities significantly affects the problem-solving efficacy of students at two universities, namely, University of Technology and University of Science. The research of Bossert showed that student involvement in class activities promoted student performances (Bossert 1988). Specifically, recent meta-analyses suggested that student involvement in class activities benefited students at all age levels, of all subject areas, and for a wide range of tasks, such as those involving problem-solving efficacy (Johnson et al. 1983; Slavin 1983). In each university, in order to make a policy for the instructional program and to select a teaching method or to evaluate the studying result of the student, the experts or the program makers of VNU-HCM should be notably concerned about this factor.

4 Conclusion

This study explored how learning experiences affect problem-solving efficacy of Vietnamese college students' in technical and scientific areas. Results of this study found that these contribute to fill in the literature gap of Vietnamese college students' problem-solving efficacy development. The study also found that Vietnamese college students' problem-solving efficacy was below high. Thus, the information provided in this study helps administrators, faculty, and scientists at VNU-HCM that they should pay special attention to enhancing their students' problem-solving efficacy. VNU-HCM should evaluate their academic learning by the effect on improving students' problem-solving efficacy. This will help administrators, faculty, and scientists at VNU-HCM to monitor and adjust the strengths and weaknesses of the academic learning to meet the needs of the country. In the process of constructing an instructional program, administrators and scientists in the universities should design better institutional policies and select advanced academic learning to not only provide background knowledge but also develop students' efficacy for future jobs.

Acknowledgements I would like to acknowledge my sincere gratitude to the reviewers for anonymous, kindest support and help, valuable advice, synthesized comments on revision, and detailed editing throughout.

References

S.T. Bossert, Cooperative activities in the classroom. Rev. Res. Educ. **15**, 225–250 (1988)

H.R. Bowen, *Investment in Learning* (Jossey-Bass, San Francisco, 1977)

D. Breiter, C. Clements, Hospitality management curricula for the 21st century. Hosp. Tourism Educ. **8**(1), 57–60 (1996)

J.M. Braxton, J.F. Milem, A. Shaw Sullivan, The influence of active learning on the college student departure process. J. High. Educ. **71**(5), 569–590 (2000)

L. Braskamp, L. Trautvetter, K. Ward, *Putting Students First: How Colleges Develop Students Purposefully* (Anker Publishing Company, Inc, Bolton, 2006)

A.W. Chickering, L. Riesser, *Education and Identify*, 2nd edn. (Jossey-Bass, San Francisco, 1993)

G.A. Ferguson, Y. Takane, *Statistical Analysis in Psychology and Education*, 6th edn. (MC Graw-Hill, New York, 1989)

R. Froman, *Florida Works: Problem Solving on the Job* (Florida Human Resources Development, Inc, Winter Springs, 2002)

M. Gustin, Think for yourself: bringing critical thinking skills to the classroom. J. Hosp. Tourism Educ. **13**(1), 41–47 (2001)

J.F. Hair, R.E. Anderson, R.L. Tatham, W.C. Black, *Multivariate Data Analysis* (Prentice Hall, New Jersey, 2006)

M.K. Hamza, K.G. Griffith, Fostering problem-solving and creative thinking in the classroom: cultivating a creative mind. National Forum Appl. Educ. Res. J.-Electronic **9**(3), 1–32 (2006)

D. Johnson, R. Johnson, G. Maruyama, Interdependence and interpersonal attraction among heterogeneous and homogeneous individuals: a theoretical formulation and a meta-analysis of the research. Rev. Educ. Res. **53**, 5–54 (1983)

J. Kilpatrick, J. Swafford, B. Findell (eds.), *Adding It Up: Helping Children Learn Mathematics* (National Academy Press, Washington, DC, 2001)

J. Krikley, *The Principles for Teaching Problem-Solving* (PLATO Learning, Inc, Edina, 2003)

S.M. Little, G.M. Hefferan, in *Development Student's Legal Problem-Solving Skills: An Integrated Model*, ed. by Tan O Seng et al. Problem-Based Learning: Educational Innovation Across Disciplines (Temasek Centre for Problem-based Learning, Singapore, 2000)

B. Luong, Students in Ho Chi Minh City are weak in soft skills. Retrieved from http://talk.onevietnam.org/students-in-ho-chi-minh-city-are-weak-in-soft-skills/ (2010)

B.J. May, J. Newman, Developing competence in problem-solving: a behavioral model. Phys. Ther. **60**(9), 1140–1145 (1980)

Ministry of Education and Training (MOET), Vietnamese education and training development strategy to year 2010 for the cause of industrialization andmodernization of Vietnam (Ha Noi,Vietnam, 2001)

National Assembly of the Socialist Republic of Vietnam, Law of Education (2005)

W.L. Neuman, *Social Research Methods Qualitative and Quantitative Approaches* 6th edn. (Pearson Education, Inc, New York, 2006)

L. Nguyen (2009), International and national skills development approaches in Vietnam. The NORRAG Conference on Policy transfer or policy learning: Interactions between international and national skills development approaches for policy making, Geneva

D.V. Pavesic, Another view of the future of hospitality education. Cornell Hotel Restaur. Adm. Q. **32**(4), 8–9 (1991)

F. Pajares, J. Kranzler, Self-efficacy beliefs and general mental ability in mathematical problem-solving. Contemp. Educ. Psychol. **20**, 426–443 (1995)

M. Schommer-Aikins, O.K. Duell, R. Hutter, Epistemological beliefs, mathematical problem-solving beliefs and academic performance of middle school students. Elem. Sch. J. **105**(3), 289–304 (2005)

W.H. Schmidt, C.C. McKnight, R.T. Houang, H.C. Wang, D.E. Wiley, L.S. Cogan, R.G. Wolfe, *Why Schools Matter a Cross-National Comparison of Curriculum and Learning* (Jossey-Bass, San Francisco, 2001)

R.M. Sirkin, *Statistics for the Social Sciences*, 3rd edn. (Sage publication, InC, New York, 2006)

A. Sirin, A. Gzel, The relationship between learning styles and problem-solving skills among college students. Educ. Sci. Theor. Pract. **6**(1), 255–264 (2006)

R. Slavin, *Cooperative Learning* (Longman, New York, 1983)

S.K. Thompson, *Sapling*, 2nd edn. (Wiley, New York, 2002)

J.V. Thomas, W. Ben, Vietnamese higher education: crisis and response. Retrieved from http://www.hks.harvard.edu/innovations/asia/Documents/HigherEducationOverview112008.pdf (2008)

T.J. Vallely, B. Wilkinson, Vietnamese higher education: crisis and response. Retrieved from http://www.hks.harvard.edu/.../asia/.../HigherEducationOverview112008.pdf (2008)

Vietnam National University - Ho Chi Minh City (VNU-HCM), Home: overview. Retrieved from http://student.vnuhcm.edu.vn/vnu/index.php?option=com_content&task=view&i=20&Itemid=51 (2009)

G. Wilson, *Problem-Solving and Decision Making* (Kogan Page, London, 1993)

C.L. Wu, A comparison of the effects of university learning experiences on student leadership at Taiwanese General and Technical universities. The Asia-Pacific Educ. Res. **21**(1), 130–140 (2012)

A.A. Zekeri, College curriculum competencies and skills former students found essential to their careers. Coll. Stud. J. **38**(3), 412–422 (2004)

Analysis of Zhejiang Business Fluctuations with Dynamic Stochastic General Equilibrium Model

Shangfeng Zhang and Xiaowen Hu

Abstract Zhejiang has experienced high economic growth as well as wild business cycle fluctuations since reforming and opening. According to the stylized facts, this paper estimates the dynamic stochastic general equilibrium model to summarize the Zhejiang business fluctuations. And we can draw the main conclusions from the quantitative analysis: technology advances and labor changes are the main drivers of Zhejiang business fluctuations, while government consumption and net exports had only ignorable impacts.

Keywords RBC model • Volatility • HP filter • Macroeconomic variable • Cyclical fluctuation

1 Introduction

Since 1978 Zhejiang has achieved rapid growth, but along with the economic growth, the volatility of macroeconomic variables in different periods varied greatly. This article uses 1978 as the basic period to calculate the true value of the macroeconomic variables, including the total output based on the expenditure method, household consumption, investment, and exogenous demand. The exogenous demand is defined as government consumption and net exports. The data used in this article is all annual.

S. Zhang (✉)
College of Economics, Zhejiang University, Hang Zhou, 310027, China

Institute of Quantitative Economics, Zhejiang Gongshang University, Hang Zhou, 310018, China
e-mail: zhshangfeng@163.com

X. Hu
Institute of Quantitative Economics, Zhejiang Gongshang University, Hang Zhou, 310018, China

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_9,

Table 1 The cyclical fluctuations' statistical description of macroeconomic variables, Zhejiang Province

variables	Standard deviation	Relative standard deviation	correlation coefficient between output and each variable's different time lag				
			x(-2)	x(-1)	x(0)	x(+1)	x(+2)
Total output	0.052991	1.000000	0.156979	0.706248	1.000000	0.706248	0.156979
Household consumption	0.052252	0.986040	-0.371860	0.009507	0.485552	***0.713297***	0.608862
investment	0.190900	3.602499	0.006916	***0.135078***	0.123986	0.047014	0.051694
exogenous demand	0.345042	6.511332	-0.044039	0.169484	***0.341468***	0.244467	0.015687

Column 2 in Table 1 explains standard deviations of various variables; column 3 gives each variable's volatility in comparisons with relative total output fluctuations in multiples. From Table 1, we know that the maximum volatility appears in exogenous demand in the compositions of total output, which reaches 34.5 %, 6.5 times the total output fluctuations. Investment is in the second place, reaching 19.1 %, 3.6 times the total output volatility. Together they explain 83.6 % of the total output volatility.

Note: all the statistics in the table are p value; the corresponding null hypothesis is: the variable in the row is not Granger cause of the variable in the column. X^* means significant in 10 % level, X^{**} means significant in 5 % level and X^{***} means significant in 1 % level. All the Granger causality tests include order lag.

Columns 4–8 in Table 1 explain the time difference correlation coefficient between outputs and each variable's different time lag. If the time difference correlation coefficient in the x (0) column is positive. By observing the position of the largest absolute value in each column figures, we can determine the leading-lag relationship of the variables. Fluctuations in the variable are prior to the volatility of output. In this sense, we believe that the variable leading one period to output fluctuations, which we can call it the leading variable of the output. On the contrary, if the time difference correlation coefficient of a variable reaches its maximum at the x (1) column. Why Zhejiang economic volatility is so big? What causes so much volatility? By the RBC model we try to answer these important questions.

2 RBC Model

In the real business cycle model, technology shocks are central to interpretation of cycles (Kydland and Prescott 1982; Cogley and Nason 1995; King and Rebelo 2000; Chen et al. 2004; Geng et al. 2011; Yang and Li 2011; Chen 2011). In the economy, there are infinite homogeneous consumers whose total measure is 1. Representative consumer chooses the per capita consumption and per capita labor $l_t(s^t)$ to maximize this discounted utility

$$\sum_{t=0}^{\infty}\sum_{s^t}\rho^t\pi_t(s^t)u(\widetilde{c}_t(s^t),l_t(s^t))N_t.$$

Budget constraint consumers faced

$$C_t(s^t)+[1+\tau_{xt}(s^t)]X_t(s^t)=[1-\tau_{lt}(s^t)]\omega_t(s^t)L_t(s^t)+r_t(s^t)K_t(s^{t-1})+T_t(s^t).$$

Capital transfer equation

$$K_{t+1}(s^t)=(1-\delta)K_t(s^{t-1})+X_t(s^t).$$

$C_t(s^t),X_t(s^t),T_t(s^t),K_t(s^{t-1})$ respectively represent total consumption in the economy, total investment, the total sum payment-type tax, and the total capital stock. $\omega_t(s^t),r_t(s^t),\rho,\delta,N_t,g$ represent wage rate, rental rate of capital, discount rate, the depreciation rate of capital, the total population, and total population growth.

The enterprise's profit maximization problem

$$\max_{\{K_t(s^t),L_t(s^t)\}}A_t(s^t)F(K_t(s^{t-1}),Z_tL_t(s^t))-r_t(s^t)K_t(s^{t-1})-\omega_t(s^t)L_t(s^t).$$

Among which $Y_t(s^t),G_t(s^t)$ represents the total social output and exogenous demand.

2.1 Model Solution

2.1.1 Smooth Conversion of the Model

Because of exogenous technological progress and population growth, the model variables will grow unboundedly. So we define variables without trend:

$$c_t=C_t/(Z_tN_t),x_t=X_t/(Z_tN_t),k_t=K_t/(Z_tN_t),t_t=T_t/(Z_tN_t),$$
$$g_t=G_t/(Z_tN_t),y_t=Y_t/(Z_tN_t).$$

The capital transfer equation can be described as follows using variables without trend:

$$(1+g_n)(1+g_z)k_{t+1}=(1-\delta)k_t+x_t.$$

The consumer's objective function can be changed as

$$\max\sum_{t=0}^{\infty}\sum_{s^t}\beta^t\pi_t(s^t)U(c_t(s^t),l_t(s^t)). \tag{1}$$

Budget constraint consumers faced changes to

$$c_t(s^t)+[1+\tau_{xt}(s^t)]x_t(s^t)=[1-\tau_{lt}(s^t)]\omega_t(s^t)L_t(s^t)+r_t(s^t)k_t(s^{t-1})+t_t(s^t).$$

Capital transfer equation changes to

$$(1+\gamma)k_{t+1}(s^t) = (1-\delta)k_t(s^{t-1}) + x_t(s^t)$$

which

$$\beta = \rho(1+g_n), 1+\gamma = (1+g_n)(1+g_z).$$

The enterprise's profit maximization problem changes to

$$\max_{\{k_t(s^t),l_t(s^t)\}} A_t(s^t)F(k_t(s^{t-1}), l_t(s^t)) - r_t(s^t)k_t(s^{t-1}) - \omega_t(s^t)l_t(s^t). \tag{2}$$

Resource constraint of the society changes to

$$c_t(s^t) + x_t(s^t) + g_t(s^t) = y_t(s^t). \tag{3}$$

2.1.2 The Equilibrium Conditions of the Model

Assume:

$$F(k,l) = k^{\alpha} l^{1-\alpha}$$

$$u(\tilde{c}, l) = \log(\tilde{c}) + \psi \log(1-l)$$

we can get

$$\frac{\psi c_t(s^t)}{1-l_t(s^t)} = (1-\alpha)[1-\tau_{lt}(s^t)]A_t(s^t)k_t(s^{t-1})^{\alpha} l_t(s^t)^{-\alpha} \tag{4}$$

$$\frac{1}{c_t(s^t)}(1+\gamma)[1+\tau_{xt}(s^t)] = \beta \sum_{s^{t+1}} \pi(s^{t+1}|s^t) \frac{1}{c_{t+1}(s^{t+1})}$$

$$\{\alpha A_{t+1}(s^{t+1})k_{t+1}(s^t)l_{t+1}(s^{t+1})^{1-\alpha} + (1-\delta)[1+\tau_{xt+1}(s^{t+1})]\}. \tag{5}$$

Production function

$$y_t(s^t) = A_t(s^t)k_t(s^{t-1})^{\alpha} l_t(s^t)^{1-\alpha}. \tag{6}$$

The equilibrium conditions of the model are described by optimal conditions (4), (5), production function (8), and resource constraints (3).

2.1.3 Steady-State Calculation

It is easy to obtain

$$l = \frac{\psi^{-1}(1-\alpha)[1-\tau_l]A}{\psi^{-1}(1-\alpha)[1-\tau_l]A - (\gamma+\delta)\xi_1^{1-\alpha} + (1-\xi_2)A}$$

$$c = \psi^{-1}(1-\alpha)[1-\tau_l]A\xi_1^{\alpha}(1-l)$$

$$y = A\xi_1^{\alpha} l.$$

among which

$$\xi_1 \equiv [(1+\gamma-\beta+\beta\delta)(1+\tau_x)/\beta\alpha A]^{1/(\alpha-1)}, \xi_2 = g/y.$$

2.1.4 Log-Linear

Define vectors:

$$s_t = [\widehat{a_t} \;\; \widehat{\tau_{xt}} \;\; \widehat{\tau_{lt}} \;\; \widehat{g_t}]' \tag{7}$$

$$s_{t+1} = Hs_t + \varepsilon_{t+1}$$

Above 3 equations can be log-linear into

$$\begin{aligned}
&\alpha(1-\alpha)(1-\tau_l)(A\xi_1^\alpha - y)\widehat{k_t} - \psi c\widehat{c_t} - (1-\alpha)(1-\tau_l)(\alpha A\xi_1^\alpha + (1-\alpha)y)\widehat{l_t} \\
&\quad +(1-\alpha)(1-\tau_l)(A\xi_1^\alpha - y)\widehat{a_t} - (1-\alpha)(A\xi_1^\alpha - y)\widehat{\tau_{lt}} \\
&\beta\alpha(\alpha-1)A\xi_1^{\alpha-1}E_t\widehat{k_{t+1}} - (1+\gamma)(1+\tau_x)E_t\widehat{c_{t+1}}\beta\alpha(1-\alpha)A\xi_1^{\alpha-1}E_t\widehat{l_{t+1}} \\
&\quad +\beta\alpha A\xi_1^{\alpha-1}E_t\widehat{a_{t+1}} + \beta(1-\delta)E_t\widehat{\tau_{xt+1}} = -(1+\gamma)(1+\tau_x)\widehat{c_t} + (1+\gamma)\widehat{\tau_{xt}} \\
&(1+\gamma)k\widehat{k_{t+1}} = [(1-\delta)k + \alpha y]\widehat{k_t} - c\widehat{c_t} + (1-\alpha)y\widehat{l_t} + y\widehat{a_t} - g\widehat{g_t}
\end{aligned}$$

3 Cournot Model Estimation

We define capital share $\alpha = 0.65$, discount rate $\beta = 0.95$, deprecation rate $\delta = 0.05$, leisure preference parameters $\psi = 2.24$. The growth rate of effective labor can be calculated directly from the time series of real output.

We assume the four exogenous shocks in (7) obey AR (1) process. Suppose further that the random error term ε_{t+1} in the AR (1) process obeys independent and identically distributed Gaussian distribution, which variance-covariance matrix is V. In order to insure the estimated V is semi-positive matrix, we assume $V = QQ'$ (Q is lower triangular matrix). We can estimate Q directly.

There are 28 parameters needed to estimate. (There are 16 in matrix H_{10},10 in matrix Q, $\tau_x$and $\tau_x's$ long-term mean.)

Define observed variables as vector:

$$f_t = [\widehat{y_t} \;\; \widehat{c_t} \;\; \widehat{g_t} \;\; \widehat{x_t}]'.$$

Define state variables as vector:

$$x_t = [\widehat{a_t} \;\; \widehat{\tau_{xt}} \;\; \widehat{\tau_{lt}} \;\; \widehat{g_t} \;\; \widehat{k_t} \;\; \widehat{k_{t-1}}]'.$$

Solution of the model can be described as

$$x_t = D_1 x_{t-1} + D_2 \varepsilon_t \quad (8)$$

$$f_t = D_3 x_t . \quad (9)$$

4 Empirical Results

First we research each shock's numerical contribution to the volatility of output. In the second column of Table 2, it gives the standard deviation of each shock, which explains the volatility of each shock. By the figures reported in the table, it is easy to find that the biggest volatility of the shocks is technology shock, whose volatility reaches 7.62 % and 1.44 times the standard deviation of real output. In Fig. 3 we know that from 1978 to 2010, the volatility of simulated output caused only by technology shock is 1.24 times the volatility of real output. For the technology shock is pro-cyclical, it can be considered that technology shock is an important cause of output fluctuations (Figs. 1 and 2).

In Table 4, note all the statistics in the table are p value; the corresponding null hypothesis is as follows: the variable in the row is not Granger cause of the variable in the column. X^* means significant in 10 % level, X^{**} means significant in 5 % level, and X^{***} means significant in 1 % level. All the Granger causality tests include order lag.

We can know from Table 2 that technology is lag variable, and it lags one time of output. Investment and exogenous demand are all leading variable and they lead one time of output. Labor is lag variable and it lags two times of output. Table 3 is similar to Fig. 2, so we don't explain it here.

Except the cycle behavior's effect to the volatility, we also use Granger causality test to analyze the predicting relationship between each shock and output. All the results are given in Table 4. From Table 4 we know that technology has a significant ability to predict the impact on the actual output, which in turn strengthens our

Table 2 The statistical properties of the various shocks

Shocks	Standard deviation	Relative standard deviation	correlation coefficient between output and each variable's different time lag				
			x(-2)	x(-1)	x(0)	x(+1)	x(+2)
Technology	7.620527	1.438066	-0.30591	0.102914	0.535981	***0.634353***	0.466363
Investment	1.587116	0.299504	0.530616	***0.633519***	0.442442	0.054283	-0.2799
Labor	3.79307	0.715789	***0.420445***	0.376344	0.156197	-0.06976	-0.26816
Exogenous demand	1.605532	0.302979	0.277256	***0.355542***	0.284746	0.02643	-0.18717

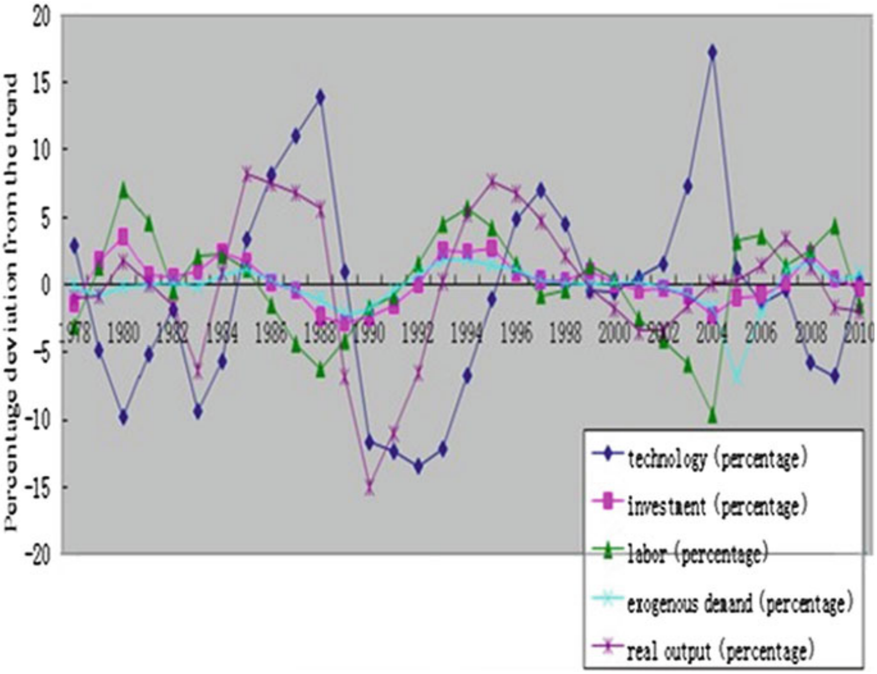


Fig. 1 Actual data and output simulated with only one shock

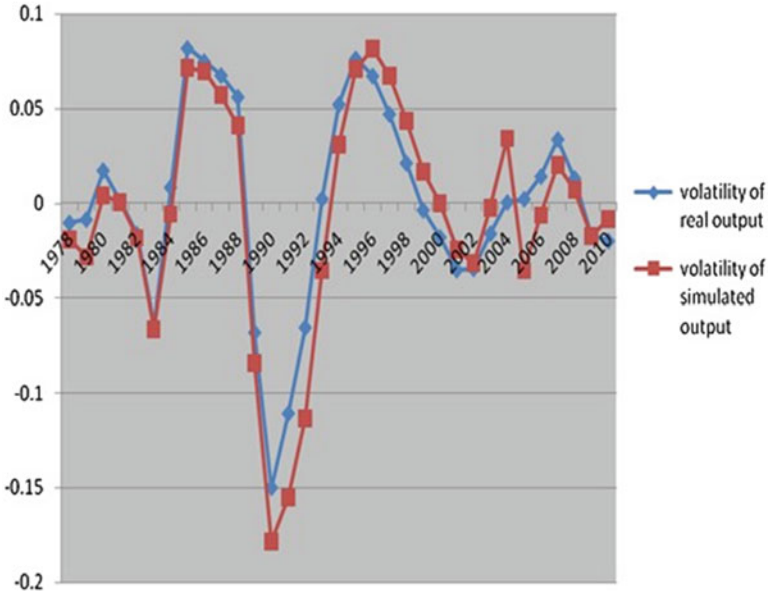


Fig. 2 The volatility of real output and output of the model simulation in Zhejiang

Table 3 The statistical properties of the simulated output in one shock

Shocks	Relative standard deviation	correlation coefficient between simulated output and each variable's different time lag				
		x(-2)	x(-1)	x(0)	x(+1)	x(+2)
Technology	1.24104	-0.25026	0.175362	0.653894	***0.708317***	0.51195
Investment	0.25847	0.649325	***0.67858***	0.37408	-0.02752	-0.35403
Labor	0.61772	***0.488659***	0.375696	0.019931	-0.18105	-0.33828
Exogenous demand	0.261469	0.379424	***0.414113***	0.304019	-0.10386	-0.33828

Table 4 Granger causality relationships between the shocks

	output	Technology shock	Investment shock	Labor shock	Exogenous demand shock
output	-	0.21	0.23	0.32	0.34
Technology shock	0.03**	-	0.08*	0.61	0.0002***
Investment shock	0.02**	0.07*	-	0.02**	0.03**
Labor shock	0.02**	0.16	0.04**	-	<0.0001***
Exogenous demand shock	0.57	0.54	0.34	0.4	-

identification of the sources of volatility. During this period Granger causality test also finds that labor shock has a significant ability to predict output, investment, and exogenous demand. This fact convinces us that labor shock is another source of output volatility during this period.

To sum up, we get the following conclusions: first, the main source of economy fluctuations in Zhejiang is technological progress and labor shock. Second, exogenous demand and investment has a small impact on the economy fluctuations in Zhejiang.

Acknowledgements This paper is supported by Natural Science Foundation of Zhejiang Province (LQ13G030006), Postdoctoral Science Foundation of China (2013M531436), Humanities and Social Sciences Foundation of Ministry of Education (13YJC790213), National Statistics Research Foundation of National Bureau of Statistics (2012LY016) and Higher Education Research Foundation of Zhejiang Gongshang University (Xgy13006).

References

P. Chen, Real shocks and Taiwanese economic fluctuations-comparative analysis based on closed and open RBC models. Taiwan Res. J. **115**(3), 43–53 (2011)

K. Chen, Y. Zhou, L. Gong, The business cycle in China. Global Econ. **10**, 47–56 (2004)

T. Cogley, J.M. Nason, Output dynamics in real-business-cycle models. American Econ. Rev. **85**(3), 492–511 (1995)

Q. Geng, F. Jiang, T. Fu, Policy-related subsides, overcapacity and China's economic–fluctuation–empirical testing based on RBC model. China Ind. Econ. **278**(5), 27–36 (2011)

F.E. Kydland, E.C. Prescott, Time to build and aggregate fluctuations. Econometrica: Journal of the Econometric Society, 1345–1370 (1982)

R.G. King, S.T. Rebelo, Resusciting Real Business Cycles. Working Paper, (2000)

L. Yang, L. Li, Money shock and Chinese economic fluctuations-quantitative analysis based on a DSGE model. Mod. Econ. Sci. **33**(5), 1–10 (2011)

All Work and No Play Makes Jack a Dull Leader? Impact Evaluation with Leisure Activities and Management Performance for the School Leaders

Mei Fen Liu and Berlin Wu

Abstract The main purpose of this paper was to create an index of leisure activity for school leaders. We constructed a nonlinear structural relationship model and researched the indicators to explain the satisfaction of leisure activities for elementary school leaders. We explored the circumstances of their participation in leisure activities, including content and indicators for ways to carry out leisure activities. We aimed at analyzing and evaluating leisure activity factors of school leaders and present the assessment program by using the two-dimensional questionnaire sampling survey. The paper provided that school leaders shows an efficient index in the leisure activity research. Finally, we proposed the relevant suggestion according to the result of this paper.

Keywords Fuzzy evaluation • Leisure activity • School leaders

1 Introduction

All work and no play makes Jack a dull boy,

All play and no work makes Jack a mere toy.

Though the spirit of the proverb had been expressed previously, the modern saying has been be extended to the management and administration field. Today's school leaders, especially those involved in research, are becoming more and more

M.F. Liu (✉)
Department of Education Policy and Ad., National ChiNan University, Nantou County, Taiwan
e-mail: molly@tc.edu.tw

B. Wu
Department of Math Sciences, National ChengChi University, Taipei City, Taiwan
e-mail: berlin@nccu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_10,

stressed due to the demanding nature of their jobs. Engaging in leisure activities can alleviate this stress and promote well-being, but the time and choice of leisure activity are very important.

"After dinner sit a while, after supper walk a mile." In the twenty-first century, people can easily get angry and anxious and lose patience and emotional control. However, unavoidably, all kinds of individuals and social problems, such as self-harm, violence, drugs, and spiritual diseases with the environment of persons, have made the discipline and counseling faced with new tests and challenges repeatedly. We should learn how to manage pressure, and that participating in leisure activities is good for our health. Taking leisure activity can duly relieve pressure and mentally grasp healthy life. Suitable leisure activities are helpful for physical and mental health. Taking challenges and breaking through difficulties are best evidence.

In such a globalized era that accompanied with dramatically competitive waves, the job of a school leader is becoming increasingly more stressful. Engaging in leisure activities can receive many positive benefits; the time and choice of leisure activity are very important. School leaders' leisure activities relate directly to many of the issues affecting them, such as mental, health, and performance. They are increasingly seeking new ways to spend their free time, out of both necessity and interest. Business, routine duties, and pressure from supervisors and leaders all contribute to mounting pressure and work-related fatigue.

When leaders have insufficient time but have to take on heavy workloads, they almost cannot help blurting out "I can't take it anymore!" The sudden increased workload and series of unsolved problems over a short period often cause physical and mental illnesses for school leaders. Leisure time holds many opportunities that can help us in the short and long term. How we use this leisure time is important; we must fill it with experiences that we can take advantage of.

Herrera, Herrera-Viedma (2000) presented the steps of linguistic decision analysis under linguistic information. They suggest that there are certain degrees of possibilities to express linguistics based on fuzzy numbers, but it should be reconsidered if the response will produce the same fuzzy number. Liu and Song (2001) developed one type of measurement whose linguistic is similar to semantic proximity. Based on the similarity of linguistic concept, they presented a formula of fuzzy association degree. They used the information of botany as an example to illustrate and analyze the categorical similarity of rare plants in the ecology. Carlsson and Fuller (2000a,b) discussed many concepts about the computation of fuzzy linguistic and these concepts were worthy to broadcast.

In this chapter, we use the concept of fuzzy statistics to explore and analyze school leaders' leisure activities that indicators attempt to understand to relieve their pressure. We'll try to establish the school leaders' fuzzy statistical indicators of leisure activities. Major objectives of this research are stated as follows: (1) to understand the relevant factors with leisure activities of school leaders, (2) to utilize fuzzy theory to establish leisure indicators of school leaders, and (3) to explore the leisure activity index and leisure activity factors of school leaders.

2 Research Methods and Procedures

This research utilizes the investigative methods of the fuzzy questionnaire and fuzzy evaluation, with the hope of establishing an index of school leaders' leisure activities. The evaluation procedure includes four main parts: goal, contents, method, and index. First of all, this research aims at the index of school leaders' leisure activities. We sum up four aspects of leisure activities for school leaders according to the literature. These aspects are exercise/games, art/music, entertainment/tourist, and religion. Secondly, we will collect realistic data from samples. Thirdly, the research approach is to compile the questionnaires of school leaders' leisure activities.

2.1 The Discussion Domain for Leisure Activities

Since fuzzy theory is generated by Zadeh (1965), the application in every research field of fuzzy statistics grows vigorously like mushrooms after rain. It regards fuzzy logic as the theoretical foundation and extends the logic concept of the two-values logic of traditional mathematics, breaking through the limitation thinking of binary logic way. Just as the fuzzy statistics scholar's concern, human thinking can't be measured or described with the single option. In other words, it should have membership of each option revealing its relative importance (Wu 2005; Law 1997; Nguyen and Wu 2006). Wu, Liu and Wang (2012) proposed different from the traditional quantized questionnaire; the fuzzy questionnaire can reflect possibility and feasibility of the human fuzzy thinking specialty even more. Because human thinking and behavior nearly reflect the fuzziness of things, languages shown are all fuzzy languages too (Wu 2005). Apply the fuzzy logic to the analysis of questionnaire investigation, and offer a novel idea of collecting and analyzing data; its a concept of fuzzy theory which allows people to have multiple experiences (Chiang et al. 2008).

Relative to traditional data, we cannot only know the final option but also the fuzzy thinking of participants in fuzzy data. In other words, the participant's preference is reflected more accurately in fuzzy voting.

We classify the level of leisure resource into four sets according to their contribution to the activities leisure. These sets are: exercise/game, art/music, entertainment/tourist, and religion.

2.2 Soft Computing in the Fuzzy Evaluation

It is appropriate to apply the membership function, a more precise mathematical technique, in analyzing the fuzzy information. The value of the membership function, between 0 and 1, is derived from the characteristic function, to express the membership grade of each element in a set. Though subjectivity coming from human thought is often involved, what fuzzy theories handle is not semantic uncertainty, but to compute the degree of objectivity for the semantic uncertainty. So there are two kinds of membership function: the continuous type, such as Z- type, Λ- type, Π- type, and S- type, and discrete type (Nguyen and Wu 2006). Researchers usually use the -type to reflect the value of the fuzzy state of human thought. It assesses the fuzzy interval of various evaluations and then calculates the fuzzy value of state according to appraiser's fuzzy weighting.

In this research, the discrete type of membership function is applied. That is, we will give the value of intelligent capital into different linguistic terms such as valueless, not too valuable, lightly valuable, valuable, very valuable, extremely valuable, hugely valuable, and invaluable. Each term will correspond with a realistic state of human thought and will be determined by the sampling survey and fuzzy statistical analysis.

In social science research, statistical analysis is indispensable, especially in the aspect of survey and methodology. Basic descriptive statistics such as mean, median, and mode are used very often in social science studies. When analyzing data, describing statistics can describe the basic structure and characteristics of the information efficiently (Wu 2000). However, many phenomena in the world, such as human language, thinking, and decision-making, all possess nonquantitative characteristics. Human behavior is particularly difficult to quantize. The argument is about the principle of applying fuzzy scale and categorization into human's interaction with the dynamic environment and to give a more concrete description and solution toward complicated/vague phenomenon (Liu et al. 2011).

Liu et al. (2010) stated that a human being's thoughts and feelings are full of ambiguity and uncertainty, such as satisfaction degree, happiness, sadness, strength, weakness, optimism, and pessimism which contribute to the language concepts that have long been unable to be analyzed by advanced knowledge framework or innovative technology. Since mode, mean, and median are essential statistics in analyzing the sampling survey. For instance, when people process a happy assessment, they classify the distraction into two categories: happy and unhappy. This kind of classification is not realistic, since that happiness is a fuzzy concept (degree) and can hardly be justified by the true-false logic. Therefore, computing the information based on the fuzzy logic is more reasonable. The generalized median by discussing aggregation operators closely related to medians and to propose new types of aggregation operators appropriate, both for the cardinal and ordinal types of information.

If the researcher can use the membership function to express the degree of persons' feelings based on their own choices, the result presented will be closer to the people's real thinking. Therefore, to collect the information based on the fuzzy mode should be the first step to take. Since a lot of times the information itself is embedded with uncertainty and ambiguity. It is natural for us to propose the fuzzy statistics, such as fuzzy mode and fuzzy median, to fit the requirement of the status quo. In this and next section we demonstrate the definitions of fuzzy mode and fuzzy median generalized from the traditional statistics.

The weight of factors for an object is different from person to person, due to the subjectivity of personal preference. In a diverse society, knowledge accumulated day and day, the change of environment, volatility of information and complicated, diverse, fuzzy and indeterminate human behavior. Therefore, how to decide the weights, called fuzzy weights, becomes a primary work before evaluating the specialized human capital. In this section, we will demonstrate an integrated design via appropriate questionnaires of field study to reach a common agreement for weight of fuzzy factors for an object/event.

2.3 Defuzzification with Fuzzy Data

Once such a transformation has been selected, instead of the original trapezoid data, we have a new value $y = f(x)$. In an ideal situation, this new quantity y is normally distributed. (In practice, a normal distribution for y may be a good first approximation.) When selecting the transformation, we must take into account that, due to the possibility of a rescaling, the numerical values of the quantity x is not uniquely determined.

Definition 2.1. Defuzzification for discrete fuzzy data. Let X be a fuzzy sample on universe domain U with ordered linguistic variable $L_i : i = 1,2,\ldots,k$ corresponding to integral values, $\mu_x(L_i) = m_i$ be the membership with respect to L_i, $\Sigma_{i=1}^{n}\mu_x(L_i) = 1$. Let $c_x = \Sigma_{i=1}^{n} m_i L_i$ be the centroid of the fuzzy data, and $dx = \frac{1}{k-1}\Sigma_{j=1}^{m} m_i|i - cx|$ be its deviation for the cx. We call $Xf = cx + dx$, the defuzzification value for the discrete fuzzy sample X.

Example 2.1. Let $X = \frac{0}{1} + \frac{0.6}{2} + \frac{0.3}{3} + \frac{0.1}{4} + \frac{0}{5}$ be a discrete fuzzy sample on the ordered linguistic variable $\{L_1 = 1, L_2 = 2, L_3 = 3, L_4 = 4, L_5 = 5\}$. Then the defuzzification value for the fuzzy data X is

$$Xf = \Sigma_{i=1}^{k} m_i L_i + \frac{1}{k-1}\Sigma_{j=1}^{m} m_i|i - cx| = 2.5 + 0.15 = 2.65$$

3 An Integrated Fuzzy Evaluation Process

On the above-mentioned human capital measurement, we will consider a new approach of measurement. This is because analysis by traditional methods usually involves the following weaknesses: (a) the use of arithmetic in traditional questionnaires is often overexplained. (b) Experimental data is often overused just to cater to the need for apparent numerical accuracy. (c) For the sake of simplifying the evolutional model, the relationship of actual condition and dynamic characteristic is neglected. We have to better make use of fuzzy statistical technique at investigation realm to estimate the human resource capital.

3.1 Discussion Domain for Weight of Factors for Leisure Activities: Fuzzy Data with Two-Dimensional Case

It is appropriate to apply the membership function, a more precise mathematical techniques, in analyzing the fuzzy information. The value of the membership function, between 0 and 1, is derived from the characteristic function, to express the membership grade of each element in a set. Though subjectivity coming from human thought is often involved, what fuzzy theories handle is not semantic uncertainty, but to compute the degree of object for the semantic uncertainty.

There are many types of membership function, such as Z- type, - type, - type, and S- type [see Nguyen and Wu (2006)]. In this research we use C-type membership functions. It assesses the fuzzy interval of various evaluations and then calculates the fuzzy value of an enterprise according to the appraiser's fuzzy weighting.

We will give the value of human capital into different linguistic terms, such as moderate important, important, very important, *highly important, and critical*. Each term will correspond to a real value, which will be determined by the sampling survey and fuzzy statistical analysis.

After detailed discussion from the above sections, an integrated process of fuzzy evaluation is shown. We use the geometric average instead of the weighted arithmetic average. The reason is that the factors are highly correlated; any extreme value of a certain factor will influence the real intelligent capital.

How to assess the value of leisure activities? Using Delphi technique, for example, we consider three factors for the leisure activity value. Since these three factors are highly co-integrated, we make a geometric average to get a more appropriated evaluation. When applying these factors at the evaluating demand side, subjective opinions of human thinking will be highly involved.

From the general point of view, the rank of the journal, the degree of similarity to the original work and the time from the first publication of this work. From a mathematical point of view, we will consider how much the factors are related/correlated to each other.

We will put these two parts of compensation by addition. While inside these two factors, we would like to take it by the production. Since inside the factors, the variables are highly co-integrated.

In this research, we take two-dimensional fuzzy data: the weight X denoted by $\mu_{U,w}(X)$, as well as the memberships of satisfactory $\mu_{U,s}(y_1, y_2, y_3, y_4, y_5)$

(y_1 = very unsatisfactory, y_2 = unsatisfactory, y_3 = medium, y_4 = satisfactory, y_5 = very satisfactory) denoted by $\mu_{U,s}(Y)$ for the questionnaires on the discussion domain $U = \text{exercise/game, art/music, leisure/tourism, andreligion}$. Hence, a random fuzzy sample for a two-dimensional case can be written as

$$\mu_U(X,Y) = \frac{[\mu_1(X), \mu_1(Y)]}{\text{exercise/game}} + \frac{[\mu_2(X), \mu_2(Y)]}{\text{art/music}} + \frac{[\mu_3(X), \mu_3(Y)]}{\text{lesuire/tourism}} + \frac{[\mu_4(X), \mu_4(Y)]}{\text{religion}}$$

Table 1 School leaders leisure activity indicators of fuzzy weight

Leisure activity	Exercise/games (w ; (1,2,3,4,5))	Art/music (w ; (1,2,3,4,5))	Entertainment/tourism (w ; (1,2,3,4,5))	Religion (w ; (1,2,3,4,5))
$\mu_{U,A}(X,Y)$,	(.4; (0,0,0,.5,.5))	(.3;(0,0,.5,.5,0))	(.2;(0,0,1,0,0))	(.1;(0,0,.8,.2,0))
$\mu_{U,B}(X,Y)$,	(.1; (.8,.2,0,0,0))	(.1;(0,0,1,0,0))	(0;(0,0,0,1,0))	(.8;(0,.0,0,.4,.6))
$\mu_{U,B}(X,Y)$,	(.2;(.4,.4,,.2,0))	(.2;(0,0,0,.5,.5))	(.5;(0,0,.8,.2,0))	(0;(0,0,1,0,0))
Fuzzy mean	(.37;(.4,.2,0,.23,.17))	(.2;(0,0,.5,.33,.17))	(.23;(0,0,.6,.4,0))	(.3;(1,0,.6,.2,.2))

Index of individual leisure activities is as follows:

$$\mathrm{ILA} = \prod_{i=1}^{k} (S_i)^{\mu_i(x)},$$

where (x_i, y_i) is the sample for weight and memberships (degree of satisfactory of the linguistic variables), $S_i = \frac{1}{m-1}\{[\sum_{j=1}^{m} j \cdot \mu_j(y_i) + \frac{1}{m-1}(\sum_{j=1}^{m} \mu_j(y_j) \cdot |j - \sum_{j=1}^{m} j \cdot \mu_j(y_i)|)] - 1\}$ is the degree of satisfactory for factors in the universe domain, $\mu_j(x_i)$ is the weight of the factor j.

In order to find the general index of leisure activities for a population, we just calculate the mean of the sample *ILA* through population, that is, general leisure activities:

$$\mathrm{GILA} = \frac{1}{n}\sum_{i=1}^{n} ILA_i.$$

From the above definition we can find that $0 \le \mathrm{ILA} \le 1, 0 \le T\mathrm{ILA} \le 1$.

Example 3.1. Suppose there are three principles doing the survey. They are asked to write down the weight as well as the degree of satisfactory based on the factors of the discussion domain. Table 1 shows the result.

3.2 *Integrated Evaluation and Decision-Making*

Since it is difficult to meet the common agreement for the supply and demand sides, in order to minimize the gap, we would like to propose an appropriate decision rule for the index of leisure activities.

The reason we choose geometric average with endpoints cross production is to avoid people's unusual estimation in the lost evaluation as well as the intelligent capital. The advantage of this estimation is that we can use this two evaluated interval to reach an appropriate (common agreement) interval so that both sides of people would like to accept the result, while most traditional evaluation methods are based on the real value operation with the mean (arithmetic average) functions.

4 Empirical Study

In the field of study, we survey 20 school leaders' responses to the information in Taiwan. Their ages ranged from 35 to 60 years. Twelve were male, and eight were female. Most of the schools are located around the city. This study established leisure activity index for the school leaders. The participant's preference is reflected more accurately in fuzzy voting. In order to test if there are no significant difference among the area, we use Wilcoxon rank-sum test to see the result, since these samples might not come from normal distribution.

4.1 Purpose and Classification of Leisure Activity for School Leaders

How did the time allocation with school leaders leisure activity? Table 2 shows the result.

As for the school leaders' leisure time allocation in daily, we find that the fuzzy mode is at night which has the membership 39 %, the second is at morning which has the membership for 30 %, the evening, membership for 29 % and finally for noon, membership for 2 %.

School leaders use most of evening time for leisure activity, because it is important to relax after working hard every day. Almost school leaders get up early to relax and take leisure activity. Very few school leaders take leisure activity at noon, because the school leaders almost stand by at school throughout the whole day, so they have no time to engage in leisure activity.

As for the school leaders' leisure time allocation annually, we find that the fuzzy mean is "get off work" which has the membership of 51 %, the second is "holiday" with fuzzy mean of 32 %, and summer vacations and winter vacations with fuzzy mean of 17 % . From this, we can understand that most principals' leisure activities are in daily life, holidays, or summer vacations and winter vacations also evenly distributed.

Table 2 School leaders leisure activity indicators of fuzzy weight

Daily time	Allocation (%)	Annual time	Allocation (%)
Morning 5:00–7:00	30	Get off work	51
Noon 12:00–13:30	2	Holidays	32
Evening 17:00–19:00	29	Summer/winter	17
Night 19:00–24:00	39	Vacation	

Table 3 School leader's leisure activity indicators of fuzzy weight

leisure activity	Exercise/games (w ; (1,2,3,4,5))	Art/music (w ; (1,2,3,4,5))	Entertainment/tourism (w ; (1,2,3,4,5))	Religion (w ; (1,2,3,4,5))
Village	(.4;(0,0,.3,.4,.3))	(.1;(0,.6,.3,.1,0))	(.2;(0,0,.5,.2,.3))	(.3;(0,0,.6,.2,.2))
Town	(.3;(.4,.2,.2,0,0))	(.1;(0,.2,.5,.3,0))	(.3;(0,0,.5,.5,0))	(.3;(0,.0,.1,.4,.5))
City	(.4;(.4,.4,0,.2,0))	(.2;(0,0,.6,.3,.1))	(.1;(.1,.2,.7,0,0))	(.3;(0,.5,.2,.3,0))

Table 4 Comparison with the index of leisure of activities

Leisure activity	Very unsatisfied	Unsatisfied	Medium	Satisfied	Very satisfied
Village			Art/music 0.41	Exercise/games 0.8 Entertainment/tourism 0.77 Religion 0.7	
Town		Exercise/games 0.27	Art/music 0.56	Entertainment/tourism 0.66	Religion 0.89
City		Exercise/games 0.3	Entertainment/tourism 0.43 Religion 0.5	Art/music 0.66	

4.2 Fuzzy Statistical Analysis and Nonparametric Test for Leisure Activity with School Leaders

In the index of leisure activity for 20 school leaders, it shows in the analysis results that the defuzzification value is between 0.62 and 0.97 for the four indicators of the assessment system, indicating that each principal leisure activity index is high. It represented that the principals leisure activity management is good.

The whole results can first calculate the arithmetic mean of the indicators' values for each factor, but avoids the value of a certain factor being too low or equal to zero, influencing the overall results and generated errors, so the four factors should not use the arithmetic mean, but separately use the geometric mean of the four factors as the integrated leisure activity value. Table 3 shows the statistical result of the sampling survey.

From Table 3, we can see that the weight of religion and exercise/games has higher values than that of others in each group. It illustrates that most school leaders feel the religion and exercise/games have been emphasized on. The school leaders in the village reach the highest value at exercise/games. Generally, we can divide the index of satisfactory into five categories: *very unsatisfied, unsatisfied, medium, satisfied, and very satisfied*. From the survey of leisure activity about school leaders, we can get the fuzzy data shown in Table 4.

From Table 4, we can see that exercise/game in village of school leaders is higher than that of town and city. While the medium degree of satisfactory for art/music is in the village area, result from the fact that the few art/music demonstration or

Table 5 Wilcoxon rank-sum test for degree of satisfactory with different areas

Leisure activity	H_0: The degree of satisfactory for different population
Village vs town	Reject H_0; $W = 78.5$ out of the critical interval (29,61), $\alpha = 0.1$
Village v.s. city	Reject H_0; $W = 80.5$ out of the critical interval (29,61), $\alpha = 0.1$
Town vs. city	Accept H_0; $W = 47.5$ in critical interval (26,52)

shows there. For school leaders in town, the highest degree of satisfactory falls on religion. It seems that leaders in town need religion as a most important leisure activity. For leaders in the city, they feel that art/music is the most favorite activity. The reason that results from that is that it is convenient to reach the art/music activity.

From the leisure activity kind, the weight of religion and exercise/games is higher than the others; the meaning is almost school's leaders thinking the religion and exercise/games are important. Only the village school leaders' ILA exercise/games are reaching satisfactory; town and city school leaders ILA exercise/games are attaining unsatisfactory. It could be they are too busy to perform exercise/games. The town school leaders' ILA religion is reaching very satisfactory; maybe there are many chances and places to join.

In order to see the differences among these three groups, we use the Wilcoxon rank-sum test to see the result (Table 5).

H_0 : The degree of satisfactory of the population is the same.
H_1 : The degree of satisfactory of the population is not the same.

5 Conclusions and Suggestions

This study builds an integrated system to evaluate the efficiency of leisure activity and its impact on the management performance. Expert's fuzzy relative weight, obtained from the membership of four factors of leisure activities, is from 0.1 to 0.4; it shows difference slightly. We also found that interval fuzzy transformation is an interesting topic with great potential to interpret the fuzzy data. Because of vagueness and imprecision on human thinking, traditional statistics could not solve the problems in the field of social sciences. Soft computing with fuzzy theory is a reasonable statistical method for this kind of research.

In this research we utilize fuzzy statistics to fuzzy multiple evaluation in the leisure activities of school leaders to be able to establish appropriate model to leisure activities. According to literature research, we sum up five factors such as satisfaction, regularity, frequency, time, and classification. The study participants are leaders of sixty schools. We utilize fuzzy data of their membership to five factors to analyze proper leisure activities.

The questionnaire of this study is different from the traditional questionnaire. It is developed by fuzzy theory. Traditional questionnaires ignore fuzzy thinking of human beings unavoidably and may explain excessively. Thus, we can use fuzzy questionnaires to obtain more accurate information which can reflect experimenters' real opinion.

From this paper, we can see that leaders' fuzzy relative weight, obtained from the membership of four aspects of leisure activity, is from 0.1 to 0.4; comparing the fuzzy weight of every aspect, it shows significant difference. The comparative result of ILA is different from three areas of school's leaders of each aspect, as shown in Table 2. The ILA from three areas of school's leaders is different, as shown in Table 2. The ILA of village school leaders is almost higher than town and city.

Further research could be done on theoretical development of rule assessment methodology. Other cognitive issues on management performance like management reasoning and relation reasoning based on administration methodology in this study could be a prospective research. We drew conclusions from the result of the study.

References

C. Carlsson, R. Fuller, Benchmarking in linguistic importance weighted aggregations. Fuzzy Sets Syst. **114**, 35–41 (2000a)

C. Carlsson, R. Fuller, Multiobjective linguistic optimization. Fuzzy Sets Syst. **115**, 5–10 (2000b)

M.F. Chiang, B.L. Wu, R.D. Hu, Network sampling and fuzzy on-line statistics. J. Taiwan Intell. Tech. Appl. Stat. **6**(1), 55–72 (2008)

F. Herrera, E. Herrera-Viedma, Linguistic decision analysis: steps for solving decision problems under linguistic information. Fuzzy Sets Syst. **116**, 67–82 (2000)

C.K. Law, A fuzzy logical model to aggregate several heterogeneous educational grades from a reductionist grading scheme. Proceedings of 8th International Conference on the Teaching of Mathematical Modeling and Applications (1997)

W.Y. Liu, N. Song, The fuzzy association degree in semantic data models. Fuzzy Sets Syst. **117**, 203–208 (2001)

M.F. Liu, H.T. Yan, B.L. Wu, Fuzzy evaluation on work assessment and time management for the school leaders. International Symposium on Innovative Management, Information and Production IMIP2010, pp. 343–357 (2010)

M.F. Liu, H.T. Yan, B.L. Wu, New approach on measuring job stress for school leaders. International Symposium on Innovative Management, Information and Production IMIP2011, pp. 393–404 (2011)

H.T. Nguyen, B.L. Wu, *Fundamentals of Statistics with Fuzzy Data* (Springer, New York, 2006)

B. Wu, *Modern Statistics* (Chien Chen, Taipei City, 2000)

B. Wu, *An Introduction to Fuzzy Statistics*, (Wu Nan, Taipei City, 2005)

B. Wu, M.F. Liu, Z.Y. Wang, Fuzzy efficiency evaluation on school management. Int. J. Innovative Computing, Information and Control 8, no. 8, pp. 5787–5795. (2012)

L.A. Zadeh, Fuzzy sets. Inform. Control **8**, 338–353 (1965)

Instructors' Perceptions of Using Student Ratings for Improving Teaching Quality

Hao T. Nguyen

Abstract This work focuses on finding out how instructors react to the use of student rating of instruction whose purpose is to help instructors to improve their teaching quality. We design questionnaires as means to collect data and use statistical methods to shed light on this issue. Our findings are that instructors of lower division courses and female instructors tend to appreciate the usefulness of the student rating procedure.

Keywords Student rating • Teaching improvement • Instructors • Perceptions

1 Introduction

Student ratings of instruction have become integral to accountability in higher education (Zabaleta 2007). Besides peer evaluation, student rating of teaching in Vietnam colleges and universities is the requirement from Ministry of Education and Training in effort of instructional improvement. However, there are still different points of view that surround student ratings of teaching, especially instructors expressing their concerns on reliability and validity of student rating results. Given these concerns, the target of the present study is to examine instructors' perceptions of using student ratings for instructional improvement and their attitudes toward student ratings of instruction as well as utilizing student rating results for improving teaching practice based on empirical evidences at the University of Social Sciences and Humanities, Vietnam National University, Ho Chi Minh City (HCM-USSH).

H.T. Nguyen (✉)
University of Social Sciences and Humanities, Vietnam National University,
12 Dinh Tien Hoang Street, District 1, Ho Chi Minh City, Vietnam
e-mail: haonguyenpy2@yahoo.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_11,

2 Review of Literature

2.1 Reliability and Validity of Student Ratings

Reliability of student ratings of teaching is defined as consistency across time and across student rating instruments for an individual faculty member (Hooper and Page 1986) and related to the accuracy and precision of a measurement procedure. In comparison with reliability, validity is more complicated and controversial as well as important. As a common sense of validity, a measurement instrument is valid if it reflects what it intends to do. For student ratings of teaching is actually measure teaching effectiveness. If a device of student ratings is valid, that means the positive correlation of student ratings and teaching effectiveness is high. Researchers have generally supported the reliability and validity of student ratings even though the empirical results are not always consistent across studies (Greenwald 2002).

2.2 Using Student Ratings of Teaching for Improving Teaching

The most important purpose of student ratings is improving instructors' teaching and their courses. Regarding using student ratings of teaching for improving teaching staffs instruction, many studies have found mixed findings and not being stable. In a meta-analysis of Cohen (1980, p. 339), he pointed out that "student ratings are a valuable source for improving instruction at the college level." However, some studies reveal to have no such effects. As Yao and Grady's (2005, p. 507) citation, Rotem and Glasman (1979) reported that "feedback from student ratings does not seem to be effective for the purpose of improving performance of university teachers."

2.3 Instructors' Attitudes on Using Student Ratings

Studying attitudes about using student ratings in higher education among faculty members received diversity picture in terms of rating purposes. Some studies asserted a more positive outlook of instructors on utilizing student evaluations of teaching in general (Beran and Rokosh 2009; Schmelkin et al. 1997; Beran et al. 2002, 2005). However, there are still negative attitudes on this issue (Kulik and McKeachie 1975). Basically, instructors tend to approve that student ratings of teaching is an acceptable means of instructional improvement, but there still exists skeptical attitude of using student ratings of teaching for summative evaluation regarding personal decisions.

Since 2008 undergraduate student rating of teaching has been implemented in HCM-USSH for improving instruction quality. Student ratings of teaching surveys are administered at the end of each term and completed before final exams are taken, and typically anonymous without the presence of lecturers. After data of student ratings are collected and processed, reports are made available across instructors, faculty deans, and department heads and viewed as evidences of teaching activities.

3 Research Method

3.1 Participants

This study was conducted at HCM-USSH where it has 822 employees in which 503 serve as full-time teaching staff.[1] The questionnaire was sent to all full-time faculty ($N = 503$). 283 out of 503 faculty members, accounting for 56.3%, completed the survey. The sample quite parallels the university population in terms of demographic variables. The demographic information for participants is summarized in Table 1 below.

3.2 Instrumentation

This study used questionnaire survey to collect data. The survey, consisting of three sections, was developed by the researcher with counseling from assessment experts and referring to other studies concerning student ratings of teaching or student

Table 1 Distribution of faculty members' background variables ($N = 283$)

Background variables		Frequency	Percentage	Mean SD
Gender	Male	126	45	
	Female	150	53	
	Not specified	7	2	
	Bachelor degree	50	18	
Academic title	Masters' degree	149	53	
	Doctorate degree	77	27	
	Not specified	7	2	
	≤5 years	106	37	
Years of teaching experience	6–20 years	107	38	
	>21 years	56	20	
	Not specified	14	5	10.85 ± 9.3

[1] Academic year 2010–2011.

evaluation of teaching. With the exception of demographic variables, 24 items of two last sections use five-point Likert scale, which score 5 presenting the highest level of agreement.

3.3 Procedure

The questionnaire survey was twice mailed to all currently full-time teaching staff from May 15–June 5. The first time sent copy of survey and a cover letter explaining the study purpose and calling their help for completing the survey. Response rate for the first time is 39.2% ($n = 197$), with unresponsive mails sent with reminder email for the purpose of follow-up. Finally, there were 88 lecturers returning their feedback with valid responded surveys. There were only two responses excluded from data analysis because more than 35% items were not completed, leaving a total sample of 283. The data from the survey was entered into SPSS.

Descriptive statistics were employed for this study, such as frequencies, percentages, average, and standard deviation. Inferential statistics, T-test, and one-way Analysis of variance (ANOVA) were applied to find out significant differences of each item among various groups in terms of gender, and academic title.

3.4 Research Questions

Based on literature review, two research questions were formulated that served as the foundation for this study:

1. To what extent instructors agree with using student ratings of teaching for the purpose of improving teaching?
2. Are there differences in instructor perceptions of using student ratings of teaching for teaching purposes based on gender, and academic title?

4 Findings

The questionnaire asked for demographic information about each participants, including gender, academic title, and years of experience. As shown in Table 1, female sample (53%) was slightly higher than male sample (45%), a common practice in disciplinary of social sciences and humanities. Majority of instructors in HCM-USSH have been holding master's degree (53%), and only 27% of participants have doctorate degree, whereas 18% have bachelor's degree. The years of teaching experience ranged from 1 to 34 with an average of 10.85 years and were grouped into five categories: ≤ 5 years, 6–20 years, and >31 years. Most of instructors in HCM-USSH as a whole are from the young generation.

Table 2 Mean of using student ratings for teaching purposes according to lecturer perceptions ($N = 283$)

Student ratings used to	Mean	SD	Rank
Improving overall teaching quality	3.58	1.11	3
Improving instructors' treatment of students	3.94	0.80	2
Refining instructional objectives	3.25	1.05	5
Refining teaching contents	3.37	1.09	4
Refining teaching methods	4.20	0.65	1
Modifying mid C term and final exams	3.16	1.13	6.5
Altering course textbooks	3.16	3.11	6.5
Selecting support material	3.10	1.10	8

Table 3 Mean of using student ratings for teaching purposes according to lecturer perceptions ($N = 283$)

Student ratings used to	Mean	SD	Rank
The same instrument of student ratings can't be appropriate for all courses of different disciplines	4.05	1.07	1.5
I feel my career has been harmed to some degree by student ratings I have received	4.05	1.17	1.5
Student ratings should be conducted every semester	3.68	1.23	3
I am improving my teaching or my course from semester to semester based on ratings of students	3.47	0.81	4
Student ratings provide reliable feedback for planning changes in teaching	3.10	0.85	5

The first research question was addressed in the following section. Table 2 displays participant perceptions on using student ratings for teaching purposes at HCM-USSH. The results indicate that in general, participants highly rate on using student ratings for *refining teaching method* (mean = 4.20), improving instructors' treatment of students (mean = 3.94). It is important to note that *improving overall teaching quality* is rated at 3.58 out of five-point scale. In summary, agreement proportion of using student ratings for teaching purposes is not really high.

In Table 3 we sorted out five of the sixteen items; the highest scores of instructor ratings included "I feel my career has been harmed to some degree by student ratings I have received" (4.05), "The same instrument of student ratings can't be appropriate for all courses of different disciplines" (4.05), and "Student ratings should conduct every semester" (3.68). Remaining items kept in medium and low scores. In summary, instructors approve using of student ratings for instructional improvement with different instruments for various disciplines but they feel a little bit harmed regarding student feedback results.

Answer to research question 2 has multiple parts. Separated part of this question will be addressed independently. For gender, we used independent sample T-test to ascertain whether there were any statistically significant differences between male and female teachers for each item. Two out of eight items were found statistically significant difference at level 0.05: "Selecting support material" (p=0.020),

Table 4 ANOVA results of instructor perceptions among groups of academic title

Factor	Background variables	Mean difference	*P*	*F* (Between groups)
Improving overall teaching quality	Bachelor (A)			
	Master (B)	0.6307 (A–B)	0.002*	6.866
	PhD (C)			
Improving instructors' treatment of students	Bachelor (A)			
	Master (B)	0.3540 (A–B)	0.027*	4.990
	PhD (C)			
Refining instructional objectives	Bachelor (A)			
	Master (B)	0.9256 (A–B)	0.000**	21.232
	PhD (C)	0.9891 (A–C)	0.000**	
Refining teaching contents	Bachelor (A)			
	Master (B)	1.0187 (A–B)	0.000*	19.593
	PhD (C)	0.9473 (A–C)	0.000*	
Refining teaching methods	Bachelor(A)			
	Master (B)	0.5107 (A–B)	0.000**	
	PhD (C)	0.3782 (A–C)	0.004**	12.773
Modifying mid-term and final exams	Bachelor (A)	0.6387 (A–B)	.001*	
	Master (B)	1.0218 (A–C)	0.000*	14.701
	PhD (C)	0.3832 (B–C)	0.033*	
Altering course textbooks	Bachelor (A)	0.8123 (A–B)	0.000*	
	Master (B)	1.3236 (A–C)	0.000*	27.414
	PhD (C)	0.5113 (B–C)	0.001*	
Selecting support material	Bachelor (A)	−0.8123 (A–B)	0.000**	
	Master (B)	1.3236 (A–C)	0.000**	28.946
	PhD (C)	0.5113 (B–C)	0.000**	

$*p < 0.05$; $**p < 0.01$; $***p < 0.001$

(mean,male = 2.99; mean,female = 3.29); and "Altering course textbooks" (p = 0.015), (mean,male = 2.98; mean,female = 3.29). It could be said that female instructors found usefulness of student ratings for selecting teaching materials than did male counterparts.

ANOVA was employed to process first eight items about lecturer perceptions of using student ratings for purposes of teaching with a background variable, academic title. The results are presented with statistically significant differences at the 0.05 level for each factor.

There were eight statements that differed significantly in regard to academic title. Specifically, bachelor's degree holding instructors rated seven out of eight statements higher than did those with master's degree holding, except statement "Selecting support material." They also scored significantly higher than did those with doctorate degree holding on six items: "Refining instructional objectives," "Refining teaching contents," "Refining teaching methods," "Modifying mid-term and final exams," "Altering course textbooks," "Selecting support material." These statements, "Modifying mid-term and final exams," "Altering course textbooks," "Selecting support material" had significantly higher ratings for master degree holding instructors in comparing with doctorate degree holding ones. It is easy to recognize that the lower the level of educational degree instructor holding, the higher the rating of student feedback's usefulness for teaching purposes (Table 4).

5 Conclusions

Student rating of teaching is not a new topic regarding higher education. Yet, in Vietnamese tertiary education, this issue is still unexplored by researchers. This current study with sample of 283 instructors at HCM-USSH indicates that (a) instructors approve and support usefulness of student rating results for instructional improvement at moderation degree (b) they show disagreement with anecdotal controversy surrounding student ratings of teaching (c) lower level of educational degree has higher rating of student rating usefulness for teaching purposes (d) female lecturers rate helpfulness of student feedback for altering instructional material significantly higher than did male ones.

Acknowledgements The authors gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

References

T.N. Beran, J.L. Rokosh, Instructors perspectives on the utility of student ratings of instruction. Instr. Sci. **37**, 171–184 (2009)

T. Beran, C. Violato, T. Collin, The universal student ratings of instruction instrument at the University of Calgary: a review of a three-year pilot project. Submitted to the Office of the Provost and Vice-President (Academic) at the University of Calgary (2002)

T. Beran, C. Violato, D. Kline, J. Frideres, The utility of student ratings of instruction for students, faculty, and administrators: a "consequential validity" study. Can. J. High. Educ. **35**(2), 49–70 (2005)

P.A. Cohen, Effectiveness of student-rating feedback for improving college instruction: a meta-analysis of findings. Res. High. Educ. **13**, 321–341 (1980)

A.G. Greenwald, in *Constructs in Student Ratings of Instructors*, ed. by H.I. Braun, D.N. Jackson, D.E. Wiley. The Role of Constructs in Psychological and Educational Measurement (Erlbaum, New York, 2002)

P. Hooper, J. Page, Measuring teaching effectiveness by student evaluation. Issues Account. Educ. 56–64 (1986)

J.A. Kulik, W.J. McKeachie, in *The Evaluation of Teachers in Higher Education*, ed. by F.N. Kerlinger. Review of Research in Education, vol 3 (F.E. Peacock Publishers, Itaska, II1, 1975)

A. Rotem, N.S. Glasman, On the effectiveness of students evaluative feedback to university instructors. Rev. Educ. Res. **49**, 497–511 (1979)

L.P. Schmelkin, K.J. Spencer, E.S. Gellman, Faculty perspectives on course and teacher evaluations. Res. High. Educ. **38**(5), 575–592 (1997)

Y. Yao, M.L. Grady, How do faculty make formative use of student evaluation feedback?: a multiple case study. J. Personnel Eval. Educ. **18**, 107–126 (2005)

F. Zabaleta, The use and misuse of student evaluations of teaching. Teaching High. Educ. **12**, 55–76 (2007)

Determinant of Labor Income with Policy and Institutional Factors

Bing Xu, Fan Zhang, and Qiuqin He

Abstract The identification of determinant and mechanism on labor income is a key to supervision labor income share. In this paper, we find that labor income depends not only on the production factors but also on the institutional and policy factors using nonparametric variable detection method. With the institutional and policy factors, determinants are constraint more than just promotion on influencing essentially the labor income, and mechanism is transition between linear and nonlinear in China during 1983–2009. As the results, we explain why the contradictory results about technological progress, trade, and industry structure are or not the determinant of labor income and provide decision support empirically on the institution design and policy implementation of labor income.

Keywords Labor income share • Nonparametric variable detection • Determinant • Institution design and policy implementation

1 Introduction

The past 30 years witnessed a great change in China's economy since China made the reform and opening-up into practice. However, the labor income share is decreasing persistently with the rapid development of China, and the trend of decreasing was even more dramatic in the recent years, which is not in accordance with China's rapid growing. China's labor income share is only a little bit higher than the Latin American countries whose income distribution is unbalanced. So it is meaningful to identify the determinant of the labor income share and its mechanism.

B. Xu (✉) • F. Zhang • Q. He
Research Institute of Quantitative Economics, Zhejiang Gongshang University, Hang Zhou, China
e-mail: bingxu@zjgsu.edu.cn; alex1231boy@163.com; heqiuqin1989@126.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_12,

Labor income share depends on the co-affection of several variables. Considering the production factors, the neoclassical economics consider capital-output ratio, per capita amount of capital, and technological progress as the benchmark explanatory variables to labor income according to the production function (Bentolina and Saint-Paul 2003; Luo and Zhang 2009; Xiao and Zhou 2010; Raurich et al. 2012 etc.). Zhou et al. (2010b) explain the determinant theory of labor income share from three different perspectives: neoclassical factors, globalization policy, and institutions.

Considering the policy, the mechanism of trade policy and industrial policy to labor income share draws great considerations (Jaumotte and Tytell 2008; Arpaia et al. 2009; Bai and Qian 2010; Lawless and Whelan 2011). While Luo and Zhang (2009) and Decreuse and Maarek (2011) consider that the Foreign Direct Investment (FDI) influence has influence on the labor share.

Considering the institution, the study is all about variables like economic development, governmental revenue and expenditure, scale of state-owned enterprises, and tax burden. The influence of economic development is in complex and nonlinear way (Li et al. 2009; Luo and Zhang 2009); the influence of governmental revenue and expenditure is more profound than the industrial structure, which is characterized as indirect, persistent, and crowd in (Fang 2011); Bai and Qian (2010) find the influence of tax burden is non-neutral empirically.

The study on labor income share considers various explanatory variables, but the results are not the same. There are three aspects of contradictory results at least.

Question 1: The influence of technological progress to labor income share. Luo and Zhang (2009) and Bai and Qian (2009b) find the influence is not significant, while Xiao and Zhou (2010) find it is significant.

Question 2: The influence of imports and exports to labor income share. It is not significant in the study of Bai and Qian (2009a) and Luo and Zhang (2009), but it is on the contrary in the study of Jiang and Zhang (2008) and Zhou et al. (2010a).

Question 3: The influence of industry structure to labor income share. The result of significant influence has been widely accepted. But few find the influence is not significant enough (Fang 2011).

In this paper, we identify the determinant and mechanism of labor income share using mixed data nonparametric variable detection method and try to give a solid explanation about the three contradictory results.

2 Variable, Data, and Econometrics Method

Labor income share: In this paper, we define the labor income share as the ratio of the labor remuneration to GDP.

The ratio capital to yield measures the deeping of capital, presented as kty. And we employ the per employer yield as the measure of technological progress, presented as tech. The ratio of FDI to GDP uses as the measure of fdi in this paper. The ratio of imports and exports to GDP is the agent variable for the openness, presented as trd. sir and tir measure the change of the secondary and tertiary industry. We use GDP per capita as the measure of economic development, presented as dev. The ratio of governmental revenue and expenditure to GDP is of importance to explain the labor income share; we use goi and goe to present the two explanatory variables. The scale of state-owned enterprises is measured by the employment of state-owned enterprise to the total employment, presented as soe. While tax represents the tax burden which is measured by the net taxes on production to GDP. All of the data we take in this paper are downloaded from the National Statistics Bureau.

Now we give an introduction about the mixed data nonparametric variable detection method (Li and Racine, 2004), which is the core econometric method we take. The regression model we build in this paper: $Y = g(X) + \varepsilon$.

Local constant least square (LCLS) method can estimate the unknown function:

$$\hat{g}(x) = (i'K(x)i)^{-1} i'K(x)Y, \tag{1}$$

where $Y = (Y_1, Y_2, \ldots, Y_n)'$, i is a $n \times 1$ vector of ones, and $K(x)$ is a diagonal n matrix of kernel weighting functions, where $K(x)$ represents the kernel weighting functions for mixed continuous and discrete data.

Local linear least square (LLLS) method is almost the same with LCLS method, which is about the weighted least square estimate with weights determined by kernel functions and bandwidths, but more weight is given to the point than LCLS.

The respective bandwidths (h, λ) of the variables can be computed through cross-validation (C.V.) method. When the LCLS method bandwidths reach its upper bound, the kernel weighting function of that bandwidth becomes a constant; the variable belonging to the bandwidth is essentially detected (Hall et al. 2007). And LLLS method bandwidths reach the upper bound, the ordered or unordered discrete data should be detected, but for the continuous data, it indicated they should model in a linear way.

Hall et al. (2007) suggest two standard deviations of the variables is an upper bound for identification of relevant and linear. For the discrete data, if the bandwidth reaches its upper bound one, these variables should be detected from our model.

We adopt the variable detection steps recommended by Henderson et al. (2011):

Step 1: Identification of the relevant variables or determinant using LCLS

Step 2: After detection of the irrelevant variables through Step1, identification of the mechanism (linearity or not) of the relevant variables using LLLS

3 Empirical Results: National and Provincial

3.1 National Data

We adopt the national data from 1983 to 2009:

LLLS method shed light on the mechanism problems. Trade policy and technological progress have a linear influence on the labor income share, and the influence of economic development, the ratio capital to yield, and tertiary industry are nonlinear. Li et al. (2009) find there exists a nonlinear U-shape relationship between labor income share and economic development, and our results testify their nonlinear judge.

In the second column of Table 1, we consider ten variables as the candidate and then detect five of them using nonparametric variable detection method. Table 2 gives an MSE comparison between the model before and after the detection. We can find that after the detection the MSE drop one order of magnitude; we can conclude that the nonparametric variable detection method is feasible.

3.2 Provincial Data

The essence of our paper is to select the relevant variables from a lot of variables, so we employ a novel modeling method different from the classical panel data method. We treat the difference between region and time as the discrete variables in our method and have variable selection with continuous variables.

Table 1 Nonparametric variable detection of national data

Variable	LCLS	LLLS	2 standard deviations
goi	26512.16 *	–	0.07680
goe	39195.29 *	–	0.07426
fdi	7924.517 *	–	0.00422
trd	0.02402	0.41376 *	0.28409
dev	6702.74	4063.736	14383.93
kty	0.03815	0.06729	0.60613
tech	1.10121	5.49864 *	2.50334
soe	58360.25 *	–	0.07933
sir	36921.77 *	–	0.03890
tir	0.00332	0.02058	0.11203
tax	26512.16 *	–	0.07680

Table 2 The MSE comparison

Comparison	LCLS	LLLS
Mean square error (MSE)	2.42061e-07	6.05954e-08

Table 3 Nonparametric variable detection of national data

Variable	Production	Region	Policy	Institution	Complex	2 standard deviations
kty	0.03144	0.02859	0.03611	0.03207	0.05408	0.60655
tech	0.32101	0.45622	4083172*	18840362*	5559999*	4.87432
year	0.53816	0.52963	0.51647	0.25312	0.75155	–
region	–	0.22078	0.50907	0.00744	0.51346	–
fdi	–	–	0.00066	–	4708.709*	0.00929
trd	–	–	0.01224	–	0.00844	0.10363
sir	–	–	0.01774	–	0.02719	0.15577
tir	–	–	0.00928	–	0.03471	0.13892
dev	–	–	–	1530.480	1250.829	24413.41
goi	–	–	–	0.00465	0.00880	0.07283
goe	–	–	–	0.12027	0.03076	0.12466
soe	–	–	–	0.03236	0.05394	0.18561
tax	–	–	–	0.00849	0.01076	0.06896

Table 3 is the bandwidths we calculate from LCLS. The last column of the table gives a complex perspective which incorporates all of the variables.

The provincial complex perspective gives us a hint: the variables we consider except technological progress and FDI are the determinant, which is in accordance with the results achieve using the national data in some extent. From national data, FDI is not the determinant; the ratio capital to yield, trade, tertiary industry, and economic development are the determinants. But technological progress is not the determinant using the provincial data, which is an exception, we consider the difference in the next part.

While LLLS method, from provincial complex perspective, finds the ratio capital to yield, government revenue and expenditure and secondary and tertiary industry have an influence in a linear way, and trade, economic development, the scale of state-owned enterprises, and tax burden are nonlinear.

3.3 Solution to Problems

Question 1: Our empirical analysis finds technological progress is not the determinant using the provincial panel data. So we give a possible explanation: Luo and Zhang (2009) find it is not significant, but Xiao and Zhou (2010) find it is significant and linear; we find the difference stems from the different data they adopt, using provincial data or national data may have different empirical results.

Question 2: Our empirical results find, when we consider FDI, trade, and secondary and tertiary industry as the policy factors, the influence of trade (import and output) is nonlinear, but not linear. Referring to complex factors, the influence of trade is linear, but not nonlinear. The contradictory results between

Bai and Qian (2009a) and Jiang and Zhang (2008) are the problem about how to model the nonlinear variables. The simple linear model can find the linear significance, but not the nonlinear significance, the difference stems from the simple linear modeling methods.

Question 3: From our results, the influence of secondary and tertiary industry is nonlinear and linear under policy perspectives but both linear under complex perspectives. Our finding supports most of study about the significance of industry structure, which adopt the linear model specification. But Fang (2011) finds the influence of individual industry is significant, but when they merge different industry together, the influence change from significance to insignificance. We find the difference arises owing to the mechanism of secondary industry is nonlinear according to our finding.

4 Economic Regions

In the classical economic region analysis papers, China is divided into three parts (East, Middle, West). From our results, if the difference between regions is big enough and the connections are small enough, the bandwidth of region should be close to 0. But the bandwidth of classical division is about 0.5. We set the GDP per capita of 2009 as the new division rule: setting the GDP per capita as our new division rule is beneficial that the bandwidths of region is almost 0 now.

4.1 The First Economic Region

The province whose GDP per capita is above 25,000 RMB is the so-called the first economic region, which consists of Shanghai, Beijing, Tianjin, Jiangsu, Zhejiang, Guangdong, Neimenggu, Shandong, Liaoning, Fujian, and Jilin.

In the first economic region, technological progress is the determinant. It has a nonlinear way considering the institutional factors; it has a linear way considering the policy factors; it has a linear way considering the complex factors combined the policy and institutional factors. Trade is the determinant as well, the influence of which is linear. Considering the complex factors, the influence is nonlinear. Secondary industry is the determinant and has a linear way under the policy perspective, but it is not the determinant under the complex modeling way. On the contrary, tertiary industry is not the determinant under the policy perspective but changes to the determinant under the complex modeling method and has a linear way.

4.2 The Second Economic Region

The province whose GDP per capita is between 20,000 RMB and 25,000 RMB is the so-called the second economic region, which consists of Hebei, Hubei, Heilongjiang, Ningxia, Shanxi, Shannxi, Henan, Hunan, Sichuang, and Chongqing.

In the second economic region, technological progress is the determinant and has a linear way considering the policy factors. But under the institutional perspective and complex perspective, technological progress is no longer the determinant anymore. These results give us an insight that the institutional factors may coerce the technological progress becoming the determinant. Under the policy perspective, trade is not the determinant. Considering the complex factors, trade changes into the determinant, and the influence is linear. The institutional factors promote the trade becoming the determinant. Secondary industry is the determinant and has a linear way under the policy perspective and the complex modeling way. And tertiary industry is the determinant and has nonlinear way under the policy perspective, but under the complex modeling method, it has a linear way.

4.3 The Third Economic Region

The province whose GDP per capita is below 20,000 RMB is the so-called the third economic region, which consists of Guizhou, Gansu, Yunnan, Guangxi, Anhui, Jiangxi, Hainan, Qinghai, and Xinjiang. In the third economic region, technological progress is not the determinant. But under the complex perspective, technological progress is the determinant and has a linear way. The results give us an insight that institutional and policy factors may promote the developing of labor income in a mutual way. Under the policy and complex perspective, trade is not the determinant; secondary industry is the determinant and has a nonlinear way. And tertiary industry is the determinant and has nonlinear way under the policy perspective, but under the complex modeling method, it is not the determinant anymore. The coercion of institutional factors to labor income is evident.

5 Conclusion

5.1 Institutional Factors May Restrict the Variables to be Irrelevant

Technological progress, using the national data, is the determinant, but is not the determinant using the provincial data. Technological progress is the determinant and has a linear way in the first and third economic regions under the complex perspective. In the second economic region, technological progress is the determinant and has a linear way under the policy factors, but not the determinant owing to the restriction of institution factors.

5.2 The Openness of Regional Economy May be Testified

Trade, using the national and provincial data, is the determinant and has a linear way in the national side but a nonlinear way in the provincial side. In the first and second economic regions, under the complex perspective, trade is the determinant and has a nonlinear and linear in the respective economic regions. But as we can find from the result of third economic regions, trade is not the determinant anymore.

5.3 Policy Factors May Promote the Variables to be Relevant

Considering the industry structure, the secondary industry is not the determinant using the national data, but is the determinant and has a linear way using the provincial data. In the secondary and third economic industry, under the complex perspective, secondary industry is the determinant and has a nonlinear way, but in the first economic region, it is not the determinant, while under the policy factors, it is the determinant and has a linear way, the result about the irrelevance stems from the restriction of institution factors. Tertiary industry is the determinant using the national and provincial data and has a nonlinear and linear way, respectively. In the first and second economic regions, tertiary industry is the determinant and has a linear way, but in the third economic regions, it is not the determinant owing to the institutional factors, while under the policy factors, tertiary industry is the determinant and has a nonlinear way.

To sum up, using national, provincial, and regional data may get different results, which stems from the different data we adopt for one side. Furthermore, the institutional and policy factors influencing mutually the labor income with constraint more than just promotion and changing the mechanism from linear to nonlinear are the essential causes.

Acknowledgements This paper is supported by the National Natural Science Foundation of China(70973110).

References

A. Arpaia, E. Perez, K. Pichelmann, Understanding labor income share dynamics in Europe. European Commission Economic Papers, vol. 37 (2009)

S. Bentolina, G. Saint-Paul, Explaining movements in labor income share. Contrib. Macroecon. **3**(1), 141–150 (2003)

C. Bai, Z. Qian, On the increase in the chinese aggregate capital income share: an investigation from provincial perspective. J. Tsinghua Univ. (Philos. Soc. Sci.). **24**(4), 137–147 (2009a)

C. Bai, Z. Qian, Factor income share in China: the story behind the statistics. Econ. Res. J. **3**, 27–41 (2009b)

C. Bai, Z. Qian, Determinants of labor income share: evidence from Chinese provincial panel data. J. World Econ. **12**, 3–27 (2010)

B. Decreuse, P. Maarek, FDI and the labor share in developing countries: a theory and some evidence. Working Paper (2011)

W. Fang, Determinants of labor income share: the effect of industrial structure or fiscal policies. J. Financial Res. **2**, 32–41 (2011)

P. Hall, Q. Li, J. Racine, Nonparametric estimation of regression functions in the presence of irrelevant regressors. Rev. Econ. Stat. **89**, 84–89 (2007)

D. Henderson, C. Papageorgiou, C. Parmeter, Growth empirics without parameters, Econ. J. **122**, 125–154 (2011)

F. Jaumotte, I. Tytell, How has the globalization of labor affected the labor income share in advanced countries? Working Paper (2008)

L. Jiang, Y. Zhang, Impacts of foreign trade on labor distribution ratio: analysis of China's provincial panel data. J. Int. Trade **10**, 26–33 (2008)

M. Lawless, K. Whelan, Understanding the dynamics of labor shares and inflation. J. Macroecon. **33**, 16 (2011)

Q. Li, J. Racine, Nonparametric estimation of regression functions with both categorical and continuous data. J. Economet. **86**, 266–292 (2004)

D. Li, L. Liu, H. Wang, The U curve of labor share in GDP during economic development. Econ. Res. J. **1**, 70–82 (2009)

C. Luo, J. Zhang, The economic explanation of the decreasing labor income share: analysis of China's provincial panel data. Manag. World **5**, 25–35 (2009)

X. Raurich, H. Sala, V. Sorolla, Factor shares, the price markup, and the elasticity of substitution between capital and labor. J. Macroecon. **34**, 181–198 (2012)

W. Xiao, M. Zhou, Change of trade mode and decrease of labor share: emprical evidences from China's industrial sector. J. Zhejiang Univ. (Humanities Soc. Sci.). **40**(13), 154–163 (2010)

M. Zhou, W. Xiao, X. Yao, Enterprise heterogeneity, ownership structure and labor income share. Manag. World **10**, 24–33 (2010a)

M. Zhou, W. Xiao, X. Yao, The decrease of China's labor income share: the development of measure and explanation. World Econ. Pap. **6**, 92–105 (2010b)

Dynamic Copula-Based GARCH Model Analysis China Outbound Tourism Demand

Jiechen Tang, Songsak Sriboonditta, Xinyu Yuan, and Berlin Wu

Abstract This paper used dynamic copula-GARCH model to analysis volatility and dependency of China outbound tourism to four leading countries, namely, Thailand, Singapore, South Korea, and Japan. It was found that Japan, South Korea, and Thailand have high volatilities. Furthermore, the conditional dependence is time-varying and different copulas generate different the time path dependence structure. There is seasonal seasonal effect; the summer holiday and Chinese Spring Festival have positive effects on the all destinations. Finally, most of the time, Thailand and Singapore have the highest conditional dependence. The result indicates that Thailand and Singapore have a complementary relationship.

Keywords China outbound tourism • GARCH model • Skewed Student-t distribution • Dependency • Dynamic copula

1 Introduction

Over the last decade, there has been strong growth in China's outbound tourism. The main factors that generally affect outbound travel are the confidence of continued and rapid economic growth, constant increasing income, furthermore the government's favorable policy framework, increased leisure time, and RBM appreciation. According to the National Bureau of Statistics of China, the outbound tourism of

J. Tang (✉) • S. Sriboonditta • X. Yuan
School of Economics, University of Chiang Mai 2397. Suthep, A.Mueang, Chiang Mai, Thailand
e-mail: tangjiechen1002@163.com; songsak@econ.cmu.ac.th; ynandre@hotmail.com

B. Wu
Department of Mathematics, University of National Chengchi, No. 64, Sec. 2, ZhiNan Rd., Wenshan District, Taipei City, Taiwan
e-mail: berlin@nccu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_13,

China underwent a rapid growth from 2000 to 2010. Outbound travel has increased from around 10.5 million in 2000 to 57.4 million in 2010, the average annual growth rate is 18.5% Tourism Flows Outbound C China (2010). According to the WTO, China placed third position in international tourism spending in 2010 UNWTO Tourism Highlights 2011 Edition (2011). This information highlights that China has became one of most important tourism source country in the global tourism market, and continuous growth of outbound tourism will bring tremendous business opportunities.

The purpose of this study is to examine the time-varying volatility and time-varying dependence structure among the destinations in China outbound tourism demand, we selected South Korea, Japan, Singapore, and Thailand as sample for this study (the top four tourism destinations for China mainland tourist). Based on the motivations discussed above, four research questions were formulated for this study: (1) Is the volatility high or low among the four destinations? (2) What is the conditional dependence among the four destinations? (3) Is the dependence between the four destinations time-varying over the study time horizon? (4) Is the dependence negative (substitute) or positive (complement) among the four destinations? The answer of these four questions can be used to help destination manager and policy makers.

This paper is organized as follows. Section 2 provides a literature review of the tourism demand. Section 3 describes the econometrics models used in the paper, namely, dynamic copula—GARCH. Section 4 discusses the data presented in the paper and also describes the estimate results of four kinds of copula-based GARCH. The last section provides implications for policy planning and destination management.

2 Literature Review

A large number of scholars have used the autoregressive conditional heteroskedasticity (GARCH) model as their tourism model (Chan et al. (2005); Shaeef and McAleer (2005, 2007); Seo et al. (2009); Kim and Wong (2006); Bartolom et al. (2009); Coşkun and Özer (2011); Daniel and Rodrigues (2010)). The univariate the autoregressive conditional heteroskedasticity (GARCH) model was applied in the Shaeef and McAleer (2005), Kim and Wong (2006), Bartolom et al. (2009), and Daniel and Rodrigues (2010), which analyze tourism demand at different time series frequencies, ranging from monthly, weekly, and daily data. However, the univariate GARCH model has a drawback that it cannot examine the conditional correlation or dependence among destination. Hence, Chan et al. (2005), Shaeef and McAleer (2005), and Bartolom et al. (2009) developed multivariate GARCH model for researching tourism demand, based on the univariate GARCH model. For example, Chan et al. (2005) used the symmetric CCC-MGARCH, symmetric VARMA-GARCH, and asymmetric VARMA-GARCH to study Australia's tourism demand from the four leading source countries. They examined the presence of interdependent effects in the conditional variance between the four leading countries and the asymmetric effect of shocks in two of the four countries. Seo et al. (2009) applied the multivariate GARCH model to analyses of the relationships in Korea outbound tourism demand. It found that conditional correlation among tourism demand was time-varying.

However, multivariate GARCH models such as the CCC-GARCH, DCC-GARCH, or VARMA-GARCH models are somewhat restrictive due to their requirements of normality for the joint distribution and linear relationships among variables. To account for nonlinear and time-dependent dependence, the parameters of the copula functions were assumed to follow dynamic processes conditional to the available information. This study applied four kinds of copula-based GARCH to estimate the conditional dependence structure as a measure of analyzing the time-varying relationship of tourism demand for the leading destinations. Recently, the copula-based GARCH model becomes popular in analyzing economic studies, especially in financial (Patton 2006; Ane and Labidi 2006; Ning and Wirjanto 2009; Wang et al. 2011; Wu et al. (2011); Reboredo 2011). As far as we know, there is no study applying copula-based GARCH model to investigate the dependence among tourism demands. Thus, in this study, we fill in the gap in literature by employing the copula-basedGARCH model to examine dependence among tourism demands.

3 Econometrics Models

3.1 The Model for the Marginal Distribution

The GARCH (1, 1) model can be described as follows:

$$y_{i,t} = c_0 + c_1 y_{i,t-1} + c_2 e_{i,t-1} + \sum_{i=1}^{2} \varphi_i D_{i,t} + e_{i,t} \tag{1}$$

$$e_{i,t} = \sqrt{h_{i,t}} x_{i,t}, x_{i,t} \sim \mathrm{SkT}(x_i | \eta_i, \lambda_i) \tag{2}$$

$$h_{i,t} = \omega_{i,t} + \alpha_i e^2{}_{i,t-1} + \beta_i h_{i,t-1} \tag{3}$$

where $D_{i,t}$ are seasonal dummies ($D_{1,t}$ and $D_{2,t}$ are Chinese Spring Festival and summer holiday, respectively) and capture the impact of the seasonal effects. The condition in the variance equation are $\omega_i > 0, \alpha_i, \beta_i \geq 0$ and $\alpha_i + \beta_i < 1$. In order to capture the possible asymmetric and heavy-tailed characteristics of the tourism demand returns, the error term of $e_{i,t}$ is assumed to be a skewed-t distribution. The density function is followed by Hansen (1994):

$$\text{skewed} - t\,(x | \eta, \lambda) = \begin{cases} nd\left(1 + \frac{1}{\eta-2}\left(\frac{nx+m}{1-\lambda}\right)^2\right)^{-(\eta+1)/2} & , x < -\frac{m}{n} \\ nd\left(1 + \frac{1}{\eta-2}\left(\frac{nx+m}{1+\lambda}\right)^2\right)^{-(\eta+1)/2} & , x \geq -\frac{m}{n} \end{cases} \tag{4}$$

The value of m, n, and d are defined as

$$m \equiv 4\lambda d \frac{\eta - 2}{\eta - 1}, n^2 \equiv 1 + 2\lambda^2 - n^2 \text{ and } d \equiv \frac{\Gamma(\eta + 1/2)}{\sqrt{\pi(\eta - 2)}\,\Gamma(\eta/2)}$$

where λ and η are the asymmetry kurtosis parameters and the degrees of freedom parameter, respectively. λ is restricted within $(-1, 1)$.

3.2 The Copula Model for Joint Distribution

In this paper we employed two families of copula model to describe the dependence structure between the four destinations that are two elliptical (Gaussian and Student-t copulas) and two Archimedean's copula model (Gumbel and Clayton copulas). The Gaussian copula and Student-t describe the symmetric dependence, while the Gumbel copula and Clayton copula reflect the asymmetric dependence. These copula models and the statistical inference derived from them are briefly discussed below.

The density of the time—varying Gaussian copula is then

$$C_t^{\text{Gau}}(a_t, b_t | \rho_t) = \frac{1}{\sqrt{1 - \rho_t}} \exp\left\{ \frac{2\rho_t x_t y_t - x_t^2 - y_t^2}{2(1 - \rho_t^2)} + \frac{x_t^2 + y_t^2}{2} \right\} \tag{5}$$

The density of the time-varying Student-t copula is

$$C_t^T(a_t, b_t | \rho_t, n) = \frac{1}{\sqrt{1 - \rho_t}} \left\{ 1 + \frac{-2\rho_t x_t y_t + x_t^2 + y_t^2}{n\left(1 - \rho_t^2\right)} \right\}^{-\frac{n+2}{2}} \tag{6}$$

where $x_t = \phi^{-1}(a_t), y_t = \phi^{-1}(b_t)$, and $\phi^{-1}(.)$ denote the inverse of the cumulative density function of the standard normal distribution. n is degrees of freedom and P_t is the degree of dependence between a_t and b_t, it belong to $(-1, 1)$.

The density of the time-varying Gumbel copula is

$$\begin{aligned} C_t^{\text{Gum}}(a_t, b_t | \tau_t) = {} & \frac{(-\ln a_t)^{\tau_t - 1}(-\ln b_t)^{\tau_t - 1}}{a_t b_t} \exp\left\{ -\left[(-\ln a_t)^{\tau_t - 1} + (-\ln b_t)^{\tau_t - 1} \right]^{\frac{1}{\tau_t}} \right\} \\ & \times \left\{ -\left[(-\ln a_t)^{\tau_t - 1} + (-\ln b_t)^{\tau_t - 1} \right]^{\left(\frac{1-\tau_t}{\tau_t}\right)^2} \right. \\ & \left. + (\delta_t - 1)\left[(-\ln a_t)^{\tau_t - 1} + (-\ln b_t)^{\tau_t - 1} \right]^{\frac{1-2\tau_t}{\tau_t}} \right\} \end{aligned} \tag{7}$$

where τ is the degree of dependence between a_t and b_t, and within $[1,+\infty)$, $\tau_t = 1$, shows no dependent and if τ_t increase to infinity which represents a fully dependence relationship between a and b. The Gumbel copula can capture the right tail dependence. The density of the time-varying Clayton copula is

$$C_t^{\text{Glay}}\left(a_t, b_t \,|\, \tau_t\right) = \left(\tau_t + 1\right)\left(a_t^{-\tau_t} + -b_t^{-\tau_t}\right)^{-\frac{2\tau_t+1}{\tau_t}} a_t^{-\tau_t-1} b_t^{-\tau_t-1}, \tag{8}$$

where $\tau_t \in [0,+\infty)$ is the degree of dependence between a_t and b_t, $\tau_t = 0$ implies no dependence, and $\tau_t \to \infty$ represents a fully dependent relationship. The Clayton copula can capture the left tail dependence.

In the dynamic Gaussian copula and Student-t copula, we commonly use Pearson's correlation coefficient ρ_t to describe the dependence structure. On the other hand, we use the τ_t on the Gumbel and Clayton copula. The dependence process of the Gaussian and Student-t are

$$\rho_t = \Lambda\left(\alpha_c + \beta_c \rho_{t-1} + \gamma_c (a_{t-1} - 0.5)(b_{t-1} - 0.5)\right). \tag{9}$$

The dependence process of the Gumbel is

$$\tau_t = \Lambda\left(\alpha_c + \beta_c \tau_{t-1} + \gamma_c (a_{t-1} - 0.5)(b_{t-1} - 0.5)\right). \tag{10}$$

The conditional dependence, ρ_t and τ_t determined from its past level, ρ_{t-1} and τ_{t-1}, captures the persistent effect, and $(a_{t-1} - 0.5)(b_{t-1} - 0.5)$ captures historical information. In this paper, we follow Patton (2006) to use the historical information $\frac{1}{10}, \sum_{i=1}^{10} |a_{t-1} - b_{t-1}|$. We proposed time-varying dependence processes for Clayton copula as

$$\tau_t = \Pi\left(\alpha_c + \beta_c \tau_{t-1} + \gamma_c \frac{1}{10} \sum_{i=1}^{10} |a_{t-1} - b_{t-1}|\right). \tag{11}$$

3.3 Estimation and Calibration of the Copula

In this paper, we use IFM method to estimate the parameters of our copula-based GARCH model. The efficiency equation is as follows:

$$\hat{\theta}_{it} = \arg\max \sum_{t=1}^{T} \ln f_{it}\left(x_{i,t}, \theta_{it}\right) \tag{12}$$

$$\hat{\theta}_{ct} = \arg\max \sum_{t=1}^{T} \ln c_{it}\left(F_{it}\left(x_{1,t}\right), F_{2t}\left(x_{2,t}\right), \cdots, F_{nt}\left(x_{n,t}\right), \theta_{ct}, \hat{\theta}_{it}\right) \tag{13}$$

4 Empirical Result

4.1 Descriptive Data

In order to estimate the dynamic dependence structure of tourism demand in the top destination, this research designated the proxy variable the number of China's tourist arrivals to the following four destinations: Thailand, Singapore, South Korea, and Japan. China monthly tourist arrival data from Jan 1997 to Oct 2011 were used for this study, yielding a total of 178 observations. The data are obtained from Bank of Thailand, Singapore Tourism Board, Japan National Tourist Organization, and Korea Tourism Organization, respectively. China's monthly tourist arrival series are plotted in Fig. 1, which rises over time and along clear cyclical seasonal patterns, although tourist arrivals fell sharply around the time of SARS (2003) and the global financial crisis (2008 and 2009).

In building a model, most of the economic time series data are processed with the use of the logarithmic transformation. Hence, the monthly tourist arrival return $r_{i,t}$ is computed a continuous compounding basis as $y_{i,t} = \mathrm{Ln}(Y_t/Y_{t-1})$, where Y_t and Y_{t-1} are current and one-period lagged monthly tourist arrivals. $y_{i,t}$ is $y_{\mathrm{thai},t}$, $y_{\mathrm{sing},t}$, $y_{\mathrm{korea},t}$, and $y_{\mathrm{jap},t}$ as incremental rate of Chinese tourist arrivals in Thailand, Singapore, South Korea, and Japan, respectively. The tourist arrival incremental rates are plotted in Fig. 2, which show the GARCH model is appropriate for modeling the

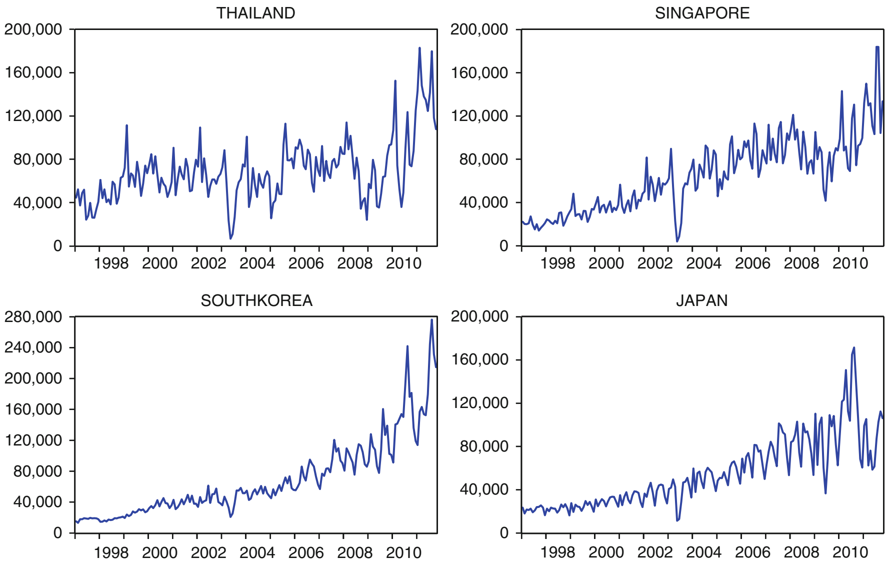


Fig. 1 Chinese tourist arrivals to each destination

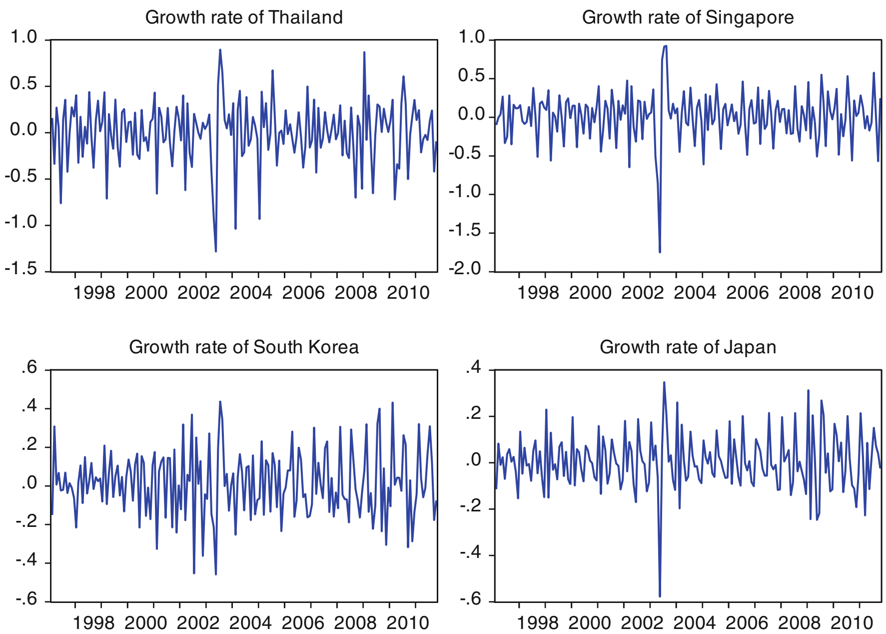


Fig. 2 Log Chinese tourist arrivals rate to four destinations

Table 1 Summary statistics for the incremental rate of Chinese tourist arrival

	Thailand	Singapore	South Korea	Japan
Mean (%)	0.005006	0.010129	0.014975	0.003711
SD (%)	0.335940	0.315345	0.169541	0.119375
Skewness	−0.708892	−0.959877	0.042120	−0.231925
Excess kurtosis	4.487008	8.061693	3.007216	5.611665
Max (%)	0.897066	0.923611	0.436791	0.347800
Min (%)	−1.281747	−1.750788	−0.459033	−0.578180
JB	31.13210	216.1332	0.052720	51.89012

tourist arrival return.[1] The descriptive statistics for the incremental rate of Chinese tourist arrival for each destination are reported in Table 1, which show that all series have heavy tail and they do not follow normal distribution. Hence, we introduced skewed-t distribution to this paper.

The data should be stationary for modeling GARCH model; thus, testing unit-roots is essential. Augmented Dickey-Fuller (ADF, Dickey & Fuller 1979) and Phillips-Perron (Phillips & Perron (1988)) can perform the test for unit-root. Table 2 shows the results of unit-root tests. The tests strongly support the null hypothesis of unit-root for the first difference of log-transformed.

[1] The large (small) incremental rate is followed by a large (small) incremental rate. It implies that there is a conditional variance processes in the data.

Table 2 Tests of hypotheses of unit-root

Variables	ADF Level	ADF Log of first difference	PP Level	PP Log of first difference
Thailand	−5.10972∗∗	−12.04982∗∗	−4.98858∗∗	−28.3882∗∗
Singapore	−0.30905**	−7.43598∗∗	−3.77929∗∗	−40.76052∗∗
South Korea	2.71588**	−5.55876∗∗	−0.09804**	−33.4513∗∗
Japan	−0.8423∗∗	−4.5195∗∗	−4.4855∗∗	−32.9507∗∗

Note: The critical values for the rejection of the null hypothesis of a unit-root are −3.451, and −2.870 for 1% and 5%, respectively. The symbol ** and * denote rejection of the null hypothesis at the 1% and 5% significance levels, respectively

Table 3 Result for GARCH model

	GARCH Thailand	Singapore	South Korea	Japan
C_0	−0.0413∗∗∗	−0.0352∗∗∗	−0.0151∗∗	−0.0211∗∗∗
	(0.0134)	(0.0110)	(0.0061)	(0.0037)
C_1	−0.5842∗∗∗∗	−0.5626∗∗∗	−0.3403∗∗∗	0.0626
	(0.0579)	(0.0583)	(0.1096)	(0.0868)
C_2	0.7070∗∗∗	0.6214∗∗∗	0.2545∗	−0.8697∗∗∗
	(0.0759)	(0.0814)	(0.1449)	(0.0441)
D_1	0.1648∗∗∗	0.1382∗∗∗	0.0955∗∗∗	0.1352∗∗∗
	(0.0260)	(0.0203)	(0.0165)	(0.0220)
D_2	0.1406∗∗∗	0.1786∗∗∗	0.0996∗∗∗	0.0815∗∗∗
	(0.0223)	(0.0213)	(0.0140)	(0.0150)
ω_i	0.0028∗	0.0040∗∗∗	0.0004	0.0011
	(0.0017)	(0.0014)	(0.004)	(0.0008)
α_i	0.1916∗∗	0.2331∗∗	0.0456	0.3266
	(0.0941)	(0.1041)	(0.0452)	(0.3488)
β_i	0.6111∗∗∗	0.3390∗	0.8571∗∗∗	0.6360∗
	(0.1556)	(0.1975)	(0.1001)	(0.3332)
η_i	5.4558∗∗∗	12.3850∗∗∗	6.0185∗∗∗	3.7896∗∗
	(1.6542)	(3.5203)	(2.2835)	(1.5674)
λ_i	−0.3668∗∗∗	−0.3223∗∗∗	−0.0233	−0.2963∗∗
	(0.1100)	(0.1140)	(0.1180)	(0.1236)

Note that ***, **, and * denote rejection of the null hypothesis at the 1%, 5%, and 10% significance levels, respectively

4.2 Estimation Results

The estimated result of the GARCH model is reported in Table 3, using a maximum likelihood estimation method. The ARCH coefficient α_i is significant in Thailand and Japan. These results imply that a shock to the tourist arrival series has short run persistence in Thailand and Japan. All autoregressive coefficients β_i are highly significant. These results imply that a shock to the tourist arrival has long-run

Table 4 Test the skewed-t marginal distribution models

	Thailand	Singapore	South Korea	Japan
First moment LB test	0.4885	0.05867	0.06428	0.1185
Second moment LB test	0.2879	0.2119	0.6221	0.7778
Third moment LB test	0.09234	0.12079	0.08118	0.13408
Fourth moment LB test	0.754	0.3643	0.4616	0.91
K-S test	0.9883	0.9852	0.9924	0.9706

Note that this table reports the p-values from Ljung-Box tests of serial independence of the first four moments of the variables. In addition we presents the p-values form the Kolmogorow-Smirnov (KS) tests for the adequacy of the distribution model

persistence in all series. The result of the conditional variance equations are $\hat{\alpha} + \hat{\beta} =$ 0.9626, 0.9007, and 0.8027 for Japan, South Korea, and Thailand, respectively. The volatilities of these three destinations are highly persistent. However, Singapore does not have such persistence. As can be seen in the variance equation, the asymmetry parameters, λ_i, are significant and negative for Thailand, Singapore, and Japan, but no significance for South Korea, exhibiting that Thailand, Singapore, and Japan are skewed to the left. For the seasonal effect, the summer holiday and the Chinese Spring Festival turn out to be quite significant and have positive effects at the all destination in the GARCH.

When we model the conditional copula, if the marginal distribution models are mis-specified, then the probability integral transforms will not be uniform (0, 1) and the copula model will maybe automatically be mis-specified. Hence, the crucially important step is to test marginal distribution. In this paper, our test divides two steps. The first step is Ljung-Box test; Ljung-Box test is to examine serial independence; we regress $(x_{i,t} - \bar{x}_i)^k$ on 5 lags of the variables for $k = 1, 2, 3, 4$. Second, Kolmogorow-Smirnov (KS) tests is used to test whether marginal distribution is uniform (0, 1). Table 4 presents the Ljung-Box tests and the Kolmogorow-Smirnov (KS) tests. The skewed-t marginal distribution of four destinations based on GARCH model passes the LB and KS tests at 0.05 level; hence, the copula model could correctly capture the dependency between tourist arrivals.

Table 5 reports the parameter estimates for four copula function-based on the GARCH model. The Table 5 result can be summarized as follows: (1) between Thailand and Singapore, the autoregressive parameter is close to 1, implying that a high degree of persistence pertaining to the dependence structure and the history information parameter is significant and displaying that the latest return information is a meaningful measure in all copula model (except Clayton copula); (2)between Thailand and South Korea, the autoregressive parameter is significant in Gaussian and Gumbel copula, indicating a degree of persistence pertaining to the dependence structure. The history information parameter is not significant in Clayton and implies that latest return information is a meaningful measure in Gaussian, Student-t and Gumbel copula; (3) between Thailand and South Korea, the autoregressive parameter is significant in Gaussian and Clayton copula, while

Table 5 Result for dynamic copula-GARCH

	Copula-GARCH					
	Thailand Singapore	Thailand South Korea	Thailand Japan	Singapore South Korea	Singapore Japan	Japan South Korea
Panel A: Estimation of Gaussian dependence structure						
α_c	0.1110**	0.0030	0.0075**	0.1538	0.1012	0.0264***
	(0.0542)	(0.0022)	(0.0030)	(0.1659)	(0.0855)	(0.0064)
β_c	0.7688***	0.9466**	0.9950***	0.4461	0.3704	0.9950***
	(0.0857)	(0.2697)	(0.00564)	(0.5093)	(0.4642)	(0.0775)
γ_c	0.8807***	−0.3037*	−0.6991***	0.9643	−0.9462	−1.3039***
	(0.1543)	(0.1588)	(0.1913)	(0.7217)	(0.8911)	(0.1375)
Ln(L)	59.66281	1.384931	3.296107	10.89347	3.32421	9.797367
AIC	−113.3256	3.230139	−0.5922134	−15.78694	−0.6484196	−13.59473
Panel B: Estimation of Student-t dependence structure						
α_c	0.2533	0.1358	0.2470	0.0232	0.2150	0.4526
	(0.1802)	(0.1419)	(0.3027)	(0.0476)	(0.1817)	(0.3487)
β_c	0.7585***	0.1804	0.0000	0.9413***	0.3410	0.0000
	(0.1347)	(0.2994)	(1.0233)	(0.0813)	(0.4801)	(0.7145)
γ_c	3.3614	3.3719*	1.8875	0.6130	−2.0530	2.2645
	(2.7799)	(1.8966)	(2.2273)	(0.7228)	(1.8814)	(2.6400)
n	141.2247***	21.1820***	26.653***	12.0641**	76.5050***	9.4572***
	(0.2253)	(1.3286)	(0.9473)	(4.7672)	(0.4491)	(1.1817)
Ln(L)	58.5307	2.385122	2.002171	11.13946	3.345037	7.025383
AIC	−109.0614	3.229756	3.995658	−14.27892	1.309926	−6.050765
Panel C: Estimation of Gumbel dependence structure						
α_c	−0.3598***	−18.4926***	−2.0646	−0.02558	−0.0152	0.0976
	(0.1358)	(2.3076)	(3.7409)	(0.75430)	(0.8252)	(0.0830)
β_c	0.5236**	0.2759***	0.2455	0.9955	0.9950	0.9950***
	(0.2201)	(0.0388)	(1.3960)	(0.2766)	(0.3588)	(0.1007)
γ_c	4.0572***	117.0893***	3.2423	0.3337	−0.2562	−6.0301
	(1.4765)	(13.8372)	(6.1443)	(0.3252)	(0.4728)	(6.2675)
Ln(L)	45.43125	10.45262	1.161393	9.427959	2.85591	7.447646
AIC	−84.86251	−14.90525	3.677214	−12.85592	0.2881799	−8.895292
Panel D: Estimation of Clayton dependence structure						
α_c	0.1823	−0.7780	−3.1137**	−0.0874	−5.4474**	−1.8565***
	(0.176)	(0.873)	(1.326	(0.464)	(2.420)	(0.581)
β_c	0.7778***	0.0328	−0.4706*	0.5596	0.8830***	−0.6992**
	(0.161)	(0.041)	(0.281)	(0.417)	(0.017)	(0.077)
γ_c	−0.6479	−8.3803	−1.3047	−1.7920	13.5870**	−3.3375***
	(0.739)	(7.185)	2.107	(1.812)	(2.2972)	(1.696)
Ln(L)	55.424	3.332	1.345	10.471	5.110	10.362
AIC	−104.8472	−0.6638	3.3106	−14.9429	−4.2206	−14.7233

Note that ***, **, and * denote rejection of the null hypothesis at the 1%, 5%, and 10% significance levels, respectively history information parameter is only significant in Gaussian copula. These results show that the latest return information in Gaussian and Clayton copula and history information in Gaussian is a meaningful measure; (4) between Singapore and South Korea, the autoregressive parameter is only significant in Student-t copula, while history information parameter is not significant in all copula. These results show that the just latest return information in Student-t copula is a meaningful measure; (5) between Singapore and Japan, the autoregressive and history information parameter is only significant in Clayton copula. This result implies that the latest return information and history information is a meaningful measure in Clayton copula; (6) between Japan and South Korea, the autoregressive parameter is significant in Gaussian, Gumbel, and Clayton copula, indicating a degree of persistence pertaining to the dependence structure. History information parameter is significant in Student-t and Clayton copula, indicating the latest return information is a meaningful measure; (7) the degree of freedom is significant in all destination and not every row (from 9 t0 141) in the Student-t copula, indicating extreme dependence and tail dependence for all the tourist arrival return. The dependence parameter estimates between the four destination returns are plotted in Figs. 3–6. We can observe that different copula generates different dependence structure. From figure, we know the conditional dependence estimates (Pearson's ρ_t) between four destinations based on Guassian copula-GARCH. DT12 and DT23 have the same structure, increasing and stabling at 0.70 and 0.326, respectively. All the dependence structure for tourism demand among four destinations has shown increasing patterns, implying that a positive relationship tends to increase as time progresses. Figure 4 plots the conditional dependence estimates (Pearson's ρ_t) between the four destinations based on Student-t copula-GARCH. DT12 is higher than other dependence structures and close to 1 at some times, dictating that Thailand and Singapore have a higher correlation and could be recognized as the "complement effect." The reason is their geographic position and the large number of groups of tourists traveling to Thailand and Singapore at the same time. DT13, DT14, DT24, and DT34 have the same structure and shock in 0.05, 0.2, 0.2, and 0.4, respectively. DT23 has a higher relationship from 2000 to 2006.

Figure 5 illustrates the implied time paths of the conditional dependence estimates (Kendall's tau) between the four destinations, based on the Gumbel copula-GARCH. The Gumbel copula captures the right tail dependence. All of the conditional dependence changes over time. DT13 is very low and nearly 0.01; it dictates that Thailand and South Korea have a lower correlation. It means that the improbability of Thailand and South Korea tourist market booms at the same time. DT23 and DT24's conditional dependence obviously exhibited negative trends, implying that negative relationship tends to increase as time progresses. Figure 6 plots the conditional dependence estimates (Kendall's tau) between the four destinations based on the Clayton copula-GARCH. The Clayton copula captures the left tail dependence. DT24 is very low and nearly 0.0001; it dictates that Singapore and Japan have a lower correlation. It means that the improbability of Thailand and South Korea tourist market crashes at the same time. DT13 jumps from 0.01 to 0.24, and DT14 and DT34 shock around at 0.6 and 0.15, respectively.

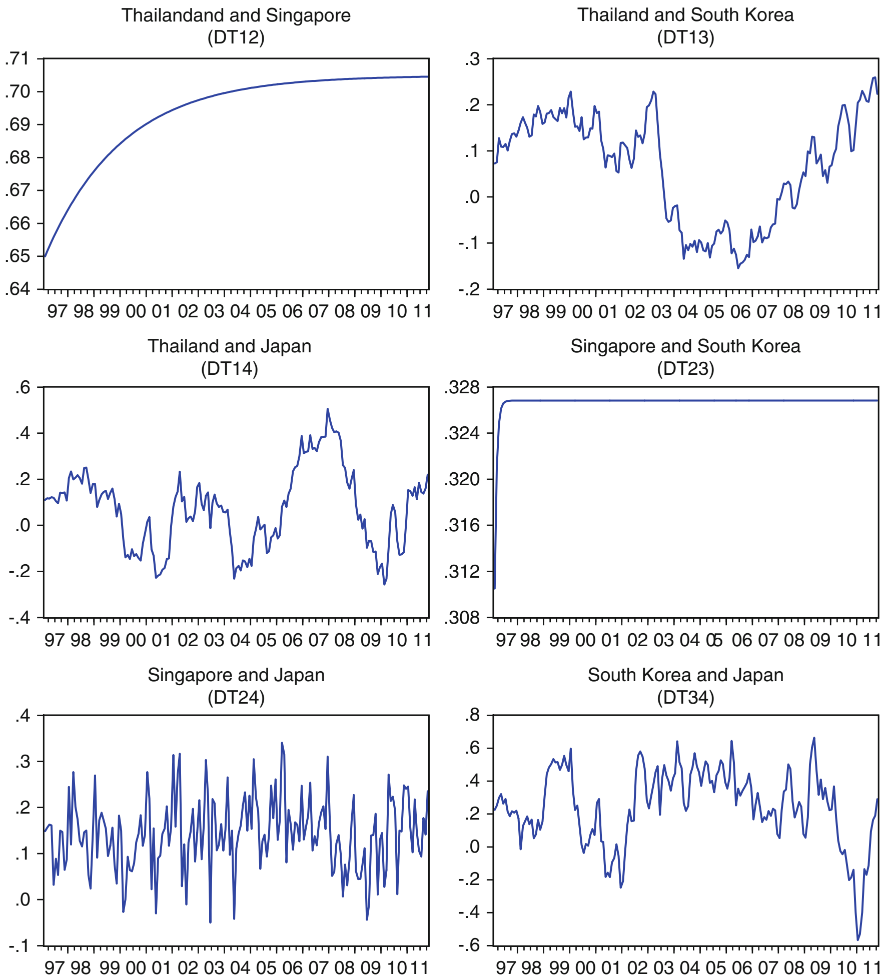


Fig. 3 Conditional dependence estimates between four destinations based on Guassian copula-GARCH

The evaluations of the copula model have become a crucially important step. Therefore, goodness of fit (GOF) was applied to the copula. This paper used Genesta et al. (2009) way to compute approximate P-values for statistics derived from this process consisting of using a parametric bootstrap procedure. Table 6 presents the results of the bivariate GOF for the copula. These tests revealed that the pair of Thailand and Singapore are not significant in the Gumbel copula at the 5% level, and the pair of Singapore and Japan is just significant in the Gumbel copula at 5% the level. The others pass the test at 5% level. In terms of the values AIC and the *P*-value in the Tables 5 and 6, respectively, the Guassian dependence structure

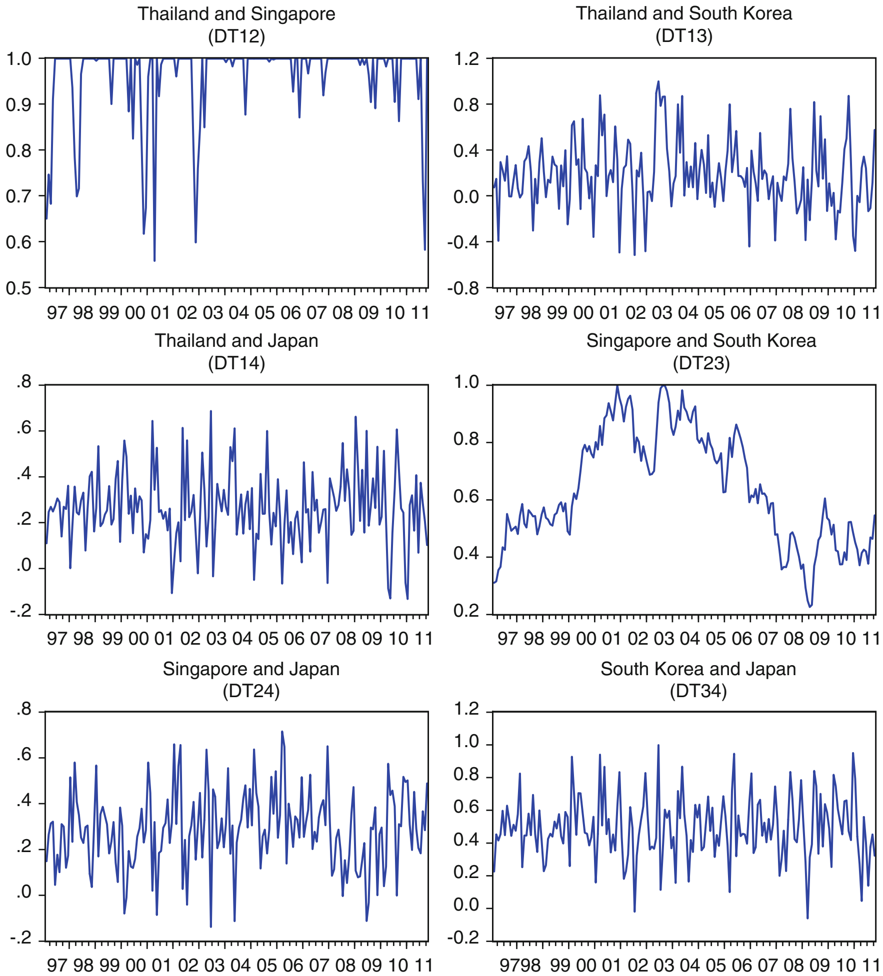


Fig. 4 Four conditional dependence estimates between four destinations based on Student-t copula-GARCH

between Thailand and Singapore, Thailand and Japan, and between Singapore and South Korea exhibits better explanatory ability than other dependence structure; the Gumbel dependence structure between Thailand and South Korea and Singapore and Japan exhibits better explanatory ability than other dependence structure, while the Clayton dependence structure between Japan and South Korea exhibits better explanatory ability than other dependence structures. These results imply that introducing the tail dependence between the four destinations adds much to the explanatory ability of the model.

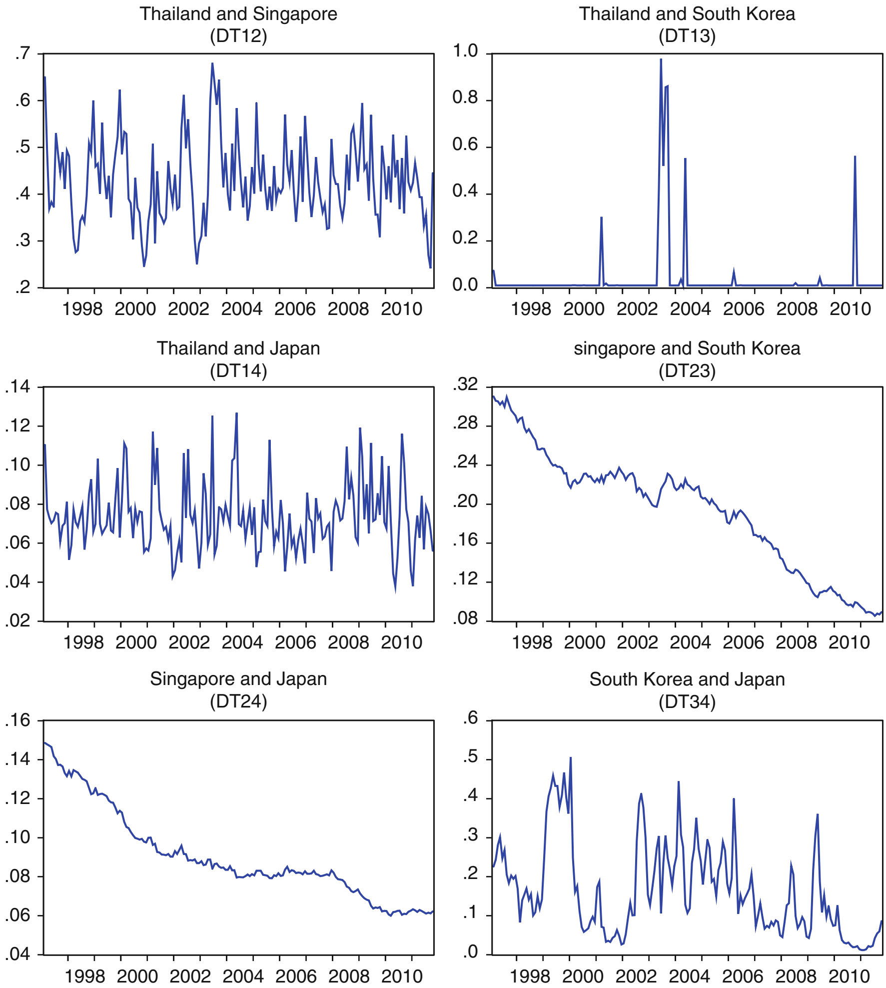


Fig. 5 Conditional dependence estimates between four destinations based on Gumbel copula-GARCH

5 Implications for Policy Planning and Destination Management

The empirical findings of this study imply that each of the conditional correlation is different between each two destinations and all of the conditional dependence changes over time. Evidently, Thailand and Singapore have the highest conditional dependence. The result indicates that Thailand and Singapore have a complementary relationship. Therefore, the policy makers and destination managers in Thailand

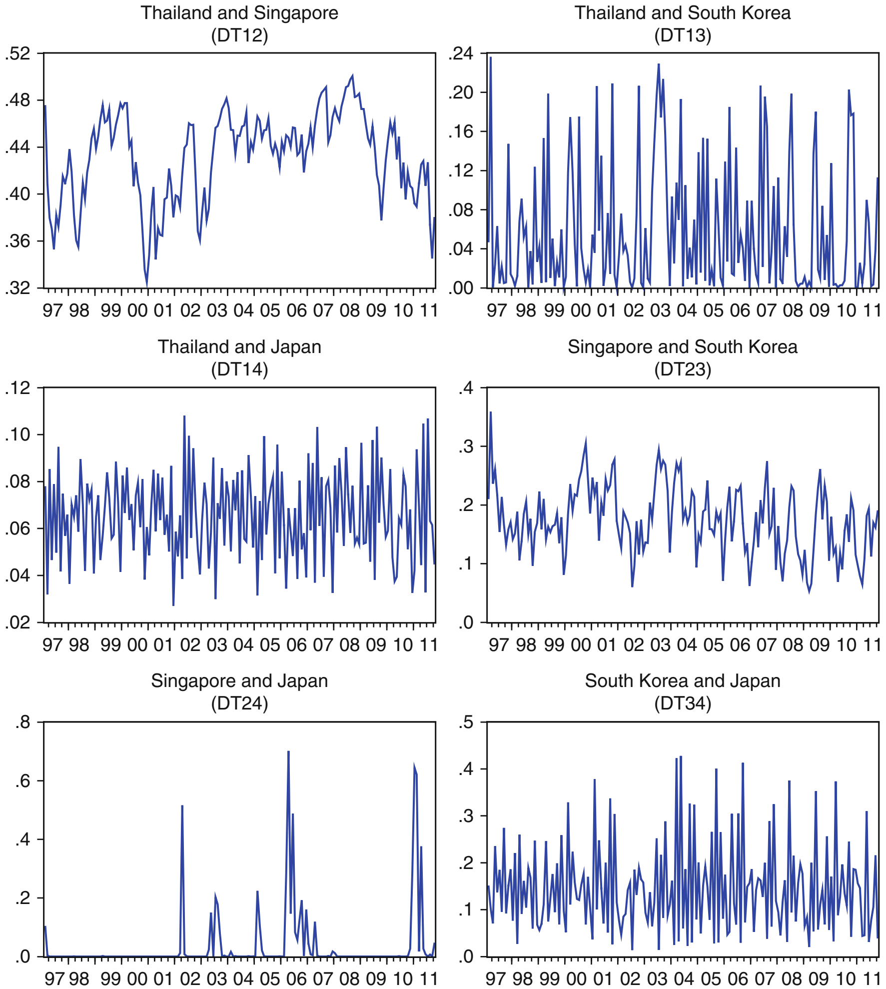


Fig. 6 Conditional dependence estimates between four destinations based on Clayton copula-GARCH

and Singapore need to consider forming strategic alliances to develop jointly products and Thailand and Singapore can complement one another to attract China's outbound tourists. They can also consider signing an agreement on visas, like the Schengen visa. It is recommended that they consider signing the Southeast Asian agreement about visa to improve competitiveness.

The results also found that the summer holiday and the Chinese Spring Festival turned out to be quite significant and have positive effects on the all destination. The summer vacation and the spring festival are the Chinese tourism seasons; the competition is fierce between destinations. Therefore, policy makers and

Table 6 Goodness of fit tests for the copula model

	Guassian copula	Student-t copula	Gumbel copula	Clayton copula
Thailand and Singapore	0.5779	0.7308	0.0034	0.0574
Thailand and South Korea	0.1024	0.1154	0.1414	0.0634
Thailand and Japan	0.6658	0.6778	0.8237	0.2972
Singapore and South Korea	0.5609	0.6449	0.5160	0.6439
Singapore and Japan	0.0365	0.0324	0.0724	0.0045
Japan and South Korea	0.4830	0.6039	0.1743	0.5270

Note: We report the *p*-value from the goodness of fit tests. A *p*-value less than 0.05 indicates a rejection of the null hypothesis that the model is well specified

destination manager should take some measure, for example, providing a wide range of competitive tour packages; reducing transportation cost and regulating real exchange rates to attract Chinese tourists.

Acknowledgements This work is partially supported by the Graduate School and Faculty of Economics, Chiang Mai University. The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

References

T. Ane C. Labidi, Spillover effects and conditional dependence. Int. Rev. Econ. Financ. **15**, 417–442 (2006)

A. Bartolomé, M. McAleer, V. Ramos, J.R. Maquieira, A risk map of international tourist regions in Spain. Math. Comput. Simul. **79**, 2741–2758 (2009)

F. Chan, C. Lim, M. McAleer, Modeling multivariate international tourism demand and volatility. Tourism Manage. **26**, 459–471 (2005)

I.O. Coskun, M. Ozer, GARCH modeling of inbound tourism demand volatility in Turkey. MIBES Trans. **5**, 24–40 (2011)

A.M. Daniel, P.M. Rodrigues, Volatility and seasonality of Tourism demand. Econ. Bull. 87–102 (2010)

D.A. Dickey, W.A. Fuller, Distribution of the estimators for autoregressive time series with a unit root. J. Am. Stat. Assoc **74**, 427–431 (1979)

C. Genesta, B. Remillardb, D. Beaudoinc,Goodness-of-fit tests for copulas: A review and a power study. Insur. Math. Econ. **44**, 199–213 (2009)

B.Hansen, Autoregressive conditional density estimation. Int. Econ. Rev. **35**, 705–730 (1994)

S.S. Kim, K.F. Wong, Effect of new shock on inbound tourism demand volatility in Korea. J. Travel Res. **44**(4), 457–466 (2006)

C. Ning, T.S. Wirjanto, Extreme return-volume dependence in East-Asian stock markets: A copula approach. Financ. Res. Lett **6**, 202–209 (2009)

A.L. Patton, Modeling asymmetric exchange rate dependence. Int. Econ. Rev. **47**, 527–556 (2006)

P.C.B. Phillips, P. Perron, Testing for a unit root in time series regression. Biometrika **2**, 335–346 (1988)

J. Reboredo, How do crude oil prices co-move? A copula approach. Energy Econ. **33**, 948–955 (2011)

J.H. Seo, S.Y. Park, L. Yu, The analysis of the relationships of Korean outbound tourism demand: Jeju Island and three international destinations. Tourism Manage. **30**, 530–543 (2009)
R. Shaeef, M. McAleer, Modeling international tourism demand and volatility in small island tourism economic. Int. J. Tourism Res. **7**, 313–333 (2005)
R. Shaeef, M. McAleer, Modeling the uncertainty in monthly international tourist arrivals to the Maldives. Tourism Manage. **28**, 23–45 (2007)
Tourism Flows Outbound China, Euromonitor International (2010)
UNWTO Tourism Highlights 2011 Edition, The World Tourism Organization (2011)
K. Wang, Y.H. Chen, S.W. Huang, The dynamic dependence between the Chinese market and the other international stock markets: A time-varying copula approach. Int. Rev. Econ. Financ. **20**, 654–664 (2011)
C.C. Wu, H. Chung, Y.H. Chang, The economic value of co-movement between oil price and exchange rate using copula-based GARCH models. Energy Econ. (2011)

e-Retail Market Characteristics: Evidence from Comparisons with USA, UK, India, and China

Yongquan Hu and Yunlei Xie

Abstract The well development of e-retail market directly constraint the performance of innovative businesses. Compared with USA, UK, and India, this systematically researches and summarizes the main characteristics of Chinese e-retail market with five representative indicators such as the size, product category, purchase frequency and monetary, concentration ratio, and regional characteristics, concluding that the size of Chinese e-retail market is large and developing rapidly, middle and small cities, even the central and western regions and rural areas will be the potential areas for the development of e-retail. However, the purchase frequency and monetary are low, the structure of consumption is imbalanced, and the concentration ratio will slow down.

Keywords e-Retail • e-Retail market • Chinese e-retail market • International comparison

1 Introduction

Stepping into the twenty-first century, with the high-speed development of computer technology, e-retail has become a black horse. e-Retail is selling goods or providing services for personal or family needs through the Internet or other electronic channels, which is belonging to the e-commerce activities for the end customer

Y. Hu
Modern Commerce Research Center of Zhejiang Gongshang University,
Hangzhou, Zhejiang, China
e-mail: 361892278@163.com

Y. Xie (✉)
Research Center of Technology and Service Management,
Gongshang University, Hangzhou, Zhejiang, China
e-mail: yunleixie@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_14,

(Shen 2010). In the United States, Amazon online bookstore is the successful example of e-retail. A good model of e-retail operation in domestic is Taobao.com. How to recognize Chinese e-retail market is a serious challenge faced by e-retail industry, as well as the theory field. Compared with USA, UK, and India, this chapter summarizes the main characteristics of China e-retail market with five representative indicators such as the size, product category, purchase frequency and monetary, concentration ratio, and regional characteristics.

2 Literature Review

e-Retail was carried out by more and more scholars. On May 21, 2011, there are 63 journal articles searched by the title “e-retail” in CNKI Database. In Scopus database, there are nearly 100 articles searched by the title “e-retail,” “online shopping,” and “e-commerce market.” However, there are little papers associated with e-retail market characteristics. In addition, a number of advisory bodies analyzed the e-retail market, such as A.T. Kearney, McKinsey, eMarketer, comScore, and iResearch.

How to grasp the characteristics of e-retail markets, scholars carried out a number of studies (Liu 2003; Shin 2008; Ivingston 2009; Valter 2010; He 2011). As a new retail model, e-retail has its own specialty. Traditional retail business competitiveness evaluation method obviously cannot be fully applicable to e-retail model (Li and Zhao 2011). Therefore, summarizing the characteristics of the e-retail market is a major task in this study. The authors found that the e-retail market is characterized by both quantitative characteristics (size, efficiency, market share) and qualitative features (e-retail mergers and acquisitions, government policies), which are summarized in Table 1.

Table 1 Indicators of e-retail market characteristic

Author	Year	Indicators of e-retail market characteristic	Research object
G. Liu	2006	B2C sales, product category operation of the market, and customer behaviors	Russia e-retail market
H.K. Shin	2008	Sales, Internet user penetration rate, retail formats, trust	Korea e-retail market
J. Ivingston	2009	Characteristics of customers, such as search and transportation costs	Global e-retail market
A. Valter	2010	Service quality: fulfillment, privacy, system availability and efficiency; customers characteristics: loyalty, commitment, and trust	Global e-retail market
S. He	2011	Scales of the Internet users, sales, share of the market	China e-retail market

3 The Characteristics of China e-Retail Market

3.1 *Size of China e-Retail Market*

3.1.1 The Size of China e-Retail Market E-Retail Sales

The e-retail sale is the total value of the Internet channel trading commodities.

The emerging markets gradually prospered, such as China and India; however, Europe and North America remains the regions of highest proportion and frequency in global e-retail market. US e-retail sales are in the first place in the global market of e-retail; the UK is Europe's largest online retail market. From 2009–2011, the average annual growth rate of China's e-retail transaction volume is 78.6 %. Despite the rapid growth of online retail transaction volume in China and India, their proportions in total social retail sales are still far below the developed countries. In 2011, China e-retail sale's contribution to total social retail is 4.3 %, compared to 17 % in the US 12 % in the UK (see Table 2).

Supply and demand are thriving in Chinese e-retail market. On the one hand, the number of people shopping online keeps fast growth, which shows the huge market demand; on the other hand, the traditional retailers begin to accelerate into the online retail market, which shows the rich market supply. India is the country with the highest-growing number of Internet users.

3.1.2 User Scale of the e-Retail Market

Internet user penetration rate refers to the number of internet users divided by number of the number of people in one country. e-Retail penetration rate refers to the number of online customers divided by number of Internet users. iResearch Research Center released data showing that, as of the end of June 2011, the number of Chinese Internet users reached 485 million, representing an increase of 27.7 million over the end of 2010. In addition, the number of online shoppers will reach about 350 million in 2014. The shopping online penetration rate will approach 50 %. However, this ratio is not high; we considered that e-retail penetration rate of 70 % is a relatively mature structure.

The United Kingdom and the United States are in the leading position in the e-retail market. Their shopping online penetration rate and Internet user penetration rate are far greater than India and China's (see Table 3). With the economic rise of China, the Internet population continues to increase, the scale of China's e-retail market users is booming.

3.2 *Product Category*

Product category refers to the retail business industry type. Usually, business is divided into several categories according to the business goods. Chinese government

Table 2 E-retail sales of China, USA, UK, and India (millions dollars)

Country	e-Retail sales 2009	e-Retail sales 2010	Growth rate 2009–2010 (%)	e-Retail sales 2011	e-Retail rate 2010–2011 (%)	e-Retail sales/total volume of retail sales, 2011 (%)	Compound annual growth rate, 2010–2015 (%)
China	417.5	790.5	89.4	1,227.9	67.8	4.3	94.2
USA	1,279	1,468	14.8	1,598	8.9	17	10.9
UK	1,298.0	1,424.9	9.8	1,615.1	13.3	12	6.5
India	–	12	–	24.1	104.1	0.69	34.2

Resource: iResearch Inc., eMarketer Inc., Boston Consulting Group Inc., Forrester Inc., www.100EC.cn, comScore Inc., IMRG Capgemini

Table 3 User scale of four countries' e-retail market

Year	2010		2011	
Country	Internet users Penetration rate	Shopping online Penetration rate	Internet users Penetration rate	Shopping online Penetration rate
China	33.9	30.8	38	41.6
India	6.9	–	7	40
United Kingdom	82.5	67.7	82	79
America	76.3	71.2	78	71

Resource: iResearch Inc., eMarketer Inc., Boston Consulting Group Inc., Forrester Inc., comScore Inc., IMRG Capgemini

Table 4 Top three product categories of four countries

Country	China	America	United Kingdom	India
Ranking list	2011	2011	2011	2011
1	Clothes	Clothes Electronic product	Clothes Sport goods	Mobile phones Accessories
2	Consumer electronics appliance	Travel	Films Music	Computer Hardware
3	Cosmetics	Household goods	Household goods	Consumer electronics

Resource: iResearch Inc., eMarketer Inc., Boston Consulting Group Inc., Forrester Inc., comScore Inc., IMRG Capgemini

divided into 16 retail product categories, for instance, food, daily necessities, and cosmetics. The e-retail product category people consumed differs to the traditional retail market.

In China, e-retail market on the year of 2011, clothing ranked first in the percentage of users reached 26.5 %; second are consumer electronics and appliance; and cosmetics, books, and video classes are in third and fourth (see Table 4). China's retail consumption structure changes from good consumption-based to the combination of goods and services.

Compared with developed countries, Chinese goods merchandise proportion is significantly higher than the developed countries. Money is mainly used to meet basic living needs. Movies travel, and other services in consumer spending in developed countries are significantly more than China's spending.

3.3 The Purchase Frequency and Monetary

To identify customer behavior, the well-known method called recency, frequency, and monetary (RFM) model is used to represent customer behavior characteristics (Xie and Shi 2010). The model is an important tool to measure the customer value and customer profitability.

This study proposes using the following RFM variables:

- Recency (R): the latest purchase amount
- Frequency (F): the total number of purchases during a specific period
- Monetary (M): monetary value spent during one specific period

The e-retail market is maturing, and user acceptance of e-retail is gradually deepened; the overall level of consumption upgrades quickly, mainly in two aspects: Firstly, monetary gradually increases and secondly, frequency mounts up. With the Internet user penetration rate rising, e-retail transaction amount is of snowballing growth. In 2010, China's online customer per capita annual consumption expenditure is 3,259 RMB, with a growth rate over 50 %. The sudden emergence of e-retail has also become a bright spot of the UK retail sector. Forrester Research expects US customers spent per person 1,207 dollars from 2011 to 1,738 dollars in 2016. In terms of frequency, Chinese online customers' frequency grows strongly. The users who purchased 3–10 times are in the highest proportion of 28.9 %. The number of people who purchase 31–40 times is growing.

Although with the rapid growth rate of recency and frequency, China e-retail market still has some gaps compared with developed countries. With the continued increase of Internet users in China, there will be more new Internet users. They are a new force of the e-retail group.

3.4 Concentration Ratio

The CR_n (concentration ratio) is defined as the market share of the n largest undertakings competing on the market:

$$CR_n = \sum (X_i)_n / \sum (X_i)_N$$

X_i : market shares of the undertakings
N: total number of undertakings competing on a certain market
n: the number of n largest undertakings competing on a certain market

If $CR_4 \leq 30\,\%$ or if $CR_8 \leq 0\,\%$, then market structure belongs to competitive industry. If $CR_4 > 30$ or $CR_8 > 40\,\%$, then market structure belongs to ligopolistic industry. If $CR_4 > 65\,\%$, market structure belongs to highly oligopolistic industry (Bain 1968).

In China, due to M&A mergers and acquisitions and expansion strategy, the leading online retailers' e-retail market concentration is very high. Compared with the United States, United Kingdom, and other global e-retail developed countries, Chinese CR_n is relatively in concentrated levels, that is, the vast majority of market share occupied by several online shopping platforms. Through collecting relevant data, we calculate the CR_4, CR_8, and CR_{100} of China and the United States from 2007 to 2009. We find that the CR_4 and CR_8 of the online retail market in China are more than 89 %. The number is much larger than the United States over the same period of CR_{100}-76 %.The e-retail industry is a highly oligopolistic industry in China. The CR_4 and CR_8 from 2007 to 2009 of the US e-retail are below 40 %, which means it is a competitive industry. In China C2C (customer to customer) e-retail market such as Taobao.com accounted for the largest market share, followed by a paipai.com and eBay.

However, to some extent, Chinese oligopolistic market structure shows the advantages of several major pioneering e-retail platforms firstly entering the market. It is not the result of perfect competition. The e-retail is an emerging industry; there is still potential in its market structure (Zhuang and Chan 2006). According to the industry characteristics and policy support factors, we can estimate that e-retail market concentration will be flat, but the market structure will continue to maintain a high concentration of an oligopoly.

3.5 Regional Characteristics

With the rapidly growing popularity of Internet technology, e-retail in rural areas meets development opportunities. The growth rate of Internet users in rural areas is far higher than that of urban Internet users. At the same time, significant regional differences have took placed in China's online retail market. The data released by Taobao.com shows that, ranking by order volume, the top five provinces of China's online shopping market in May 2011 were as follows: Guangdong, Zhejiang, Jiangsu, Shandong, and Fujian. From a national perspective, the higher online shopping penetration areas concentrated on the eastern coast of the Yangtze River Delta Economic Zone, and the Pearl River Delta Economic Zone and parts of central and western economically developed central city the overall online retail environment is better in these regions; followed by the Bohai Sea region and central region, possibly in the future, they are areas of high growth; west is another potential area for the development of the e-shopping market, including Shaanxi and Sichuan; speed of e-retail market development in Northeast old industrial area gently.

In 2013, the transaction volume of Chinese e-retail industry is expected to more than 1 trillion RMB. The coastal province alone is unable to meet the high demands. Therefore, the second and third tier cities and even the central and western regions and rural areas are large potential areas for e-retail development.

4 Research Findings

To systematically grasp and summarize the characteristics of the e-retail market, this paper constructs radar chart of a comprehensive comparison of four indicators (see Fig. 1).

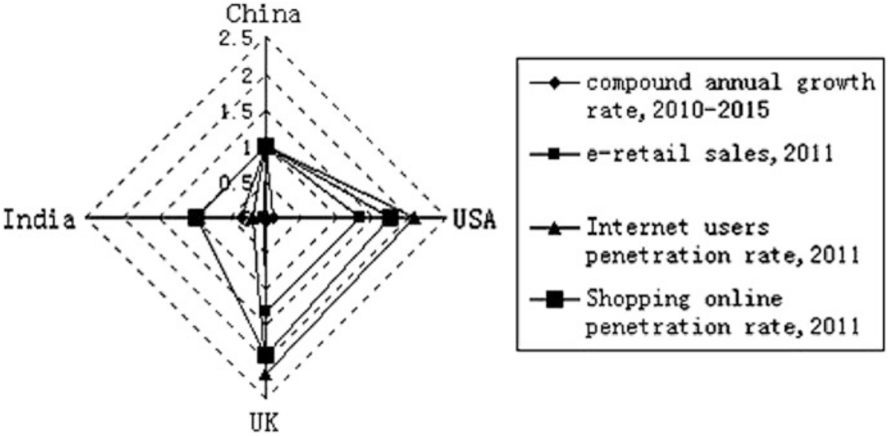


Fig. 1 Comparison of four indicators in four countries

Note: all values of China is 1, the values of other countries are compared with the relative ratio of China

The main conclusions of this study are as follows:

1. The growth rate of Chinese e-retail industry market size is much faster than the United Kingdom and America. However, the Internet user penetration was much lower than developed countries. The Chinese e-retail has become a powerful complement to the retail market. There are ample spaces for development in China.
2. Proportion of Chinese online shopping consumer spending in clothing goods is higher than developed countries. Money is mainly used to meet basic living needs. Service consumption is dominant in developed countries' e-retail market. Good consumption is dominant in Chinese e-retail market.
3. Online shopping customers' monetary and frequency are of rapid growth rate. It still lags far behind developed countries. The increasing monetary and frequency indicates that a habitual consumption-based era of online shopping is already visible.
4. Compared with the United States and the United Kingdom, Chinese e-retail industry concentration is high, that is, the vast majority of market is shared by several online shopping platform. However, it is not the result of perfect competition. e-Retail market concentration will be flat, but the market structure will continue to maintain a high concentration of an oligopoly.
5. By the combined effects of the policy, natural conditions, the economic base, and quality of labor, our e-retail industry regional development imbalances. The second and third tier cities and even the e-retail market in central and western regions and rural areas increased faster. In the future they will become potential areas for e-retail development.

Acknowledgements This work is partially supported by the National Natural Science Fund Projects (71173191), Base Project in Universities of Zhejiang Province (1010JF250502), Social Science Fund of Ministry Education 1010JF250502, and Zhejiang Gongshang University Graduate School of Science and Technology innovation project 1010XJ1511004. The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

References

J.S. Bain, Industral organization, 2nd Ed. New York: John Wiley (1968)

S. He, Status and trends of the online retail market analysis. SME Manag. Technol. **35**, 23–29 (2011)

J. Ivingston, Chen, affect as a mediator between web-store design and consumers' attitudes toward the store. Electron. Commer. Res. Appl. **8**(8), 56–60 (2009)

G. Liu, Russian online retail (electronic retail) market. Russian and Central Asian markets in Eastern Europe **11**, 23–29 (2003)

J. Li, X. Zhao, Status and trends of the online retail market analysis. SME Manag. Technol. **5**, 57–59 (2011)

H. Shen, *E-Retail* (Chongqing University Press, Chongqing, 2010), pp. 5–6

H.K. Shin, The development of online shopping in South Korea and implications for China. Consum. Guide **20**, 45–51 (2008)

A. Valter, The measurement of service quality in the electronic retail and its impact on behavioral intentions. Revista de Administracao de Empresas **50**, 2–9 (2010)

H. Xie, Y. Shi, Characteristics and trends of urban development of electronic commerce in China. E-commerce **10**, 12–19 (2010)

Y. Zhuang, L. Chan, China's retail market formats and scale pattern analysis. Business Times **12**, 44–49 (2006)

Enterprise Scale and Tax Burden: Empirical Research on Chinese Enterprises

Jing Huang

Abstract The scale of an enterprise usually represents the different stages in the enterprise's development. In this article, through empirical investigation of enterprise scale and tax burden, the tax burden differences between different enterprises in China have been investigated.

Keywords Tax burden • Enterprise scale • Small-scale enterprises • Large-scale enterprises

1 The Research on Chinese Enterprise's Scale and Tax Burden

There are not many research works of the study to the relationship of the scale and tax burden on Chinese enterprises (Lin and Shen 2009; Piao 2005). Most of these research works stay in policy discussion and qualitative analysis and lack of empirical data to support (Chandler and Hanks 1993; Man 2002). Here we use distance analysis method and survey data to make an empirical analysis of this problem.

1.1 Enterprise-Scale Distribution in China

Divided by enterprise scale, there were 200,615 small-scale enterprises (M1) (by the end of 2006 in China); the proportion was 72.53 %, an increase of 8.52 % comparing with the last year's data; 58,200 medium-scale enterprises (M2), the proportion was 21.04 %, an increase growth rate of 12.79 % comparing with last year's data.

J. Huang (✉)
Wuxi Administration of State Taxation, Wuxi 214007, China
e-mail: wxhuangjing@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_15,

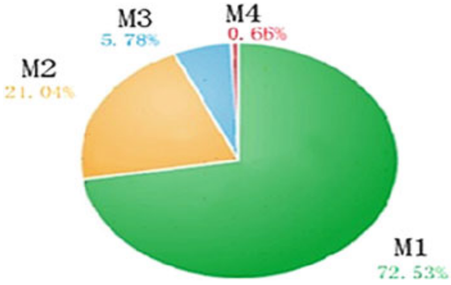


Fig. 1 Enterprise-scale maps (2006, China)

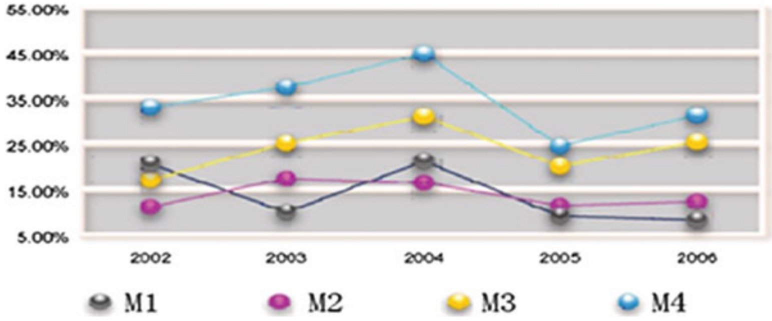


Fig. 2 Comparison chart of enterprise development trend in China (2006)

M1: small-scale enterprises (main business income less than 10 million RMB yuan), M2: medium-scale enterprises (main business income of 10–100 million yuan), M3: large-scale enterprises (main business income of 100 million yuan to 10 billion yuan), M4: overscale enterprises (main business income large than 1 billion yuan). Figure 1 shows the number of different type enterprises: M1:200,615, M2:58,200, M3:15,977, and M4:1,813. Figure 2 shows that small-scale enterprise has a large number accounts but a slower growth rate, while overscale enterprise has lower number accounts but a faster growth rate.

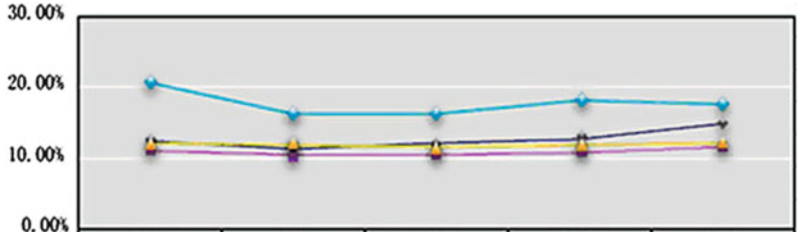
1.2 The Tax Burden of Small And Medium Enterprises (Rate of Income Tax to Profits)

When we are discussing the data collected in China, it can be seen that divided by the enterprise scale, in 2006, the tax burden of small businesses was 14.93 %, the tax burden of medium-scale enterprise was 11.57 %, the tax burden of large-scale enterprise was 12.01 % and the tax burden of overscale enterprise was 17.48 %. It shows that the tax burden of small businesses is going up while the tax burden rate of medium-scale enterprise remains staying at a certain level (Zhao 2007). The tax

Table 1 Comparison table of income tax rate of different scale enterprises

Income scale	10,000–100,000	100,000–500,000	500,000–1 million	1–5 million	5–10 million
Tax rate (%)	26.64	18.1	16.93	13.17	11.62
Income scale	10–50 million	50 million–0.1 billion	0.1–1 billion	More than 1 billion	
Tax rate (%)	11.62	11.5	12.01	17.48	

Resource: iResearch Inc., eMarketer Inc, Boston Consulting Group Inc, Forrester Inc, www.100EC.cn, comScore Inc, IMRG Capgemini



	2002	2003	2004	2005	2006
M1	12.37%	11.20%	12.23%	12.76%	14.93%
M2	11.05%	10.48%	10.44%	10.80%	11.57%
M3	12.04%	11.95%	11.55%	11.76%	12.01%
M4	20.70%	16.15%	16.29%	18.20%	17.48%

Fig. 3 The change of income tax burden rate on different enterprise from 2002 to 2006

burden rate of small business was 12.37 % in 2002 and rose to 14.93 % in 2006. The medium-scale enterprises tax burden rate was 11.05 % in 2002 and 11.57 % in 2006. Classified by the main business income, the enterprise income tax burden rate from 2002 to 2006 can be illustrated in following table and figure (Table 1 and Fig. 3).

2 The Empirical Investigation of Enterprise Scale and Tax Burden

A special investigation has been taken and the data have been collected on 718 enterprises in Wuxi, Jiangsu province, from 2008 to 2011, including 211 M1, 353 M2, 123 M3, and 31 M4. The collection of variables includes the enterprises annual revenue, the actual payment of VAT, and income tax actually paid. Comprehensive tax burden rate for enterprise is defined as the ratio of paid up tax to the operating income.

To the M1, the lowest rate of the consolidated tax burden rate is 0.09 %, the highest is 19.63 % and is 6.47 % on average. To the M2, the consolidated tax burden rate is ranging from 0.03 % to 24.06 % and is 3.1 % on average. To the M3, the

Table 2 Collected aggregate data are as follows

	2008	2009	2010	2011	Avg
M1 (consolidated tax rate)	0.0535	0.0995	0.051	0.0546	0.0647
M2 (consolidated tax rate)	0.0304	0.0317	0.0319	0.03	0.031
M3 (consolidated tax rate)	0.0445	0.0434	0.0404	0.0394	0.0419
M4 (consolidated tax rate)	0.0345	0.037	0.0338	0.027	0.0331
Total (consolidate tax rate)	0.0407	0.0529	0.0393	0.0378	0.0427

Table 3 The consolidated tax rate of different enterprise from 2008 to 2011

	M1	M2	M3	M4
Numbers	211	353	123	31
2008 consolidated tax rate	0.0535	0.0304	0.0445	0.0345
2009 consolidated tax rate	0.0995	0.0317	0.0434	0.037
2010 consolidated tax rate	0.051	0.0319	0.0404	0.0338
2011 consolidated tax rate	0.0546	0.03	0.0394	0.027

Table 4 Approximation matrix (Euclidean distance)

	M1	M2	M3	M4
Numbers	211	353	123	31
M1	0.000	0.046	0.005	0.009
M2	0.046	0.000	0.049	0.046
M3	0.005	0.049	0.000	0.008
M4	0.009	0.046	0.008	0.000

consolidated tax burden rate is ranging from 0.107 % to 27.81 % and is 4.19 % on average. To the M4, the consolidated tax burden rate is ranging from 0.1 % to 8.93 % and is 3.31 % on average (Tables 2–4).

Through the analysis to the distance of different type enterprises tax burden, we can get the following approximate matrix (it is not a similar matrix):

We can see the visible gaps between different types of enterprise in following figures (Fig. 4).

The different enterprises tax burden rate in all this year shows us same characteristic; there is relatively higher tax burden on small enterprise. The tax burden rate of medium-scale enterprise and large-scale enterprise is approximately the same. The large-scale enterprises tax burden rate is lower than the small-scale enterprise and higher than the overscale enterprise.

Tax burden of small enterprise amounted to top (9.95 %) in 2009 is 2.7 times to that of large enterprises (3.7 %). In 2010 and 2011, the gap has been narrowed, but the tax burden of small enterprise is still two times to that of large enterprises.

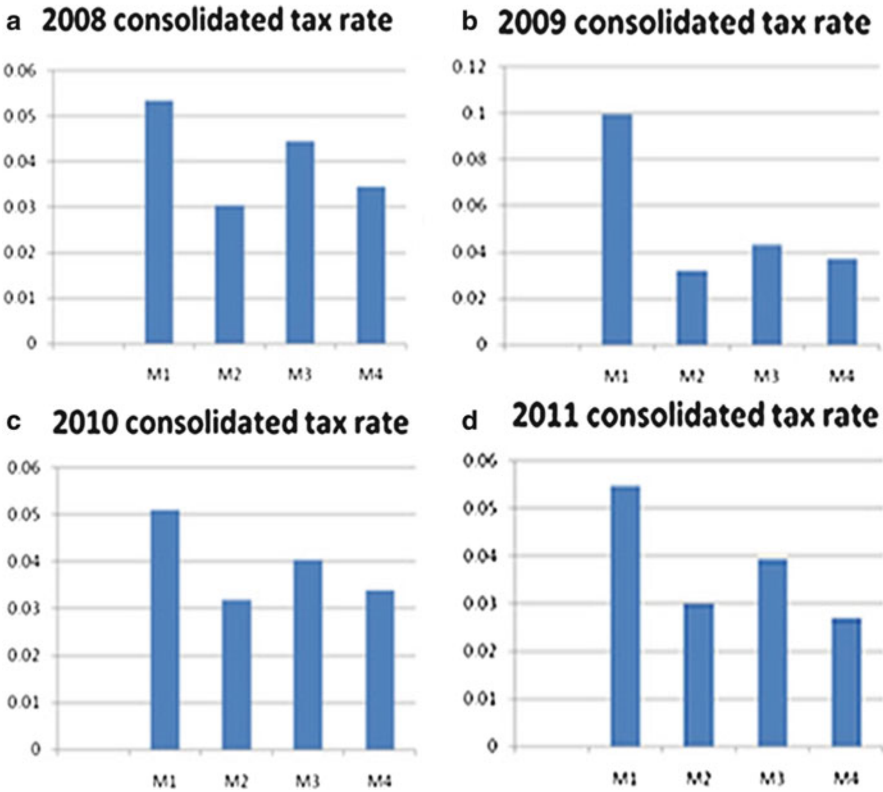


Fig. 4 The comparison of consolidated tax rates for the years (**a**) 2008, (**b**) 2009, (**c**) 2010, and (**d**) 2011

3 Conclusion

When we look at the VAT system in China, taxpayers have been divided into small-scale taxpayers and general taxpayers; the statutory VAT tax rate of the general taxpayer is 13 % or 17 % in different circumstances and the rate of small-scale taxpayer is 6 %; on exteriorly it seems small-scale taxpayer has a lower VAT tax rate.

Considering the income tax law in China, the nominal tax rate is 25 %, and there is a preferential tax rate of 20 % levied to the taxpayer that their annual income is below 300,000 RMB yuan.

Actually there are enabling preferential tax treatments given to the large state-owned enterprise. Considering the private enterprise has less tax deductions and low economic efficiency, it seems that the small- and medium-scale enterprise tax burden is still relatively high in China.

References

G.N. Chandler, S.H. Hanks, Founder competence, the environment, and venture performance. Entrepren. Theo. Prac. **75**, 77–89 (1993)

W. Lin , J.F. Shen, The empirical analysis of enterprise scale and the regions and corporate tax-burden to the listed companies of China's wholesale and retail industry. Tech. Econ. **l28**, 81–84 (2009)

T.W.Y. Man, The competitiveness of small and medium enterprises: A conceptualization with focus on entrepreneurial competencies. J. Bus. Venturing **17**, 123–142 (2002)

J.S. Piao, Empirical analysis of the scale and tax-burden to the listed companies in China. J. Yanbian Univ. **9**, 67–70 (2005)

G. Zhao, The studies of the policy effect to SME. Econ. rev. **2**, 116–122 (2007)

Analysis of Value-Added Process for a Logistics System in Manufacturing Business: A Case Study of Yurun Food Company

Yueqin Tang, Qing Zhuang, and Panpan Wen

Abstract The logistics process of a manufacturing business is a value-added process, in which the value added proceeds with each logistics procedure. Therefore, the design and operation of the various logistics procedures must be customer-oriented. This paper deals with value-added process within a logistics system for Yurun Food Company, summarizing the feature on time value of logistics and space value of logistics. It concludes that a thought of moving towards integration as the company did is required. On the one hand, it reduces the logistics costs, thus lowering the total cost of the firm; on the other hand, it extends rapid logistics service to meet the customers need, resulting in enhancing the core competitiveness of a manufacturing enterprises.

Keywords Logistics system • Value-added process • Yurun Food Co.

1 Introduction

With rapid development in economy technology and business management, more and more manufacturing businesses focus on the third profits source—logistics. This is because the room to make a further cost reduction becomes smaller and smaller in the producing and selling area, while many businesses exploit the potential of logistics links like transportation, warehousing, distribution, and stocking process. Whether the function of logistics system is reasonable, it does not depend on how

Y. Tang (✉) • P. Wen
Business School of Jiangxi normal University, Nanchang, China
e-mail: yueqintang@hotmail.com; 1062665586@qq.com

Q. Zhuang
Science & Technology School of Jiangxi Normal University, Nanchang, China
e-mail: liaoyangorchid@gmail.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_16,

much work the logistics has done but how much cost it has saved for the enterprise. From the point of view of manufacturing to distribution, the least operation makes the best logistics.

Michael Porter defines the value chain as a collection of a series of valuable activities during the processes of designing, producing, selling, distributing, and other auxiliary activities. Logistics is a value-added chain, i.e., logistics is not only a process that connects the input and output of the products but also a process of value-adding, and the value of its final outputs is measured and confirmed by the external consumers Sun and Song (2003). As pointed out by Karl Marx's capital cycle theory (G-W-G'), from the W to G' is a thrilling movement, only when this action moves successfully can the exchange of goods achieve and can the social reproduction be repeated. Therefore, the logistics process must be customer-oriented ultimately by delivering customer value. Therefore, logistics process is a service network built for needs of the target customers. To provide the customers with services beyond the basic logistics functions is to offer them innovative, unconventional, and customer-satisfied and other characteristics-possessed logistics services.

In summary, the value-added process is perceived as a whole system with the logistics from the procurement of raw materials to the final delivery of the finished good to the end customers. The logistics value-added processes exist in every aspect, which constitute the logistics value chain. Food processing is a type of production which shows how the value-added processes take place.

2 Value-Added Processes Based on Time Value and Space Value in Yurun's Logistics System

Yurun Food Co., Ltd. is one of the biggest manufacturers of meat-packing in China, which is featured in time value of logistics and space value of logistics, As far as time value of logistics is concerned, the distinctive feature of the meat-packing is to stay fresh. For this reason, the selling price is directly proportional to the degree of freshness to a certain extent. If freshness of the food reduces, the original value of the products cannot be fully realized, let alone any time value of logistics. However, the added value of the logistics process is obtained by shortening the time duration of the logistics. Apparently, shortening the logistics duration not only reduces the logistics value loss and material consumption but also accelerates the turnover rate and saves money.

In terms of space value of logistics, as manufacturers and consumers of the same products are distributed in different geographical areas, the value created by a change in this spatial variation is known as logistics space value. The space value of logistics is obtained from the logistics which transports the products from the lower-value regions (the Yurun meat-packing base) to the higher-value regions (the Yurun meat-packing sales areas) Wang and Gong (2005). This is because of the existence of the various structures of the industry and the social division of labor force, which

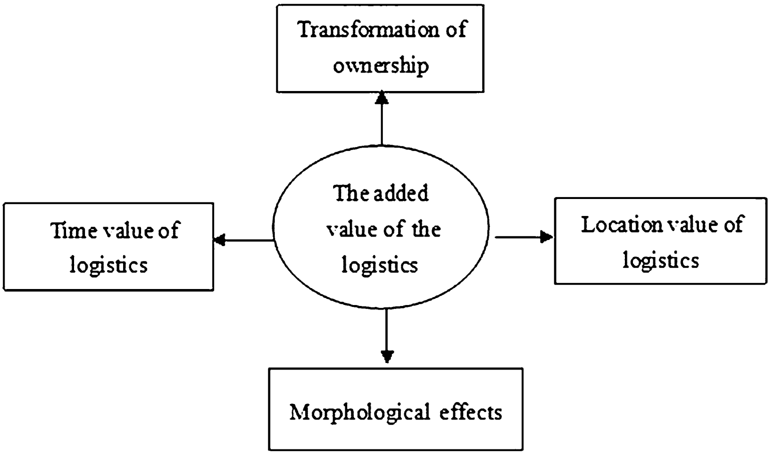


Fig. 1 Change of the morphological effects

causes the same meat-packing products, appear different prices in different areas. Logistics has changed the geographical location of the products, thus achieved the added value.

The value-added processes of the logistics have speeded up the above time and spatial effects, as well as the change of the morphological effects and the transformation of ownership of the goods (as shown in Fig. 1). The processing sectors of the logistics change the morphology of the goods. However, logistics makes the goods into commodities, and marketing makes the transformation of ownership. All these value-added processes are inseparable from the logistics processes.

To achieve the above four aspects of logistics value-added requirements, a highly efficient logistics system is required that puts the original dispersive logistics resources to reintegration and sets up a special logistics department or logistics subsidiary company to reinforce the whole processing management in sequence of production, supply, and marketing. As a result, Yurun sets up a logistics subsidiary company, employing modern organizational and management practices to achieve the accuracy and timeliness of the logistics.

3 Customer-Oriented Design in Practice

The value-added processes vary within a supply chain, as the case in point for Yurun meat-packing company (as shown in Fig. 2).

The added value of logistics from the road map is found to be reflected by the added value of the products, together with the products are blended in logistic services. Because a product development is to meet requirements of customers, a design of logistics process is also to meet the needs of the customers, i.e.,

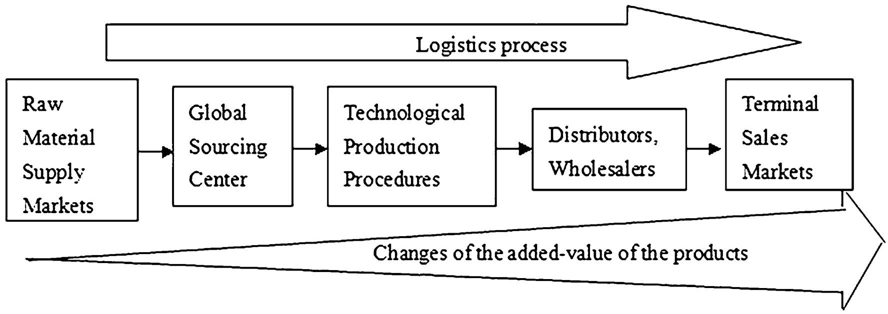


Fig. 2 Changes of the added value of products

be customer oriented. However, transportation, storage, loading and unloading, packing, distribution, and other services are provided by a subsidiary company attached to Yurun meat-packing company with the permission of parent company to execute the value-added process which is gone through as follows:

At first, the optimization of transport routes, the use of multimodal transport, and the enforcement of fleet management have met the requirements of safety, fastness, punctuality, and low cost during transportation, aimed at the space effects and increased the added value of the logistics. Next, during the process of storage, it conducts professional inventory process which is designed to minimize its inventory capacity and space in compliance with the conditions of the markets and the demands of consumers. This allows the enterprise to reduce the cost and the advantages of warehousing are well expressed.

Afterward, the operations of plain packaging, loading, and unloading have ameliorated the morphological and spatial effects of the products, and the logistics departments are bound to contribute the necessary investment; all these factors contribute to increasing the value of the products. And finally, from the warehouse in-out management to staff and vehicle arrangement management, logistics expenses management, and logistic external business operations management, all these managements are reflected by the Logistic Enterprise Resource Planning in Yurun Company, which promotes the scientific convergence of all the steps of logistics and improves the working efficiency of logistics.

Furthermore, the subsidiary of the logistic company serving this meat-packing firms makes their service of logistics the first-class level among the same industry through the using of the advanced transportation equipments tracking system which covers the whole continent to track the logistics information during the whole journey.

To sum up, the following formula is found:

$T = Wi * Fi$

Where T refers to the total value added during logistics

Wi refers to the proportion of each added value procedure

Fi refers to the quantity of each added value procedure

It is duty for the logistics subsidiary company to integrate the procedures of transportation, storage, loading and unloading, processing, distribution, information-collecting into an integrated operation in direction global development. In fact the purpose of using advanced technology and modern management tools of the value chains is to maximize the realization of functional integration in technology and management integration to break away from the traditional functional organization structure in the hope of the best operating results of the entire logistics process. Also the company will better reduce costs and add value. The basic idea is to minimize the total cost and to satisfy the customers' demands to the fullest extent.

Therefore, the logistics subsidiary company of the Yurun meat-packing company is able to make the logistics operations more effective through the designing of more efficient logistics value chains, through the sharing of information between the various logistics procedures of the value chains, and through the inventory availability and good coordination of production.

However, the re-optimization of logistics processes are required for further analysis and transformation of the existing nodes of the workflow in the value chain to adapt to the new enterprise value chain; thereby a efficiency and effectiveness of the entire value chain of the enterprise improves Zhou (2003).

It is required that an optimization of the business processes follow those principles:

1. To unify the customers' satisfaction in and beyond the value chain
2. To value the optimization of the entire process
3. To achieve the information sharing
4. To reduce the staff members and give full play to the employee collaboration

Specific practices go along this way. Eliminate the non-value-added activities and reduce waste, including the waste of transportation, the waste of distribution, the waste of inventory, and the waste of incompleteness and damages. Simplify the necessary activities. Integrate tasks, including tasks from the aspects of work, teamwork, and customers. Achieve the automation of workflow tasks Zhou (2009).

In addition, it further establishes the IT support systems. The information sharing is an important way to improve and strengthen the operational efficiency of the value chain. Preeminent IT support system enables the logistics companies to capture market information quickly and conduct the information feedbacks in the entire value chain of the logistics network within the enterprise, thereby eliminating the information distortions. Only when the advanced information and communication technology have been operated in the entire value chain can it execute the coordinated management of the value chain effectively, so that the operation of each node can achieve synchronization and harmonization.

4 Conclusion

The added value of logistics is designed to be customer-oriented with value-added services applied in the conventional process of logistics, and more importantly, it is to form a logistics system. Therefore, the added value of logistics is taken as a whole, so that advanced technology and modern value chain management tools can be applied to realize the logistics process to the greatest degree both in the aspects of function and management achieving the goal of management integration. At the same time, the expansion of value-added logistics scope helps the value-added procedures of logistics to form an organic whole, which reduce the loss of funds and achieve the high efficiency and lower cost of the logistics, thus enhancing the core competitiveness of the enterprise.

References

L. Sun, J. Song, Observe the industry of modern logistics from the perspective of added-value. Observing and Thinking **7**, 125-132 (2003)

L. Wang, G. Gong, The speed and acceleration of the supply chain. Logist. Technol. **3**, 24-32 (2005)

Q. Zhou, Analysis of the supply chain and value relationship. Bound Financ. Econ. **3**, 42-49 (2003)

Q. Zhou, Analysis of the supply chain and value relationship. Bound of Financ. Econ. **5**, 79-85 (2009)

Profit Distribution Based on Producer Service Outsourcing Value Chain

Sanfa Cai, Li Qiu, and Bin Zou

Abstract This paper suggests an improved principal-agent model for profit distribution under double moral hazard risk based on the maximum profit of the producer service outsourcing value chain in order to realize the maximum profit of both the manufacturer and contractor. Then the related profit distribution parameters are set by calculation, and relevant variables are analyzed. The results show that the optimal output share for contractor is negatively correlated to the output coefficient of manufacturer's effort and positively correlated to the output coefficient of contactor's effort and irrelevant to the effort and cost coefficient of the both sides, while the optimal fixed payment can be selected within a certain range decided by the agreement reached from the expected profit of the two sides, and the selection makes no difference to the profit of producer service outsourcing value chain.

Keywords Producer service outsourcing • Value chain • Profit distribution parameters

1 Introduction

The value chain theory was firstly put forward by Michael Porter in the book Competitive Advantage (1985). This paper defines the producer service outsourcing value chain as a collection of value-added activities in the producer service outsourcing.

At present, there have been some researches about the profit distribution of producer service outsourcing. Laffont and Tirole (1993) and Laffont and Martimort (2002) made studies on the profit distribution based on the principal-agent theory with consideration about agent's risk attitude and discovered that the optimal profit

S. Cai (✉) • L. Qiu • B. Zou
School of Economics & Management Tongji University, Shanghai China
e-mail: csf@tongji.edu.cn; qiuli.zzu@foxmail.com; bilare@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_17,

distribution varied with different risk tolerance; Tarakci et al. (2006) found out that the profit distribution with fixed payment and output share generally brought a win-win; on the basis of principal-agent theory, Zhang and Li (2008) established an IT outsourcing profit distribution model which combined incentive mechanism with supervision and reward-punishment mechanism and showed out manufacturer's best incentive strength and contractor's optimal effort level; Huang et al. (2009) designed a reasonable incentive mechanism to prevent the contractor's moral hazard through profit distribution; Huang et al. (2011) further studied incentive mechanism based on the profit distribution under double moral hazard risk to make sure that the two sides will share their personal information and make their optimal effort; Elitzur et al. (2011) made researches on the profit distribution of information system outsourcing under double moral hazard risk. Song et al. (2010) thought the performance of outsourcing was influenced by the contractor's effort and manufacturer's participation, and they designed an informal contract under double moral hazard risk and analyzed the contract's incentive effect on the two sides' effort. Dan et al. (2010) studied the double moral hazard risk in IT outsourcing and designed an outsourcing contract and analyzed the variables of contract parameters.

Based on maximum profit of the producer service outsourcing value chain, this paper makes an improved principal-agent model and figures out the relevant profit distribution parameters to get the maximum profit of both the manufacturer and contractor and get rid of double moral hazard risk and provides theoretical support for the profit distribution of producer service outsourcing.

2 Hypothesis

Based on the profit distribution with fixed payment and output share, we make the following hypothesis:

Hypothesis 1. The formula of producer service outsourcing value chain output. For the complementary relationship between the producer service outsourcing output and the effort of manufacturer and contractor, we use the traditional Douglas output function to describe the output of producer service outsourcing value chain. The producer service outsourcing output can be described as $\pi(I,e) = kI^a e^r + \theta$(2005), where I stands for manufacturer's effort, e for contractor's effort, a for the output coefficient of manufacturer's effort, r for the output coefficient of contactor's effort, θ for random disturbance, and the output coefficient k for the outsourcing project's value. There is a positive proportional relationship between π and k, which means the larger k is, the greater the producer service outsourcing project value. The above formula meets the following conditions: $\frac{\partial\pi(I,e)}{\partial I} > 0, \frac{\partial\pi(I,e)}{\partial e} > 0, \frac{\partial^2\pi(I,e)}{\partial I^2} < 0$ $\frac{\partial^2\pi(I,e)}{\partial e^2} < 0$, which means that when I, e increase, π will also increases, but the increased speed drops. Therefore, we can make a further hypothesis $0 < a, r < 1$.

Assume that the mean value of θ is 0 and the variance is δ^2, then the expected output of the producer service outsourcing value chain is $E\pi(I,e) = kI^a e^r$ with the hypothesis above.

Hypothesis 2. Cost formula. The manufacturer's cost is $\frac{\delta_c I^2}{2}$, and the contractor's cost is $\frac{\delta_s e^2}{2}$(1996), where δ_c and δ_s are the cost coefficient of manufacturer and contractor respectively.

Hypothesis 3. Information risk. The efforts of both sides are private information and cannot be known by each other, while other information is public. Both the manufacturer and contractor are risk neutral.

Hypothesis 4. Profit distribution formula. The payment for contractor is $W(\pi) = F + \beta\pi = F + \beta kI^a e^r$, including fixed payment and output share, where $W(\pi)$ is the total payment for contractor, β is the output share ($0 < \beta < 1$), and F is fixed payment.

Hypothesis 5. The precondition of the producer service outsourcing occurring is $E(R) \geq U$, where $E(R)$ is the expected profit of the producer service outsourcing value chain and U is contractor's expected retained profit.

3 Model Description

The expected profit of producer service outsourcing value chain equals to the outcome minus the cost of both sides, that is,

$$E(R) = E\pi(I,e) - \frac{\delta_s e^2}{2} - \frac{\delta_c I^2}{2} = kI^a e^r - \frac{\delta_s e^2}{2} - \frac{\delta_c I^2}{2} \tag{1}$$

Expected contractor and manufacturer profit respectively are

$$E(R_s) = W(\pi) - \frac{\delta_s e^2}{2} = F + \beta kI^a e^r - \frac{\delta_s e^2}{2} \tag{2}$$

$$E(R_c) = \pi - W(\pi) - \frac{\delta_c I^2}{2} = (1-\beta)kI^a e^r - F - \frac{\delta_c I^2}{2} \tag{3}$$

The model can be described as the following optimization problem P1:

$$kI^a e^r - \frac{\delta_s e^2}{2} - \frac{\delta_c I^2}{2} \tag{4}$$

$$max F + \beta kI^a e^r - \frac{\delta_s e^2}{2} \tag{5}$$

$$max(1-\beta)kI^a e^r - F - \frac{\delta_c I^2}{2} \tag{6}$$

$$st. \quad F + \beta k I^a e^r - \frac{\delta_s e^2}{2} \geq U \tag{7}$$

$$(1-\beta) k I^a e^r - F - \frac{\beta_c I^2}{2} \geq 0 \tag{8}$$

For the above model description, formula (4) means the maximum profit of producer service outsourcing value chain; formula (5) means maximizing contractor's profit; formula (6) means maximizing manufacturer's profit; formula (7) is for contractor's participation constraint, which means that the producer service outsourcing profit of the contractor is more than retained profit; formula (8) is for manufacturer's participation constraint, which guarantees the manufacturer's profit.

4 Model Solution

Our target is to solve the model with optimal resource allocation, namely both sides will make their optimal effort level. Therefore, we need to take the derivative of formula (5) and (6) respectively by e and I to satisfy the constraint that both sides pay their optimal effort level. We can change the optimization problem P1 into the following optimization problem P2:

$$min - k I^a e^r + \frac{\delta_s e^2}{2} - \frac{\delta_c I^2}{2} \tag{9}$$

$$st. \quad \frac{\partial E(R_s)}{\partial e} = r\beta k I^a e^{r-1} - \delta_s e = 0 \tag{10}$$

$$\frac{\partial E(R_c)}{\partial I} = (1-\beta) k a I^{a-1} e^r - \delta_c I = 0 \tag{11}$$

$$F + \beta k I^a e^r - \frac{\delta_s e^2}{2} \geq U \tag{12}$$

$$(1-\beta) k I^a e^r - F - \frac{\beta_c I^2}{2} \geq 0 \tag{13}$$

Multiply the two sides of formula (10) by e, and the same way for formula (11) by I, we can get two new formulas (14) and (15):

$$I^a e^r = \frac{\delta_s e^2}{\beta r k} = \frac{\delta_c I^2}{(1-\beta) k a} \tag{14}$$

$$\beta = \frac{a \delta_s e^2}{a \delta_s e^2 + r \delta_c I^2} \tag{15}$$

By eliminating β in formula (14) with formula (15), we can get a new Eq. (16):

$$I^a e^r = \frac{a\delta_s e^2 + r\delta_c I^2}{ark} \tag{16}$$

Then the optimization problem P2 can be changed into optimization problem P3:

$$min - kI^a e^r + \frac{\delta_s e^2}{2} - \frac{\delta_c I^2}{2} \tag{17}$$

$$st. \quad I^a e^r = \frac{a\delta_s e^2 + r\delta_c I^2}{ark} \tag{18}$$

$$F + (\frac{1}{r} - \frac{1}{2})\delta_s e^2 \geq U \tag{19}$$

$$(\frac{1}{a} - \frac{1}{2})\delta_c I^2 - F \geq 0 \tag{20}$$

To solve the problem, we can put formula (18) aside for the time being and follow Kuhn-Tucker (K-T) method to get the solution. The Kuhn-Tucker conditions of optimization problem $P3$ are the following formulas from Eqs. (21) to (25) with the precondition: $r_1, r_2 \geq 0$:

$$-akI^{a-1}e^r + \delta_c I - 2r_2(\frac{1}{a} - \frac{1}{2})\delta_c I = 0 \tag{21}$$

$$-rkI^a e^{r-1} + \delta_s e - 2r_1(\frac{1}{r} - \frac{1}{2})\delta_s e = 0 \tag{22}$$

$$r_2 - r_1 = 0 \tag{23}$$

$$r_1[F + (\frac{1}{r} - \frac{1}{2})\delta_s e^2 - U] = 0 \tag{24}$$

$$r_2[(\frac{1}{a} - \frac{1}{2})\delta_c I^2 - F] = 0 \tag{25}$$

We can get the following Eq. (26) through solving the K - T problem:

$$\frac{I}{e} = \sqrt[4]{\frac{(\frac{1}{r} - \frac{1}{2})a^2\delta_s^2}{(\frac{1}{a} - \frac{1}{2})r^2\delta_c^2}} \tag{26}$$

Then we turn back to take formula (18) into consideration, by plugging equation (26) into formula (18), we can get the final solution:

$$e^* = exp\left[\frac{1}{a+r-2}\ln\frac{(\sqrt{\frac{\frac{1}{a}-\frac{1}{2}}{\frac{1}{r}-\frac{1}{2}}}+1)\delta_c}{ak} + \frac{a-2}{4(a+r-2)}\ln\frac{(\frac{1}{a}-\frac{1}{2})r^2\delta_c^2}{(\frac{1}{r}-\frac{1}{2})a^2\delta_s^2}\right] \tag{27}$$

$$I^* = exp\left[\frac{1}{a+r-2}\ln\frac{(\sqrt{\frac{\frac{1}{r}-\frac{1}{2}}{\frac{1}{a}-\frac{1}{2}}}+1)\delta_s}{rk}+\frac{r-2}{4(a+r-2)}\ln\frac{(\frac{1}{r}-\frac{1}{2})a^2\delta_s^2}{(\frac{1}{a}-\frac{1}{2})r^2\delta_c^2}\right] \tag{28}$$

The maximum profit of the producer service outsourcing value chain is $kI^{*a}e^{*r} - \frac{\delta_s e^{*2}}{2} - \frac{\delta_c I^{*2}}{2}$. We can have the optimal β^*,F^* by plugging equation (26) into formula (15):

$$\beta^* = \left(1+\sqrt{\frac{\frac{1}{r}-\frac{1}{2}}{\frac{1}{a}-\frac{1}{2}}}\right)^{-1} \tag{29}$$

$$U-(\frac{1}{r}-\frac{1}{2})\delta_s e^{*2} \leq F^* \leq (\frac{1}{a}-\frac{1}{2})\delta_c I^{*2} \tag{30}$$

So far, we have found out the solution of the optimization problem, which means we have figured out the profit distribution parameters F^*,β^* and found out the optimal effort level I^*,e^* of the manufacturer and contractor to get the maximum profit of the producer service outsourcing value chain, as well as the manufacturer and contractor.

5 Conclusions

Conclusion 1. The optimal output share β^* for contractor is irrelevant to the effort I,e and cost coefficient δ_c, δ_s. But through taking the derivative of β^* by a and r, we can know that β^* is negatively correlated to the output coefficient of manufacturer's effort a and positively correlated to the output coefficient of contactor's effort r:

$$\frac{\partial\beta^*}{\partial a} = -\frac{1}{2a^2}\times\frac{1}{\left(\sqrt{\frac{1}{a}-\frac{1}{2}}+\sqrt{\frac{1}{r}-\frac{1}{2}}\right)^2}\times\sqrt{\frac{\frac{1}{r}-\frac{1}{2}}{\frac{1}{a}-\frac{1}{2}}} < 0 \tag{31}$$

$$\frac{\partial\beta^*}{\partial r} = -\frac{1}{2r^2}\times\frac{1}{\left(\sqrt{\frac{1}{a}-\frac{1}{2}}+\sqrt{\frac{1}{r}-\frac{1}{2}}\right)^2}\times\sqrt{\frac{\frac{1}{a}-\frac{1}{2}}{\frac{1}{r}-\frac{1}{2}}} > 0 \tag{32}$$

Conclusion 2. The optimal fixed payment F^* is not fixed but a range, and is related to all the variables including the effort I,e, the cost coefficient δ_c,δ_s, the output coefficient a, r and the contractor's retained benefit U. So in the producer service outsourcing, the two sides should cooperate and negotiate the fixed payment F^* and realize their expected maximum profit with optimal effort level.

6 Summary

In order to get the maximum profit of the producer service outsourcing value chain, this paper suggests an improved principal-agent model for outsourcing profit distribution to get rid of the double moral hazard risk and maximize both the manufacture's and contractor's profit and then analyzes the variables of the profit distribution. The results show that the optimal output share for contractor is negatively correlated to the output coefficient of manufacturer's effort and positively correlated to the output coefficient of contactor's effort, but irrelevant to the effort and cost coefficient of the both sides while the optimal fixed payment can be selected within a certain range decided by the agreement reached from the expected profit of the two sides, and the selection makes no difference to the profit of whole producer service outsourcing value chain. The research reveals that the manufacturer and contractor should maintain good negotiation and communication to ensure that they both realize their expected maximum profit.

References

R. Elitzur, A. Gavious, K.P. Anthony, Information systems outsourcing projects as a double moral hazard problem. Omega-int. J. Manag. Sci. **4**(3), 379–389 (2011)

B. Dan, H. Song, X. Zhang, R&D outsourcing contracts considering double moral hazards in cooperative innovation. R&D Manag. **22**(2), 89–95 (2010)

B. Huang, W. Meng, Y. Li, Optimal profit distribution method for R&D outsourcing based on mechanism designing. Sci. Technol. Manag. Res. **11**, 5–10 (2009)

B. Huang, W. Meng, X. Pi, Design of incentive mechanisms for R&D outsourcing with double-sided moral hazards. J. Ind. Eng. Eng. Manag. **2**, 178–185 (2011)

J.J. Laffont, J. Tirole, *A theory of the incentives in procurement and regulation* (MIT Press, Cambridge, MA, 1993)

J.J. Laffont, D. Martimort. *The theory of the incentives: the principal-agent model* (Princeton, New Jersey, Princeton University Press 2002)

H. Song, B. Dan, X. Zhang, Relational incentive contracts and double moral hazard in service out-sourceing. Syst. Eng. Theor. Pract. **30**(11), 1944–1953 (2010)

H. Tarakci, K. Tang, H. Moskowitz, R. Plante, Incentive maintenance outsourcing contracts for channel coordination and improvement. IIE T. **38**(8), 671–684 (2006)

H. Zhang, H. Li, Research on incentive mechanism for IT outsourcing based on the principal-agent relationship. Sci. Technol. Manag. Res. **4**, 93–99 (2008)

Enlightenment of International Experience in the "Green Economy" Transformation for Developing Countries

Lin Jun

Abstract This chapter explores how developing countries should transform their patterns of economic development at a lower cost to follow the international trend of "green economy" development. By comparing practices among those countries that have already launched their transformation programs, the chapter summarizes some experience available for reference in developing countries. The thesis selects China as a typical model of developing countries, considers China's developing status at an early stage, and proposes that developing countries should strengthen their science and technology innovation through market functions, regulate the transfer of pollution, and establish balance and supportive frameworks for gender equality.

Keywords Green economy • Developing countries • International experience

1 Introduction

After the Industrial Revolution, the economic development model of the world basically relied on the consumption of resources and fuels, which is called the "black economy" model. In recent years, especially since the global economic crisis in 2008, people around the world have realized that the "black economy" model is not sustainable and that humans must find a way of "green development." As indispensable components of a global economic system, developing countries are faced with the challenge while transforming from a traditional economy to a green economy, because the environment has paid a heavy cost after developing for a long time in a mode of "high consumption, high inputs, high emissions, less coordination, difficult cycle and inefficiency," which has caused serious environmental problems,

L. Jun (✉)
China University of Geosciences,
29th, Xueyuan Road, Haidian District Beijing, 100083, China
e-mail: chenjunjun26@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_18,

constrained economic and social development, and had a bad effect on people's health as well as countries' sustainable development. Since the crisis in 2008, countries around the world have been actively transforming their economy by taking measures to promote the ”green economy.” They are transforming the pattern of economic development to achieve ”green economic development,” which is an inevitable choice for developing countries. China, a typical developing country, witnessed great development during 1978–2010, with its total economy rising from the tenth to the second in the world, and an average GDP growth of 9.8 % annually. The Chinese standard of living has significantly improved, and national integrated power has been significantly enhanced. China has become an emerging economic power. But at the same time, as a country with a large population and having a significant geographical size as well as a fragile natural environment, extensive economic growth pattern, and weak environmental regulation, China has typical developing pressures. This chapter will explore the international experience of transforming to the ”green economy” and serves to find inspiration for developing countries, taking China as an object of analysis.

2 The "Green Economy" Concept

Today there are many explanations for the "green economy"; the main recognized explanation is defined by the United Nations Economic Program (UNEP) and defines the "green economy" as an economy contributing to improving human well-being and social justice while significantly reducing environmental risks and ecological scarcity. In short, it is a low-carbon, resource-efficient, and socially inclusive economy. In China, the concept of "green economy" covers three aspects: The first is based on the concept of green growth, which is put forward by the UNEP and the Organization for Economic Cooperation and Development (OECD); the second is a combination of China's status quo of social development, economy, and environmental protection; the third is a development pattern that is based on environmental protection and sustainable use of the environment and natural resources. This development pattern gives prior attention to human health and well-being by continuously reducing damage to and bad effects on the environment caused by human activities and by highly recognizing native ecosystems as well as the function and value provided by artificial ecosystem services. The pattern will obtain new green economic growth by continuously combining innovation and efficient management.

3 International Experience of the "Green Economy" Transformation

Since the Second World War, during a period of more than a half-century, major industrialized countries have utilized many approaches to continuously make adjustments to the industrial structure and economic development patterns to upgrade them, under their domestic environment and diversified international conditions, and based on their own development conditions. Take the United States as an example: In the "Second World War," the United States was focused on adjusting and upgrading the industrial structure of the world engine; today the United States focuses on the development of the information industry in the transition-oriented high-tech industry, the financial sector (mainly banks), and innovative industries.

Since there are differences in cultures and political systems, for other countries it is relatively difficult to transform, and each country has its own ideas of transformation. First, the Western European countries, for example, have a relatively slow development of innovative industries, so they are now trying to nurture an atmosphere for the growth of the knowledge economy, and they strive to transform integrated industries into innovative industries. Second, Latin America and some countries in Asia are facing the dual pressures of informationization and industrialization and strive to progressively adjust and upgrade resource- and labor-intensive industries. Third, the "four little dragons of Asia" as well as Japan are gradually achieving their transformation from capital- and technology-intensive industries to knowledge- and technology-intensive industries. Korea, Japan, and the United States are typical representatives of countries leading the green industry transformation.

Under different backgrounds and historical stages, the main driving factors of promoting green development–oriented system innovations and structural adjustments include, first, resource constraints, such as the oil crises and the shortage of raw materials crisis, and second, the effects of the technological revolution, such as the revolution in information and communication technology, and the continuous impact of globalization, such as human resources, investment, trade, and international movement. But from an integrated view, in the process of global economic transformation, no effective policy program or general mode has yet formed. We can summarize only four common aspects through researching the experiences of some OECD countries in their green economic structure adjustment and green economy reforms, hoping that they can be of some reference on the policy making and development of a green economy, and provide some enlightenment and help for China's transformation and development of a green economy.

The first aspect is to publicize policy information and increase the transparency of policy information. Through publicized policy information, the public can easily understand policy information; a government can gain public support for structural adjustment and reform to increase the transparency of information. There are two key points: First, increase the transparency of policy information and strengthen the information disclosure policy; second, establish an exchange platform. Through this platform, the government can have effective communication with the public, focusing on impact reform policies, so as to gain public support for the structural adjustment and reform.

The second aspect is to adjust enterprise behaviors through policies, mainly focusing on the connections between policy-oriented and enterprise acts. In the green economy transformation, through the leading role of policies, the government can guide enterprises to change their business practices. The enterprises' responses and actions are particularly important. On the other side, enterprises will have their own requirements on the development of policy frameworks: The first requirement is satisfying the needs for the development of capital markets, mostly in risk, market risk, market return, and the constant change of the market; the second requirement is increasing the transparency of market information by announcing market signal information on time, especially resource aspects, energy aspects and other related areas, such as energy resources' price signal, energy supply and demand changes; the third requirement is to evolve the government in the enterprises' new technologies project and push the promotion and development of new technologies.

The third aspect is to establish an interest mechanism. It is very important to establish an interest-coordinating mechanism among government departments and different interest parties. In the policy-making process, the government faces conflicts and contradictions in interest in different areas and levels. The solutions for this problem are cooperation and close coordination. Only through cooperation and close coordination can different interest parties achieve a common interest for a win–win condition, thus avoiding conflicts. There will be no constraints among the development of all parties.

The fourth aspect is to pay attention to inequitable distribution problems and the interests of vulnerable groups. A compensation mechanism should be established. The government can solve the inequitable distribution problems caused by economic structural adjustments and periodic reforms. A successful practice of a compensation mechanism is that the government can directly give cash subsidies to farmers, or earn income tax relief under the conditions of growth in environment-related taxes.

The fifth aspect is the relationship between international competitiveness and the implementation of environmental and climate policies. The government should properly protect the relationship between international competitiveness and environmental and climate policy implementation, and comprehensively measure the importance of international competitiveness in terms of the economic benefits and the environmental impact. From the experience of many OECD countries, environmental and climate-changing policies will not negatively impact international competitiveness.

4 International Lessons and Measures to Promote the Green Economy Initiative

The international "green economy initiative," presented by international multilateral cooperation and at the international level and actively pursued mainly after the 2008–2009 financial crisis, has as its primary objective to achieve sustainable economic recovery and as its medium- and long-term strategic objectives to seek new employment opportunities and create new competitiveness.

Table 1 Organization for Economic Cooperation and Development Countries’ new green growth programs

Country	Year	New green growth program
U.K.	2010	United Kingdom Green Investment Bank will be set up in 2012; early public input for the 3 billion, aimed at financing for low-carbon projects.
KOR	2009	Korea national green growth plan: develop comprehensive policy framework for green growth, green planning, and projects annual growth in GDP target of 2 %. As a part of “green new deal,” the funds invest 50 trillion won and strive to create 960,000 green jobs.
DEN	2009	The tomorrow agriculture in Denmark: a modern agriculture with high-level protection of the environment, nature, and climate.
JPN	2011	Green innovation (Japan): aimed at creating 50 trillion said meta-resources and environment-friendly technologies, as well as related to 1.4 million new jobs.
NZL	2010	Green Senior Advisory Committee (New Zealand): a Joint Advisory Committee composed of heads of the Ministry of Finance, the Ministry of Economic Development, and the Ministry of the Environment, seeking to export innovation and SME-led green growth.

Source: “Towards a green growth—Summary of the decision makers,” OECD, 2011

4.1 The OECD Green Growth Strategy

The OECD green growth strategy focuses first on the maintenance and accumulation of natural resources. The maintenance and accumulation of natural resources are one of the bases and sources of national wealth creation; the importance and value should be fully reflected in economic development and policy decision making. The second area of focus includes reforms in fiscal and tax policy. Fiscal and tax policy reform becomes important policy instruments for achieving harmonious development between the economy and the environment; strengthening environmental protection and promoting economic growth must be complementary twin goals. The third area of focus in OECD green growth strategy encompasses technological and nontechnological innovation. Technological and nontechnological innovation as a means of promoting green growth and the transformation of measures and the green economy, such as policies, mechanisms, and institutional innovation, are indispensable (Table 1).

4.2 Development of the Global Green Economy Initiative

The UNEP launched the global green economy initiative for a sustainable recovery in the global economy and to create green jobs in the twenty-first century. Green economic development is based on a combination of green investment and policy and institutional reform. During the economic crisis, the “Global Green New Deal” made by the UNEP received national recognition and response. During the 2008–2009 financial crisis, G20 countries invested in the financial plan to stimulate the economy; the total investment was up to US $ 4.5 trillion, and green investment–related resources in the field accounted for more than 15 %. China launched an economic stimulus plan of total investment of US $ 586 billion, with a "green stimulus investment" of more than 200 billion dollars. Short-term capital input does not happen overnight, but rather is a long-term process. The UNEP's global green economy initiative stressed green investment combined with long-term strategic planning in various countries, emphasizing long-term behavior in order to have a lasting effect. Scenarios such as UNEP estimates show that in 2010–2050, if 1–2 % of global annual GDP invested in 10 focus areas related to environmental and social development at this stage, integrating the economic, social, and environmental benefits would amount, under normal conditions, to the entire economic activity (production and employment) of investment income coupled with environmental benefits (Table 2).

4.3 China's Enterprises Under the Background of a Global Green Economy in Transition

The gradually internationalization of Chinese enterprises is also increasingly playing an active role in the global green economy transition. Green enterprises in China participate actively in international activities, particularly in the traditional "black" and "brown" line of business, and are an important starting point in the transition to low-carbon and green development. One of the Chinese enterprises that participate in international action for sustainable development involves the cement industry (CSI). CSI is an enterprises' union, made up of the largest global cement enterprises, designed to take action toward sustainable development. As of 2010, five large cement companies in China (China Resources Group, China National Building Material Group Limited, Sinoma Group, Yatai Group, and Tianrui Group) were part of CSI. The roadmap of CSI is that the enterprise union leads the industry in a global context common commitment for action on sustainable development. Specific actions include (1) introducing advanced monitoring tools, particularly monitoring of CO2 emissions; (2) on this basis, developing CO2 emission reduction strategies, as published in its objectives and progress; (3) participating in the construction of global cement industry information databases, which include CO2 emissions and cement used (GNR-Getting the Number Right); (4) providing information on reduction for building a database. CSI has become the starting point for Chinese enterprises to participate in the success of the International Alliance for Sustainable Development. In this league, not only will valuable information and experience be exchanged, but also the international community will view China's traditional "black" and "brown" industry technical progress and new image. Jointly with other international cement enterprises, such as Lafarge and Holcim, China's CSI franchise enterprises provided communication, training, and capacity-building activities for other enterprises in health and safety, energy-saving, emission reduction,

Table 2 Cost estimates of the greening of industry transformation in China

Restructuring costs	Estimates	
	12th five-year plan	13th five-year plan
Cost of investment in energy conservation and environmental protection	5.77 trillion yuan	6.83 trillion yuan
Reduction in employment of energy-intensive industries and high-emission industries	952,100 jobs	2,907,900 jobs
Potential loss of macroeconomic	More than 100 billion yuan	

Table 3 Cost estimates of the greening of industry transformation in China

The proceeds	Estimates	
	12th five-year plan	13th five-year plan
Reduce energy costs	1.43 trillion yuan	5.47 trillion yuan
The development of energy-saving and environmental protection industries	Total output: 6.35 trillion yuan Increase in GDP: 8.08 trillion yuan	Total output: 7.51 trillion yuan Increase in GDP: 9.56 trillion yuan
Create opportunities for green jobs	10.58 million jobs	12.52 million jobs
Positive health effects/avoid negative health impacts	More than 1 % of GDP	

new energy technologies, and other areas (source: World Business Council for Sustainable Development) (Table 3).

5 Inspiration for Developing Countries to Develop a Green Economy

Developing countries saw a long period of a high consumption of resources, high resource intensities, high pollution discharge, low productivity, and low circulating levels, characterized by low coherence patterns of economic growth, so that they face serious resource bottlenecks and eco-environmental impacts. Obviously, if developing countries continue their old patterns, it will not work. Continuing industrialization, urbanization, and agricultural modernization will make developing countries face a double challenge. A green economic transformation is a reflection of the extensive economic development model in the past, focusing on how to explore the realization of economic, social, and environmental benefits. There are five international experiences from which developing countries can learn, as described next.

5.1 With the Function of the Market

The government should fully respect the basic role of the market in resource allocation. If the government does not respect the market, excessive intervention in running the market will seriously impede the role of markets. At the same time, the government should pay attention to playing a leading role in the development of the green economy, giving more intensive supervision policies and guidance in the market, to compensate for market failure brought about by negative externalities such as pollution and a waste of resources.

5.2 Strengthening the Scientific and Technological Innovation

Science and technology make up the first productivity. In green economic development, industry transformation to green, green production, and cross-industry coordination among developments are inseparable from the development and innovation of science and technology; strengthening innovation in science and technology is an important driver of green economic development.

5.3 Monitoring of Pollution Transfer

In their process of greening the industry structure and enlightenment of international experience in the "green economy" transformation for developing countries' economic structure, many advanced developing countries will consider transfer to other countries or regions in order to avoid harm to the national environment. Many countries tend to transfer pollution and brown industries through trade and foreign investment. They should attach due importance to the developing countries, to be vigilant and actively respond to supervision in imports and foreign investment promotion in the process of the pollution transfer problem.

5.4 Coordination of Policies and the Transformation of the Green

The coordination of macroeconomic policies and the green industry in transition is essential. Strengthening fiscal and tax policy reform and support in furthering the green transformation of the industrial structure and upgrading will play an active role throughout the process.

5.5 Balance Support Framework for Establishing Gender Equality

In February 2009 at its 25th meeting report, the United Nations Environment Program Governing Council/Global Ministerial Environment Forum noted that "women and children benefit from the transition to a green economy; they should not be suffering any negative impacts of this transition." This statement attaches great importance to women and women's organizations in a leading role in green development. In employment, financial credit, and resource property right system design aspects, a supportive framework for women in green development should be established.

References

L. Chao, Countries are developing the green economy. Ecol. Econ. **1**, 12–17 (2011)

DB Climate Change Advisors, The Green Economy. (Apr. 2010)

Department of Social Development in Ministry of Science & Technology of the PRC, *Studies on National Strategy of Climate Change*, Adaptation (Science Press, Beijing, 2011), pp.7–8

K.S. Hebbel, OECD Economic Outlook Interim Report Handout for Journalists (2009)

H. Liang, H. Wang, Development of the global green economy and enlightenment. Adv. Mater. Ind. **12**, 27–31 (2010)

H. Lju, J. Fan, G. Giroir, Carbon emission trend and green economy prospect in China. China Popul. Resour. Environ. **21**(3), 151–154 (2011)

D. Mou, Y. Li, Green opportunities and challenges to economic development in China. J. Southwest Petrol. Univ. (philosophy and social sciences edition) **2**(6), (2009)

OECD. OECD Economic Outlook Interim Report (2009)

OECD. OECD Strategic Response to the Financial and Economic Crisis (2009)

J. Strand, M. Toman, Green stimulus, economic recovery, and long-term sustainable development. World Bank (2010)

L. Zhang, Obama's climate diplomacy. World Knowl. **20**, 42–43 (2009)

Effects of Globalization and Necessity of Vietnamese Educational Management for Integration into the World

Pham Lan Huong

Abstract Vietnamese education has a long history. It has been influenced by some advanced educational systems, including French, American, Eastern European, and Chinese. Vietnamese people value diligent study and do not lack intelligence. The Vietnamese education market is considered to have great potential. Today, with the whole world becoming a "flat world" education worldwide is gradually moving toward a unified approach. Integrating with the educational market worldwide is the only way to move forward for Vietnamese education. The process of integration presents to Vietnam many great challenges, especially for management. If Vietnam can take full advantage of the opportunities and overcome the challenges of this new era, Vietnam will develop quickly. At first, renovation for management is the best way for the integration of Vietnamese education to the world.

Keywords Globalization • Vietnam • Education • Integration

1 Tradition

Vietnam is a country with a long tradition of education. Through 4000-year history of building and defending the country, with many immigrants and feudal war, Vietnamese education is by blending folk culture as well as foreign influences. Oldest influence is probably cultural Confucianism. To this day the values of Confucianism is still preserved as five virtues: nhan (kindness toward others), nghia (understanding one's duty), le (knowing how to relate to those under and over you in the social hierarchy), tri (knowledge), and tin (trustworthiness).

P.L. Huong (✉)
International Educational Research Center AD, Ho Chi Minh City, Vietnam

visiting professor of education faculty of USSH (HCMC National University), Ho Chi Minh City, Vietnam
e-mail: p.lanhuong@yahoo.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*, DOI 10.1007/978-1-4614-4857-0_19,

2 Changing of Thinking from Effects of Globalization

Besides affected by Confucianism, Vietnam has been also greatly influenced by the education of Europe such as France and Russia and the United States. The education also helped advanced VIETNAM achievements for the development of scientific-technical for country. VIETNAM education gradually moved from an education with a feudal backwardness into an advanced education and more modernization.

Since 1986 a profound socioeconomic policy change has taken place in Vietnam: the transition from a centrally planned to a market economy. Thus, Vietnam has become one of the many economies now classified as a transitional economy. From 1992 to 2003, the average GDP per year of Vietnam increases to 6–7 %. Among that, the labor contributes about 60–65 % increase in GDP. Vietnam has had considerable success, especially in increasing the size of the education sector.

The education renovation in that time was the changing of thinking system from subsidize to marketing. Absolutely, it was a process of thinking change. The success of economic renovation has pushed education to change. The idea of democracy in education has been developed.

With the influence of globalization, Vietnam is being brought into the process of democratization. It is possible to observe the following shifts in the emphasis on higher education:

- From meeting human resource demand for state organizations and enterprises to meeting human resource demand for a multi-sector market economy
- From relying solely on state budget for the provision of higher education to multiple sources of funding
- From centralized planning in university admission and training to decentralized planning at the provincial and sector level
- From offering government financial scholarship to requiring students to pay tuition fees.
- From narrow specialization in specialized institutes to broad-based education in comprehensive universities
- From training for state-allocated job employment to lifelong learning gearing for occupational changes throughout one's lifetime

3 Successes and Challenges

After more than 25 years of innovation, Vietnamese education also has not only achieved certain successes but also accompanied by numerous challenges.

Scale education has developed quite strong in number and moved from elite education to mass, for example, in higher education during the period 2001–2011, an increase from 918,228 to 2,162,106 students. In 2011, there are 163 universities and 223 colleges (more than doubled since 2001) (MOET), but they do not retain the quality requirements. The problem seems that the relationship between size and effectiveness of training has not found a proper solution.

Education has international orientation, but comparative studies seriously in order to find the most appropriate model for VIETNAM education have not really been interesting. In addition, in an era of globalization, to successfully integrate, we need to understand, and respect the rules of the game, first of all the rules, standards, and international practices. But the most common standards for facilities, teaching staff, for admission to master's, doctoral and evaluation of scientific research work, reviews of Master and doctor, selection, evaluation Professor, Associate Professor, evaluating etc. are not in compliance with international standards, lack of objectivity, lack of scientific basis (Hoang.T)

Social policy education helped VIETNAM education and richer diversity in academic year 2008–2009, the and percentage of students in nonpublic institutions on general students is 13.3 % (up from 11. 8 % in 2000) (MOET), but the government has been very confused for policy-making as well as the management for type of private institutions. Because VIETNAM has not been through the capitalist stage, so it lacks of big capitalists. There are no investors who have the potential to build universities of international standard. Therefore generally the most nonpublic schools and private universities in VIETNAM are very small and weak. They can hardly compete with public schools, which are state sponsored. Besides, management work of government to maintain harmony between the intellectual education for operating with financial interests of investors in the nonpublic schools is still very difficult to solve.

The management and human resources development is still inadequate. The structure of Vietnamese human resources is the reverse pyramid—engineer degree more than workers. Plan of branch division at the high school through many revisions has not met the requirements, not to satisfy the learners, needs and demands of socioeconomic modernization. According to Pham Chi Lan, former vice president of Chamber of Commerce and Industry of Vietnam, the human resources of Vietnam do not currently meet the requirements of human resources with international competitiveness such as specific levels, fitness, professionalism, discipline, and adaptability to change.

One thing that public opinion pressing wider cheating are blatantly still exists although the MOET has set many policies and measures for handling.

Concerned about the quality of higher education in the country, many students choose to study overseas. Only in the United States (LTHy), number of Vietnamese students has increased from 2,022 in 2000 to 12,823 in 2009 (source: Institute for Vietnamese Culture & education (IVCE), New York, 04.08.2010). Just take the average cost of $ 30,000 / student / academic year, the 2008–2009 school year, the amount from Vietnam to the USA for overseas study students is about $ 30,000 x 12,823 = $ 384,690,000 / year. And perhaps the total cost of Vietnamese overseas study in all other countries is approximately nearly $ 1 billion / year. It was approximately two-thirds of the cost of higher education / college both public and private schools in the country! (P.D.N.Tien).

Besides the initial achievements, the weaknesses in quality and efficiency, structural development, for social justice has accumulated, which challenges economic and social change than ever

4 Causes of Weakness

The fundamental cause of the persistent weakness is partly due to the global recession affect to VIETNAM, led to the financial shortfall for the education sector. In addition, economic model-oriented market socialist VIETNAM selection means that there are no practical examples to follow. Therefore, Vietnam must find own answers through the process of exploration, experimentation, and creativity. And from that subjective reasons are the lack of an overall vision and lack of a uniform plan, resulting in a patchwork reform. Educational management mechanisms focus primarily on the relationship between the State and the school but lack interest in two new areas that are the market and civil society (Pham, D.N.T). The mechanism is necessary to reform from the state to monitor and control autonomy for more schools. Innovation requires synchronize management of teachers, teaching and learning methods, curriculum-textbooks, scientific research towards international standard and more practical, more effective, transparent financial management.

5 Necessity of second Renewal for Educational Management

Now, when the country has become a middle-income country, again deep integration with the world, the economic system-society becomes more complex and diverse than ever before. Education itself has also been on the scale of dramatic development in terms of the network of schools, with higher requirements for quality and efficiency, various policy systems and expanding international relations International integration on education puts Vietnamese education with new challenges. VIETNAM education to the 2nd renewal has been stronger and more comprehensive than the first innovation in 1980. Innovation and comprehensive basic education and training from the perception of innovation approach, innovation conditions, the solution, the core, elements of systematizing process of education creates quality products as well as orients towards standardization, modernization, socialization, democratization and international integration and all changes must be suitable with the new stage of national and regional development (Education action Plan period 2011 - 2016, MOET).

6 Conclusion

With VIETNAM, international integration is both an opportunity and a challenge and is also the only way to VIETNAM development. Educational innovation, especially innovation management toward a comprehensive internationalization, is opening up a horizon of hope for VIETNAM and education for future integration, also the contribution of VIETNAM with the region.

References

Hoang, T. Petition for Vietnam Education Renovation (Kiến nghị chấn hu’ng giáo dục cho Việtnam), Vietnam Week (2009)

L.H. Pham, *Opportunities and Challenges for Vietnamese Higher Education on the Way of International Integration* (the paper for International Conference in the HCM Pedagogical University, 2008)

Lê. T.H Investment for Education: building university with high quality (Đầu tu’ giáo dục: xây dụ’ng đại học chất lu’ọ’ng cao), Tuoitre (2011)

MoET Education action Plan period 2011–2016 (2012)

A New Approach for Predicting and Simulating Inflation Expectations in China

Xiaowen Hu and Bing Xu

Abstract A new approach is proposed to investigate inflation expectations, which develops classical Phillips curves with the control factors of money, house prices, and interest rates. We find that (1) annual inflation rate is no more than 3 % in 2012 if real money growth is kept less than 14% and real house price index and real interest rate are both in [−1 %, 1 %], which means the inflation targeting by the government can be implemented. However, if real money growth increases to 14 % and real house price index and real interest rate both increases to 1 %, inflation rate will reach 5.2 % in 2013Q2. (2) Interest rates rule is more effective in managing inflation expectations among money, house prices and interest rates policy. While effecting directly inflation, house prices are more significant than interest rates

Keywords Money growth • Interest rates and house prices • Inflation expectations • Interest rates rule

1 Introduction

Central Economic Work Conference in 2009 clearly stated the job requirements of the need to effectively manage the inflation expectations. The crucial question addressed is how to measure inflation expectations accurately. The purpose of this paper is to present an approach to measure inflation expectations accurately under the condition of keeping annual output growth rate by 7.5 % and annual money growth rate by 14 % and changing house prices steadily.

X. Hu (✉) • B. Xu
Research Institute of Quantitative Economics,
Zhejiang Gongshang University, Hang Zhou, 310018, China
e-mail: hxw_0551@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_20,

The model in this paper is based on Phillips curves; it is necessary to give a brief introduction about the application and development on Phillips curves. Phelps (1967) and Friedman (1968) additionally proposed the expected Phillips curve:

$$\pi_t = \pi_t^e + \gamma(U_t - U_*)$$

where π_t,U_t,π^e,U_* denote inflation rate, unemployment rate, inflation expectations rate, and the natural unemployment rate, respectively. Taylor (1980) put forward the staggered contract model which contains rational expectations and assumes nominal wages viscous:

$$\pi_t = E_t\pi_{t+1} + \gamma(y_t + y_{t-1})$$

where $E_t\pi_{t+1}, y_t$ denote inflation expectations rate and output gap rate.

Calvo (1983) assumed manufacturers adjust price with a certain probability each period, and then

$$\pi_t = E_t\pi_{t+1} + \gamma y_t$$

Fuhrer and Moore (1995) found those models cannot reflect inflation persistence, so considering forward expectations, assuming that negotiation salary is relative average real contract pay, obtained hybrid Phillips curves from the two periods contract model:

$$\pi_t = 0.5(\pi_{t-1} + E_t\pi_{t+1}) + \gamma(y_t + y_{t-1})$$

Gali and Gertler (1999) also put forward a similar model:

$$\pi_t = \gamma_b\pi_{t-1} + \gamma_f E_t\pi_{t+1} + \gamma_{mc}mc_t$$

where it denotes real marginal cost.

Wang and Zhao (2006) studied the relationship among money growth,interest rate, and inflation expectations by the model:

$$logm_t = \lambda logA + \lambda\alpha logy_t + \lambda\beta logi_t + (1-\lambda)logm_{t-1}$$

where λ, $m_{t,\ y_t,\ i_t}$ denote money holding adjustment coefficient, real money growth rate, real income, and interest rates.

Yang (2009) took three factors: household consumption, manufacturers investment, and impact of the excess liquidity into Phillips curves:

$$\pi_t = \sum_{i=1}^{k}\gamma_{b,l}\pi_{t-1} + \gamma_f E_t\pi_{t+1} + \gamma_{mc}mc_t + \emptyset_1 DS_t + \emptyset_2 BR_t + \emptyset_3 EL_t$$

where DS, BR, and EL denote household consumption, manufacturers investment, the impact of and excess liquidity, respectively.

Chengsi Zhang and Joel Clovis (2010) defined inflation persistence to be estimated as parameter in univariate regression of the form

$$\pi_t = c + \alpha_\pi \pi_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta \pi_{t-i} + \varepsilon_t$$

Compared with other dynamic inflation model, hybrid Phillips curves model has the following advantages: (1) It is based on microscopic company pricing mechanism and also considers forward-looking and rearview behavior would influence overall economy system in the future. (2) It not only reflects the impact of inflation persistence to the current inflation but also reflects the pressure of the trend of future economy to inflation.

Compared with the researches above, the paper has the following contributions:

(1) We take money house prices and interest rates factors as path control variables into the nonparametric part to construct model.
(2) When currencies, interest rates, and prices index change, we can do scene simulation and analysis.

The paper proceeds as follows: In Sect. 2, we make a brief description about the data and construct analytical model, including benchmark model and path model. Section 3 gives the solution and explains how money, interest rates, and house prices influence inflation. In Sect. 4 we predict inflation expectations in 2012Q4. Section 5 gives the simulation .The final section is the conclusion and proposals.

2 The Data and Model Construction

2.1 *The Data*

In this paper, mainly includes five variables: inflation rate, output gap rate and real money growth, real house prices growth rate and real interest rates. We adopt year-on-year data; the sample period covers quarterly data from 1998Q2 to 2012Q2. All data are real variable data.

We assume inflation expectations equal to the inflation rate of next period, $E_t \pi_{t+1} = \pi_{t+1}$.

2.2 *Potential Model*

Construct the general hybrid Phillips curve:

$$\pi_t = aE_t \pi_{t+1} + b\pi_{t-1} + cy_{t-1} \tag{1}$$

where $E_t \pi_{t+1},\ \pi_{t-1},\ y_{t-1}$, denote inflation expectations at time t, and inflation rate at time t-1, output gap at time t-1.

2.3 Benchmark Model

We take time factor into nonparametric part to construct benchmark model, consider that coefficients are time varying, construct semiparametric time-varying model based on model above:

$$\pi(t_i) = 7a(t_i)E_{t_i}\pi_{t_i+1}(t_i) + b(t_i)\pi_{t_i-1}(t_i) + c(t_i)y_{t_i-1}(t_i) + G(t_i) + \varepsilon(t_i) \quad (2)$$

$$G(t_i) = \sum_{j=1}^{n} z_j(t_i)(\pi(t_j) - a(t_j)E_{t_i}\pi_{t_i+1}(t_j) - b(t_j)\pi_{t_i-1}(t_j) - c(t_j)y_{t_i-1}(t_j)) \quad (3)$$

where $z_j(t_i)$ denotes weight, $\sum_{j=1}^{n} z_j(t_i) = 1$, select $z_j(t_i) = K(\frac{t_j-t_i}{h_1}) / \sum_{l=1}^{n} K(\frac{t_l-t_i}{h_1})$, K and h_1 denote kernel function and bandwidth, and h_1 is figured out by the cross-validation method.

In order to solve time-varying coefficients $a(t_i)$, $b(t_i)$, $c(t_i)$, and $G(t_{t_i})$, using Taylor expansion,

$$a(t_i) = a_1 + a_2(t - t_i), b(t_i) = b_1 + b_2(t - t_i), c(t_i) = c_1 + c_2(t - t_i) \quad (4)$$

2.4 Path Model

Recentlymore and more scholars believe that the relation among money, house prices, and interest rates inflation is nonlinear (Duan (2007); Zheng and Liu (2008); Xiang et al. (2011); Zheng and Liu (2010); etc.). So we take money growth, housing price index, and interest rate, respectively, into G and then obtain three path models based on previous benchmark model:

$$\pi(t_i) = a(t_i)E_{t_i}\pi_{t_i+1}(t_i) + b(t_i)\pi_{t-1}(t_i) + c(t_i)y_{t-1}(t_i) + G(t_i, \Delta M_{t_i-1}) + \varepsilon(t_i) \quad (5)$$

$$\pi(t_i) = a(t_i)E_{t_i}\pi_{t_i+1}(t_i) + b(t_i)\pi_{t-1}(t_i) + c(t_i)y_{t-1}(t_i) + G(t_i, h_{t_i-1}) + \varepsilon(t_i) \quad (6)$$

$$\pi(t_i) = a(t_i)E_{t_i}\pi_{t_i+1}(t_i) + b(t_i)\pi_{t-1}(t_i) + c(t_i)y_{t-1}(t_i) + G(t_i, r_{t_i-1}) + \varepsilon(t_i) \quad (7)$$

If the sample size is large enough the models (5), (6), and (7) will be convergent in probability to model (2) (Xu 2010):

$$G(t_i, \Delta M_{t_i-1}) = \sum_{j=1}^{n} z_j(t_i)(\pi(t_j) - a(t_i)E_{t_i}\pi_{t_i+1}(t_i) - b(t_j)\pi_{t_i-1}(t_j) - c(t_j)y_{t_i-1}(t_j)) \quad (8)$$

where $G(t_i, h_{t_i-1})$, $G(t_i, r_{t_i-1})$ can be expressed by the same token, $z_j(t_i)$ denotes weight, $\sum_{j=1}^{n} z_j(t_i) = 1$, $z_j(t_i) = K(\frac{t_j-t_i}{h_1})K(\frac{\Delta M_{t_j} - \Delta M_{t_i}}{h_2}) / \sum_{l-1}^{n} K(\frac{t_l-t_i}{h_1})K(\frac{\Delta M_{t_l} - \Delta M_{t_i}}{h_2})$, K, h_1, and h_2 denote kernel function and bandwidth, and h_2 is calculated by the cross-validation method.

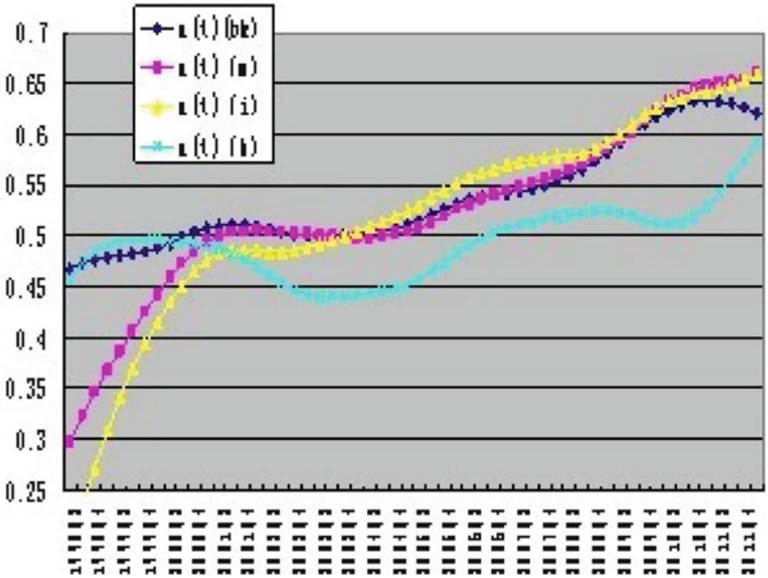


Fig. 1 The coefficient $a(t)$ in each model

3 The Model Solution and Marginal Effect Analysis

As can be seen, $a(t_i)b(t_i)c(t_i)$ reflects marginal inflation of the inflation expectations, inflation inertia, and output gap; we take $a(t_i)b(t_i)c(t_i)$ in path models and subtract corresponding $a(t_i)b(t_i)c(t_i)$ in benchmark model. If it is positive, there exists positive marginal effect, otherwise negative marginal effect.

Figures 1, 2, and 3 show marginal effect, bk denotes benchmark model, and m, h, and i, denote a path model including money, house prices, and interest rates, respectively in G; Fig. 4 shows each model nonparametric part, because money growth, interest rates, and house prices are in this part, it can reflect "direct effect" to inflation.

In Fig. 1 marginal effect of inflation expectations originated from money and interest rates is very weak, especially after 2000. Marginal effect originated from house prices is negative.

In Fig. 2, marginal effect of inflation inertia originated from money turns to be positive from 2003Q4, and marginal effect originated from interest rates is very weak, while marginal effect originated from house prices is positive.

In Fig. 3, marginal effect of output gap originated from money is similar from interest rates, while marginal effect originated from house prices is primary positive and stronger between 2002 and 2007.

In Fig. 4, direct effect of inflation originated from interest rates is very small, and direct effect originated from money growth is weak before 2007 and after 2007 is stronger and negative except 2009, while direct effect originated from house prices to inflation is stronger and fluctuant.

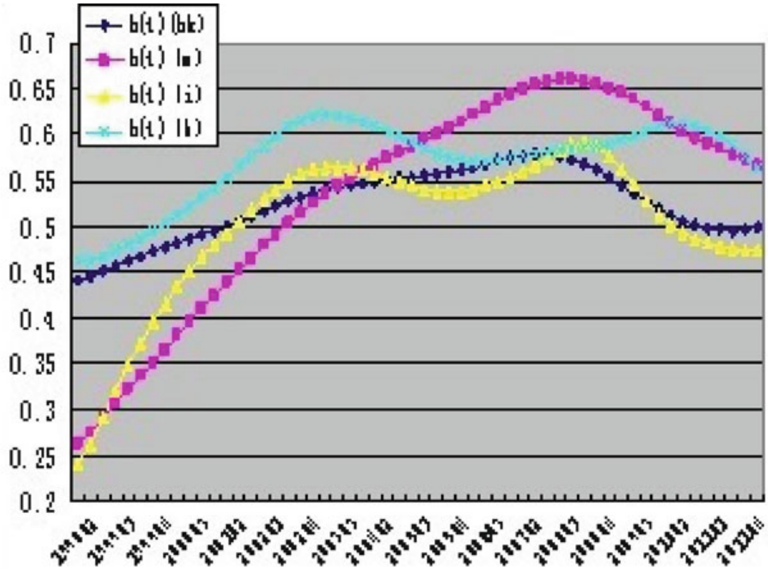


Fig. 2 The coefficient $b(t)$ in each model

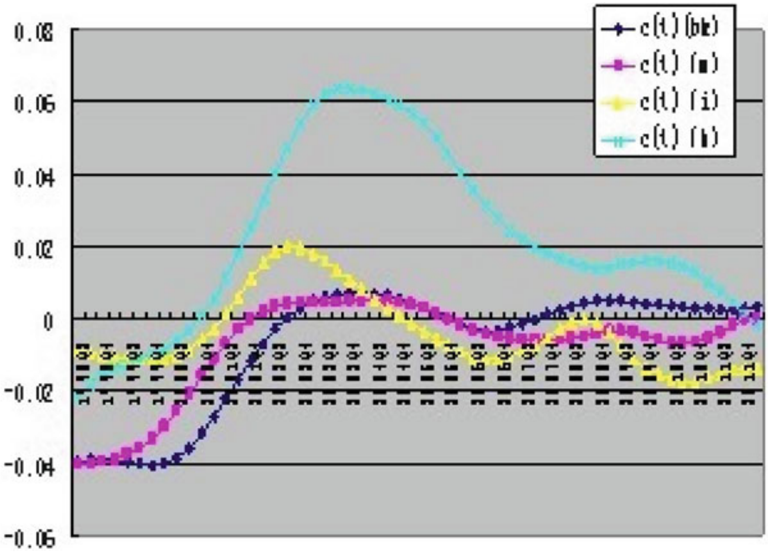


Fig. 3 The coefficient $c(t)$ in each model

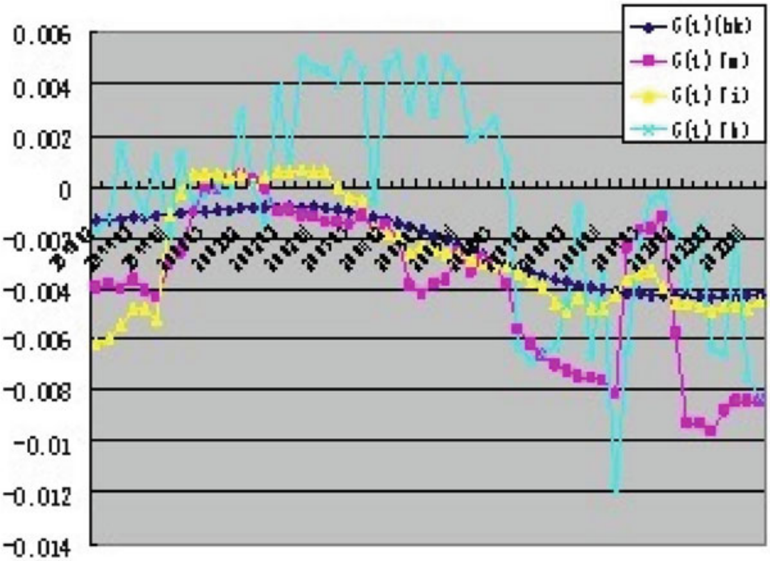


Fig. 4 The coefficient $G(t)$ in each model

4 Predict Inflation Expectation in 2012Q4 in The Benchmark Model

In order to simulate inflation expectations in a unified level in each path model, we predict inflation expectations in benchmark model. Considering that the coefficients change fractionally with time, we construct model (9) for prediction:

$$E_{t_i}\pi_{t_i+1}(t_i)=(\pi(t_i)-b(t_{i-1})\pi_{t_i-1}(t_i)-c(t_{i-1})y_{t_i-1}(t_i)-G(t_{i-1})-\varepsilon(t_i-1))a^{-1}(t_{i-1}) \tag{9}$$

We give a iterative algorithm to predict inflation expectations:

(1) We substitute $a(t_{i-1}), b(t_{i-1}), c(t_{i-1}), G(t_{i-1}), \varepsilon(t_{i-1})$ for $a(t_i), b(t_i), c(t_i), G(t_i), \varepsilon(t_i)$, respectively, and take them as the initial value into Eq. (9), and then

$$\pi_1(t+1)=\widehat{E_{t_i}}\pi_{t_i-1}(t) = [\pi(t_i)-b(t_{i-1})\pi_{t_i-1}(t_i) \\ -c(t_{i-1})y_{t_i-1}(t_i)-G(t_{i-1})-\varepsilon(t_i-1)]\,a^{-1}(t_{i-1})$$

(2) Substitute $\pi_1(t+1)$ into Eq. (2), and then

$$\pi(t_i)=a(t_i)\pi_i(t+1)+b(t_i)\pi_{t_i-1}(t_i)+c(t_i)y_{t_i-1}(t_i)+G(t_i)+\varepsilon(t_i)$$

figure out $a_1(t_i), b_1(t_i), c_1(t_i), G_1(t_i-1), \varepsilon_1(t_i)$,then substitute them into Eq. (9):

$$\pi_2(t+1) = \left[\pi(t_i) - b_1(t_i)\pi(t_i) - c_1(t_i)y(t_{i-1}) - G_1(t_{i-1})\right]a_1^{-1}(t_i)$$

(3) Repeat step 2 for k times, given $\varepsilon_0 = 0.0001$, and make $|\pi_k(t+1) - \pi_{k-1}(t+1)| \le \varepsilon_0$; finally we select $\widehat{E_{t_i}}\pi_{t_i+1}(t_i) = \pi_k(t+1)$ .Our results of prediction are as follows:

The inflation value above is based on benchmark model; the prediction is regardless of the effect of money, interest rates, and house prices to inflation. The main purpose of the prediction is not used for real prediction but for providing a unified inflation value to simulate inflation expectations in each path model

5 Simulation of Inflation Expectations

5.1 Assume Variables Value in 2012Q4

For simulation in the condition of keeping annual output growth rate by 7.5 %, and annual money growth rate by 14 % and changing house prices steadily. All variables values in 2012Q4 must be assumed for simulation (Table 1):

(1) Output gap: The national output growth target is 7.5 % in 2012, output in 2012Q1–2012Q3 can be obtained, we assume output in 2012Q4, and then output gap in 2012Q4 can be calculated.
(2) House prices: Assume that house prices regulation still continue, so we assume the next quarter house price index equals recently eight quarter average housing prices index.
(3) Money growth rate: The national nominal money growth rate target is 14 % in 2012; money growth value of the first two quarters in 2012 is obtained. We assumed real money growth rate is 12 % or 14 % in 2012Q4.
(4) Interest rates: Considering interest rate policy relative stability, we assumed real interest rate is −1 % or 1 % in 2012Q4.

5.2 Simulation

All simulations are in the comprehensive model:

Simulation 1: First figure out coefficients $a(t_i)$, $b(t_i)$, and $c(t_i)$ of 2012Q4 by the benchmark model (3) when assuming that inflation is 0.025 in 2012Q4 and 0.026 in

Table 1 Simulation of inflation expectations by benchmark model

Quarter	2012Q4	2013Q1	2012Q2
Inflation expectations	0.025	0.026	0.025

Table 2 Simulation of inflation expectations by comprehensive model at 2012Q4

Money growth rates	House prices growth rates	Interest rates −1 %	Interest rates 1 %
12 %	−1 %	0.027	0.025
	0 %	0.029	0.026
	1 %	0.0274	0.018
14 %	−1 %	0.024	0.018
	0 %	0.028	0.0253
	1 %	0.026	0.013

Table 3 Simulation of inflation expectations by comprehensive model at 2013Q1

Money growth rates	House prices growth rates	Interest rates −1 %	Interest rates 1 %
12 %	−1 %	0.026	0.025
	0 %	0.027	0.025
	1 %	0.0258	0.021
14 %	−1 %	0.0248	0.023
	0 %	0.0262	0.025
	1 %	0.025	0.018

2013Q1, and then substitute the coefficients into this formula in condition that the inflation expectations are unknown:

$$G(t_i) = \pi(t_i) - a(t-i)E_{t_i}\pi_{t_i+1}(t_i) - b(t_i)\pi_{i-1}(t_i) - c(t_i)y_{i-1}(t_i) - \varepsilon \quad (10)$$

$$G(t_i) = \sum_{j=1}^{n} z_j(t_i)(\pi(t_j) - a(t-j)E_{t_i}\pi_{t_i+1}(t_i) - b(t_i)\pi_{t_i-1}(t_i) - c(t_i)y_{t_i-1}(t_i)) \quad (11)$$

When Eq. (10) equals (11), we can figure out inflation expectations. The results are as follows:

From the viewpoint of mode, we assume the inflation is 0.027 in 2012Q4 (Table 2).

While keeping real money growth by 14 %, real house price index by 1 %, and real interest rate by 1 %, inflation rate will be 1.3 % in 2012Q4.The best way to prevent deflation is to reduce real interest rates to −1 %, and then inflation rate will be 2.6 %.

Simulation 2: In the same way, we can obtain the simulated inflations value for 2013Q1 when money growth rates, housing prices rates, and interest rates change for 2012Q3 (Table 3).

From the viewpoint of mode, we assume the inflation is 0.025 in 2013Q1.

While keeping real money growth by 14 %, real house price index by 1 %, and real interest rate by 1 %, inflation rate will be 1.8 % in 2013Q1.The best way to prevent deflation is to reduce real interest rates to −1 %, and then inflation rate will be 2.58 %.

Table 4 Simulation of inflation expectations by comprehensive model at 2013Q1

		Interest rates	
Money growth rates	House prices growth rates	−1%	1 %
12 %	−1 %	0.022	0.02
	0 %	0.028	0.03
	1 %	0.0268	0.0356
14 %	−1 %	0.021	0.021
	0 %	0.0274	0.037
	1 %	0.027	0.052

Table 5 Simulation of the inflation expectations

Time	2012Q4	2013Q1	2013Q2
Inflation	0.027	0.025	0.027

Simulation 3: In the same way, we can obtain the simulated inflations value for 2013Q2 when money growth rates, house prices rates, and interest rates change for 2012Q4 (Table 4).

From the viewpoint of mode, we assume the inflation is 0.027 in 2013Q2.

While keeping real money growth by 14 %, real house price index by 1 %, and real interest rate by 1 %, inflation rate will be 1.3 % in 2012Q4. To prevent inflation, reducing real interest rates to −1 % or reducing money growth rates to 12 % is feasible.

To sum up, we can find out if interest rates rule is likely to be more effective in managing inflation expectations in recent several quarters than money and house rules. From the viewpoint of mode, we summarize the simulated results.

As can be seen from Table 5, under the condition of keeping annual output growth rate by 7.5 %, annual money growth rate by 14 %, and house prices growth rates by −1 %, 1 %, or 0 %, the inflation target of 4 % in 2012 can be implemented. But we also notice that under the condition of monetary growth rate by 14 %, house prices growth rates by 1 %, and interest rates by 1 % in 2012Q4, the inflation expectation is 0.052 in 2013Q2.

6 Conclusion and Proposals

As can be seen from the simulation:

(1) The inflation targeting by the government can be implemented.
(2) Interest rates rule is more effective in managing inflation expectations among money, house prices, and interest rates policy.
(3) If keeping real money growth by 14 %, real house price index by 1 %,real interest rate by 1 %, inflation rate will be 5.2 % in 2013Q2.

To manage the inflation expectations especially in 2013, attention should be paid to the following:

(1) Control the real monetary growth rate and ensure that it is not more than the national target.
(2) It is best to avoid excessive volatility of the price of the house.
(3) Interest rates policy should be paid more attention to by the government to manage inflation expectations in recent quarters.

Acknowledgements This paper is supported by the National Natural Science Foundation of China (70973110).

References

G.A. Calvo, Staggered prices in a utility maximizing framework. J. Monetary Econ. **12**, 383–398 (1983)
Z. Duan, The Relationship between house price and inflation, output. J. Quant. Tech. Econ. **12**, 127–139 (2007)
M. Friedman, The role of monetary policy. Am. Econ. Rev. **58**, 1–17 (1968)
J.C. Fuhrer, G.R. Moore, inflation persistence. Q. J. Econ. **110**(1), 127–129 (1995)
J. Gali, M. Gertler, Inflation dynamics: a structural econometric analysis 0. J. Monetary Econ. **44**(195), 222 (1999)
E. Phelps, Phillips curves, expectations of inflation, and optimal inflation over time. Economica **135**, 254–281 (1967)
J.B. Taylor, Aggregate dynamics and staggered contracts. J. Polit. Econ. **88**, 1–22 (1980)
Y. Wang, L. Zhao, Inflation expectations and the demand for money:test of the real or nominal adjustment process. Financ. Trade Econ. **8**, 3–9 (2006)
H. Xiang, X. Pan, Q. Xi, Exchange rate change monetary policy and inflation. Stat. Res. **28**(5), 4–14 (2011)
B. Xu, Path converged design application to production efficiency of FDI in regions. Econ. Res. J. **2**, 44–54 (2010)
J. Yang, Expectation, excess liquidity and inflation dynamics in China. Econ. Res. J. **1**, 106–117 (2009)
C. Zhang and J. Clovis, China inflation dynamics: Persistence and policy regimes. Journal of Policy Modeling **32**, 373–388 (2010)
T. Zheng, J. Liu, Empirical analysis of asymmetric money-output causality in China: based on the smooth transition vector error-correction model. Econ. Res. J. **1**, 33–45 (2008)
T. Zheng, J. Liu, Taylor rule with regime switching and its application to China. Monetary Policy, Econ. Res. J. **3**, 40–52 (2010)

Evaluating City Leisure Index with Soft Computing Methods

Tsungkuo Tienliu, Yu-Yun Hsu, Berlin Wu, and Wentsung Lai

Abstract The purpose of this paper is to present a new approach of city leisure index (CLI). We are comprehensive estimates of the recreational functions of cities and the development of a quantitative description of the city recreation system. It uses a combination of objective evaluation and subjective evaluation, the form of index to reflect the environment of a city's leisure, leisure conditions, and leisure and economic development of standards and public awareness of urban leisure awareness. This integrated evaluation procedure is aimed at yielding appropriate and reasonable rank and value of leisure evaluation. We also give empirical examples to illustrate the techniques and how to evaluate the city leisure index. Result shows that fuzzy statistical analysis with soft computation is tending to be more realistic and reasonable in the city leisure index evaluation.

Keywords Human capital • Evaluation • Fuzzy statistics • Fuzzy weighting

T. Tienliu (✉)
Department of Education al Policy and Administration & Center for General Education, National Chi Nan University no.1, Daxue Rd., Puli Township, Nantou County 545, Taiwan (R.O.C.)
e-mail: tkliu@ncnu.edu.tw

Y.-Y. Hsu
General Education Center, China University of Technology, no.56, Sec. 3, Xinglong Rd., Wenshan Dist., Taipei City 116, Taiwan (R.O.C.)
e-mail: yyhsu@cute.edu.tw

B. Wu
Dept. of Math Sciences, National Cheng Chi University no.64, Sec. 2, Zhinan Rd., Wenshan Dist., Taipei City 116, Taiwan (R.O.C.)
e-mail: berlin@nccu.edu.tw

W. Lai
Department of Education Policy and Administration, National Chi Nan University, Nantou, Taiwan (R.O.C.)
e-mail: s100407904@mail1.ncnu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_21,

1 Introduction

Leisure city is largely defined as travel to visit friends or relatives, for outside recreation and for entertainment and other relaxing personal or group activities (LaMondia and Bhat 2012). In fact, leisure travel has become human way of life, with many travelers routinely making both daily short-distance leisure trips and long-distance vacation trips (Jun et al. 2012). The city leisure index (CLI), comprehensive estimates of the recreational functions of cities, and the development of a quantitative description of the city recreation system.

Estimating factors of leisure city, specialized culture, and nature condition are complex. It involves vary elements, such as traffic, people, culture, effort, and objective conditions. The value of LC is difficult to evaluate by traditional statistics, such as Wu and Hsu (2004a,b) identified the model construction through qualitative simulation, Chen and Wang (1999) proposed fuzzy statistical testing method to discuss the stability of Taiwan short-term money demand function, Wu and Sun (2001) demonstrated the concepts of fuzzy statistic and applied it to social survey, and Wu and Tseng (2002) used fuzzy regression method of coefficient estimation to analyze Taiwan monitoring index of economic. For an extensive treatment of the theory of fuzzy statistics the interested reader may refer to see Nguyen and Wu (2006). In addition, Chen and Niou (2011); Yeh (2011) fuzzy relative weights of the analysis of fuzzy numbers, these studies are to obtain good results. How to evaluate the index of leisure from the perspective of human needs, leisure city is to meet the leisure needs as the core. Form the perspective of urban economic, leisure and city factors of production (labor, capital, land, ect.). nevertheless, the leisure industry, and the tertiary industry, the main industries in the urban economy which accounts for the absolute proportion of the city.

2 How to Evaluate the Index of Leisure

Soft computing in the fuzzy evaluation, it is appropriate to apply the membership function, a more precise mathematical techniques, in analyzing the fuzzy information. The value of the membership function, between 0 and 1, is derived from the characteristic function, to express the membership grade of each element in a set. Though subjectivity coming from human thought is often involved, what fuzzy theories handles is not semantic uncertainty but to compute the degree of objectivity for the semantic uncertainty. That is, we will give the value of intelligent capital into different linguistic terms, such as *valueless, not too valuable, lightly valuable, valuable, very valuable, extremely valuable, hugely valuable, and invaluable*. Each term will be correspondent with a real value, which will be determined by the sampling survey and fuzzy statistical analysis. In social science research, statistical analysis is indispensable, especially, in the aspect of survey and methodology. Basic descriptive statistics, such as mean, median, and mode, are used very often in social science study. When analyzing data, describing statistics can describe

Table 1 Memberships for five factors with five interviewees

Factors sample	1	2	3	4	5
1	0.10	0.10	0.6	0.10	0.10
2	0.20	0.15	0.5	0.05	0.10
3	0.10	0.10	0.7	0.05	0.05
4	0.10	0.20	0.5	0.10	0.10
5	0.25	0.10	0.4	0.15	0.10
Sum of memberships	0.75	0.65	2.7	0.45	0.45
w	0.15	0.13	0.54	0.09	0.09

It shows that $w_1 = \frac{\sum_{i=1}^{n} m_{ij}}{n} = \frac{0.75}{5} = 0.15, \ldots, w_5 = \frac{\sum_{i=1}^{n} m_{ij}}{n} = \frac{0.45}{5} = 0.09$.

the basic structure and characteristics of the information efficiently (Wu 2000). However, many phenomena in the world, such as human language, thinking, and decision making, all possess nonquantitative characteristics. Human behavior is particularly difficult to quantize. It is about the principle of applying fuzzy scale and categorization into human's interaction with the dynamic environment and to give a more concrete description and solution toward complicated/vague phenomenon. Therefore, to collect the information based on the fuzzy mode should be the first step to take. What some information has embedded with uncertainty and ambiguity. It is naturally for us to propose the fuzzy statistics, such as fuzzy mode and fuzzy median, to fit the requirement of the status quo. In this and the next section we demonstrate the definitions of fuzzy mode and fuzzy median generalized from the traditional statistics.

How to decide the weights, called fuzzy weights, becomes a primary work before evaluating the specialized human capital. In this section we will demonstrate an integrated design via appropriate questionnaires of field study to reach a common agreement for weight of fuzzy factors for an object/event.

Here, the calculating process of entity fuzzy weight is presented:

Step 1: First, determine the factors $A = A_1, A_2, A_K$ *for the specialized factors.*
Step 2: Ask interviewees to give the importance of factors set with a membership $m_{ij} \sum_{j=1}^{k} m_{ij} = 1$. *Let* m_{ij} *be the membership of importance of factor* j *for the interviewee.*
Step 3: Calculate the fuzzy weight w_j *of* A_j *by* $w_j = \frac{\sum_{i=1}^{n} m_{ij}}{n}$.

Example 2.1. Suppose there are five interviewees to rank a certain event with five factors for a discussion domain, Table 1 illustrates the result.

Distance among fuzzy data. Once such a transformation has been selected, instead of the original trapezoid data, we have a new value y = f(x). In the ideal situation, this new quantity y is normally distributed. (In practice, a normal distribution for y may be a good first approximation.) When selecting the transformation, we must take into account that, due to the possibility of a rescaling, the numerical values of the quantity x are not uniquely determined.

Definition 1 (Scaling for a interval fuzzy number on R). Let $A = [a,b]$ be an interval fuzzy number on U with its center $(a-b)/2$. Then the defuzzification number RA of $A = [a,b]$ is defined as $RA = cx + (1 - \frac{ln(1+\|A\|)}{\|A\|})$, where $\|A\|$ is the length of the interval.

However, there are few literatures and definitions appear on the measurement system. In this section, a well-defined distance for interval data will be presented.

Definition 2. Let $A^i = [a_i, b_i](i = 1,2,n)$ be a sequence of interval fuzzy number on U with its center $(a-b)/2$. Then the distance between the trapezoid fuzzy number A_i and A_j is defined as

$$d(A_i, a_j) = |cx_i - cx_j| + |\frac{ln(1+\|A_i\|)}{\|A_i\|} - \frac{ln(1+\|A_j\|)}{\|A_j\|}|$$

The traditional five-point scale used in scoring is often five options. The sequence score from small to large is often 1, 2, 3, 4, and 5 points then to calculate the sum. According to this principle, the scoring method also can apply in discrete type of fuzzy numbers. It can let the distance of option value become larger, and it might help achieve a significant level after testing.

Definition 3. Defuzzification for discrete fuzzy data. Let X be a fuzzy sample on universe domain U with ordered linguistic variable $L_i; i = 1, .k$, corresponding to integral values, $\mu_X(L_i) = m_i$ be the membership with respect to $L_i, \sum_{i=1}^{n} \mu_X(L_i) = 1$. Let $cx = \sum_{i=1}^{k} m_i L_i$ be the centroid of the fuzzy data and $\mathrm{d}x = \sum_{i=1}^{k} m_i |i - cx|$ be its deviation for the cx. We call $X_f = cx + dx$ the defuzzification value for the discrete fuzzy sample X.

Example 2.2. Let $X = 0/1 + 0.6/2 + 0.3/3 + 0.1/4 + 0/5$ be a discrete fuzzy sample on the ordered linguistic variable $L1 = 1, L2 = 2, L3 = 3, L4 = 4, L5 = 5$. Then the defuzzification value for the fuzzy data X is

$$Xf = \sum_{i=1}^{k} m_i L_i + \sum_{i=1}^{k} \frac{1}{2} m_i |i - cx| = 2.5 + 0.3 = 2.8$$

3 An Intergrated Fuzzy Evaluation Process

On the above-mentioned human capital measurement, we will consider new approach of measurement. Analysis by traditional methods usually involves the following weaknesses: (a) The use of arithmetic in traditional questionnaires is often an over-explanation. (b) Experimental data are often overused just to cater to the need for apparent numerical accuracy. (c) For the sake of simplifying the evolutional model, however, will neglect the relationship of actual condition and dynamic characteristic. We better make use of fuzzy statistical technique at investigation realm to estimate the human resource capital.

3.1 Discussion Domain and Weight of Factors

It is appropriate to apply the membership function, a more precise mathematical techniques, in analyzing the fuzzy information. The value of the membership function, between 0 and 1, is derived from the characteristic function, to express the membership grade of each element in a set. Though subjectivity coming from human thought is often involved, what fuzzy theories handles is not semantic uncertainty but to compute the degree of object for the semantic uncertainty.

We will give the value of human capital into different linguistic terms, such as moderate important, important, very important, highly important, and critical. Each term will correspond to a real value, which will be determined by the sampling survey and fuzzy statistical analysis. Factors with highly co-integrated property, after detailed discussion from the above sections, which an integrated process of fuzzy evaluation is shown at the following. We use the geometric average instead of the weighted arithmetic average. The reason is that the factors are highly correlated; any extreme value of a certain factor will influence the real intelligent capital. When applying these factors at evaluating demand side, subjective opinions of human thinking will be highly involved.

3.2 How many Factors Contribute to the Leisure City Evaluation? And How Much?

When we calculate the contribution of leisure city resource, we must take two points into considerations: (1) supply side and (2) demand side. **Supply: Resource of the leisure city**. From the supply point of view, the factors of value will be computed from the statistical record with standard unit (0, 1). Since the variables are highly co-integrated we illustrate the above description for

$$IS = \prod_{i=1}^{k} Sf_i^{w_i}$$

where S_i is the value of factory. Sf_i = index for factor i that influences the city leisure resource in the discussion domain (1 = moderate important, 2 = important, 3 = very important, 4 = highly important, 5 = critical), w_i = weight of the factors, and $\sum_{i=1}^{k} w_i = 1$.

To explain Eq. (1), lets give the following points: (1) we use geometric mean to compute the index of leisure city and (2) we use the weights to calculate the importance of the factors. **Demand: Market evaluation**. From the supply point of view, the factors of value will be computed from the statistical record with standard unit (0, 1). Since the variables are highly co-integrated we illustrate the above description for

$$ID = \prod_{i=1}^{k} D_i^{w_i}$$

3.3 Integrated Evaluation and Decision Making

Since it is difficult to meet the common agreement for the supply and demand sides, in order to minimize the gap, we would like to propose an appropriate decision rule for the index of leisure city. We will compute the ILC from the discrete and continuous type of fuzzy data. **For the fuzzy data with discrete case,** let ID and IS be the value of the discrete type of leisure city, and then we will measure the ILC by the mean of these two values.

The reason we choose geometric average with endpoints cross production is to avoid peoples unusual estimation in the lost evaluation as well as the intelligent capital. The advantage of this estimation is that we can use these two evaluated intervals to reach an appropriate (common agreement) interval so that both sides of people would like to accept the result. While most traditional evaluation methods are based on the real value operation with the mean (arithmetic average) functions,

$$Index\ of\ Leisure\ City = \begin{cases} \frac{\mathrm{IS+ID}}{2} + \left(1 - \frac{\ln(1+\mathrm{A})}{\|\mathrm{A}\|}\right), \text{ if ID} > \text{IS} \\ \frac{\mathrm{IS+ID}}{2} - \left(1 - \frac{\ln(1+\mathrm{A})}{\|\mathrm{A}\|}\right), \text{ if ID} < \text{IS} \end{cases} \quad (1)$$

3.4 For the Fuzzy Data with Continuous Case

Let $IS = [a,b]$ *and* $ID = [c,d]$ stand for the index of supply and index of demand, respectively; an integrated index of leisure city is formulated as $ILC = [l,u]$, where

$$l = min(\sqrt{ad}, \sqrt{bc})u = max(\sqrt{ad}, \sqrt{bc}). \quad (2)$$

The reason we choose geometric average with endpoints cross production is to avoid peoples unusual estimation in the lost evaluation as well as the intelligent capital. The advantage of this estimation is that we can use these two evaluated intervals to reach an appropriate (common agreement) interval so that both sides of people would like to accept the result. While most traditional evaluation methods are based on the real value operation with mean (arithmetic average) functions. That is not enough. Therefore, this study will be the following research.

4 Empirical Study

In this study, we will illustrate the detailed process of evaluating the certain famous leisure city: Chiangmai, Thailand, Bali Island, Indonesia, Sapporo, Japan, Hangzhou, China, and Melben, Singapore. We start from calculating the weights of factors, and then we compute the value of factors. Finally we integrated this

Table 2 Illustrates the weight for four intelligent capital factors

Supply: Weight		Demand: Weight	
S_1.Natural Environment,	0.50	D_1.Trafic and Live	0.16
S_2.Culture and Humanity	0.23	D_2 Living and Facility	0.52
S_3.Green Assessment	0.27	D_3Entertainment	0.32

Table 3 The CE, PE as well, and the common agreement of the evaluate value

	Chiangmai	Bali Island	Hangzhou	Chiju	Sappolo	Melben
IS	3.435	3.508	3.466	3.596	3.661	3.593
ID	3.240	3.080	3.040	3.192	3.112	3.164
ILC	3.27157	3.31142	3.30104	3.27691	3.32410	3.39211

Table 4 The membership (degree) for leisure city for three levels

	Chiangmai	Bali Island	Hangzhou	Chiju	Sappolo	Melben
S_1.Natural Environment,	1.85	2	1.9	2.2	2.35	2.15
S_2.Culture and Humanity	0.667	0.644	0.621	0.667	0.69	0.552
S_3.Green Assessment	0.918	0.864	0.945	0.729	0.621	0.891
D_1.Trafic and Live	0.56	0.72	0.72	0.608	0.608	0.496
D_2 Living and Facility	1.56	1.56	1.456	1.56	1.352	1.196
D_3Entertainment	1.12	0.8	0.864	1.024	1.152	1.472

information and find the ILC from both sides of ID and IS. In order to find weights of factors, firstly, we interviewed ten independent appraisers, to rate the weight of factors. *I=index of importance (from 1=very unimportant to 5=very important).* Table 2 illustrates the weight for four intelligent capital factors.

From Table 3 example showing the highest score is *Melben* ILC. Its followed by the score of *Sappolo*. There's order row down the *Bali Island, Hangzhou, Chiju,* and *Chiangmai*. Since traditional computing methods are based on the operation of real value system, it is difficult to get a decision rule or find a comment agreement from two sides. In this case, peacemaking is reached due to the IPR violators individual choice – his concern for reputation and career. If not for this, an IPR case that requires juridical prosecution to rule out responsibilities will be on process. Whether or not the compensation, which is determined by the court, is reasonable is still open to discussion. Since a precise (real-valued) evaluating process often reflects the drawbacks of incomplete and uncertainty properties in the real case, it is traditional scale or questionnaires. If we apply the fuzzy data with the techniques of soft computing it will be a more appropriate way to overcome those problems. Reviewing the result with fuzzy mode and fuzzy median representation, see Table 4, an innovative improvement in evaluation performance can be found.

5 Conclusions

We also found that (1) traditional methods use all equal weights for every assessment factor, but in reality, factors are variously important. This text proposes fuzzy weighting in accordance with real conditions. (2) This research provides a method for evaluating intellectual capital, using a type membership function to establish the value interval, according to the above weights, and to determine a membership grade to calculate fuzzy value and rank. The future development of this research will be (1) applying the soft computing technique to get the more appropriate evaluation. Besides (2) intellectual capital, wide ranging, complex expand the assessment of factors to include the type of enterprise, increasing the objectivity of the evaluation, and (3) using of the fuzzy regression methods, according to sub assessment factors, to determine the appropriate value of human capital.

References

T. Chen, M. Wang, Forecasting methods using fuzzy concepts. Fuzzy Sets Syst. **105**, 339–352 (1999)

S-M. Chen, S-J. Niou, Fuzzy multiple attributes group decision-making based on fuzzy induced OWA operators. Expert Syst Appl. **38**, 4097–4108 (2011)

J. Jun, G.T. Kyle, S.P. Vlachopulos, N.D. Theodorakis, J.D. Absher, W.E. Hammitt, Reassessing the structure of enduring leisure involvement. Leisure Sci. **34**, 1–18 (2012)

J.J. LaMondia, C.R. Bhat, A conceptual and methodological framework of leisure activity loyalty accommodating the travel context. Transportation **39**, 321–349 (2012)

H. Nguyen, B. Wu, *Fundamentals of Statistics with Fuzzy Data* (Springer, Heidelberg New York, 2006)

B. Wu, *Shadows of Fuzzy Sets-A natural Way to Describe 2-D and Multi-D Fuzzy Uncertainty in Linguistic Terms*, Proceedings of the 2000 FUZZ-IEEE, (2000)

B. Wu, Y-Y. Hsu, A New approach of bivariate fuzzy time series: with applications to the stock index forecasting. Int. J. Uncertainty, Fuzziness and Knowledge-based Systems **11**(6), 671–690 (2004a)

B. Wu, Y-Y. Hsu, The use of kernel set and sample memberships in the identification of nonlinear time series. Soft Comput. J. **8**, 207–216 (2004b)

B. Wu, C. Sun, Interval-valued statistics, fuzzy logic, and their use in computational semantics. J. Intell. Fuzzy Syst. **11**, 1–7 (2001)

B. Wu, N. Tseng, A new approach to fuzzy regression models with application to business cycle analysis. Fuzzy Sets Syst. **130**, 33–42 (2002)

C.T. Yeh, Weighted semi-trapezoidal approximations of fuzzy numbers. Fuzzy Sets Syst. **165**, 61–80 (2011)

Empirics with Inequity Distribution for Elementary School Resource

Baiqing Sun, Chun-ti Su, and Dayong Zhang

Abstract As the wave of globalization and improvement of ICT technology, the poverty gap that keeps widening has the transitional effects on education. Equity and quality are two critical issues for education in the future. This article intends to establish a reasonable model for evaluation at school level and compare the differences of educational equity among the target schools. With the adoption of fuzzy theory, we propose a fuzzy model for monitoring the educational equity in schools. From the empirical study, we can collect a more reasonable and real information for improving school equity.

Keywords educational equity • Fuzzy statistics • Fuzzy weight

1 Introduction

The assurance and monitoring on education quality is an issue that all the educators or policy makers cannot neglect (OECD 2010). Under the globalization impact, we especially need to pay more attention to the equity issue, for the poverty gap is getting wider and wider. Since the twenty-first century, international organizations, such as Organization for Economic Cooperation and Development (OECD) and

B. Sun (✉)
School of Management Harbin Institute of Technology, Harbin, Hei Long Jiang Province, China
e-mail: baiqingsun@hit.edu.cn

C.-t. Su
National Chi Nab University, PhD student of Department of Education Policy and Administration, No.1, University Rd., Nantou County, Taiwan
e-mail: voodoobiker@gmail.com

D. Zhang
Department of New Media Technologies and Art Harbin Institute of Technology, Harbin, China
e-mail: yonghit@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_22,

European Commission (EC), have endeavored to discover the condition of equity in education (European Group for Research on Equity in Education Systems 2005; Field et al. 2007; OECD 2005).

Although there are a lot of theoretical and dispute articles on the educational equity issues, we could hardly find out related empirical studies. The possible reason for the condition might be the lack of concrete indicators and evaluation models. So we need to propose an efficient index to get a clear measure for the distribution of educational equity.

The purposes of the study are to discover the meaning of educational equity, to establish a reasonable model for evaluation at school level, and to compare the differences of educational equity among the target schools.

2 Literature Review

Education may have great impacts on humans adult life in terms of wealth, fitness, and a better life. If people lack knowledge and skills for their job and health care, they tend to spend more governmental budgets of social welfare (Field et al. 2007). Hence, how to improve educational quality and equity has become one of the critical issues all over the world.

In the past decades, the educational authorities focus mainly on the equality of educational chances and budgets. At present, most countries get rich and can afford to provide pupils sufficient educational chances. However, the problems of equity in education still exist. European Group for Research on Equity in Education Systems (2005) proclaims that equity is a more difficult concept to be defined than equality, for it allows the existence of inequality. Traditionally, equality deals with the same chance and resources for each person. The measures are dangerous for reproducing the original inequality that blocks the chance of social flow.

Field et al. (2007, p. 29) have indicated that equity in education consists of fair and inclusion. Fairness that refers to personal and environmental factors, such as gender, social status, and race, cannot be the obstacle against educational achievement. Inclusion refers to an ideal belief that every student can obtain the basic education.

In order to solve the problem of equity, Baker and Friedman-Nimz (2003) suggest researcher ought to consider two vital points. (1) What special features need to be treated differentiated? (2) How much resources should put in to reach the demand of truly equity

Above all, educational equity is a complicated concept to be defined. To pursue educational equity, we better design a suitable mode or method to evaluate the status quo of equity in education. With a clear and concise understanding, we can therefore suit the medicine to the illness of equity problems in education.

3 Research Methods

3.1 Evaluation of School Educational Equity

The purpose is to evaluate educational equity in schools from insiders perspectives. The insiders perspectives include the stakeholders of a school, such as teachers, staffs or administrators, and parents. Evaluation contents involve school educational equity and school background. The former can be categorized into five dimensions, while the latter refers to school size and location. We carry out an investigation based on the fuzzy theory in June 2012. Data collected from the questionnaires are critical parameters for our evaluation model. The results can provide the school a chance for self-monitor and interscholastic comparison. By doing so, we can have a reference framework to define whether the schools meet the spirits and principles of educational equity. Finally, the study tries to generate conclusions and suggestions on educational equity for policy making, school development, and research.

3.2 Fuzzy Statistics

Fuzzy theory is generated by Zadeh in 1965. He utilizes fuzzy logic as the foundation to extend the concepts of traditional maths binary logic. To begin with, the theory defines attribute as a set and then develops related concepts that include attribute set, attribute space, and measurable space. Furthermore, fuzzy theory builds up the measure space based on the measurable space from the point of view in math.

The attribute statistics is completely different from traditional probability statistics in terms of logical conception and frameworks. We provide an example for clear illustration and present the results in Table 1. Let X be the population of the samples that describe X = school stakeholders and refers to samples in certain area and time. If we want to study a specific feature within X, we define the feature as attribute space F. We consider the universe set X = school stakeholders; one of the element in X is x, and defined as some professional development, let membership set of X, F = organizational commitment, the cut of F set *C1, C2, C3, C4, C5* = very strong, strong, not so strong, weak, very weak. Either *C1* or *C2* is one the conditions in F; therefore, we can view *C1* or *C2* as attribute set that belongs to Fs subset.

Data analysis of the study includes the status quo of educational equity in schools, differences of educational equity among the three target schools, and the index of educational equity. We design fuzzy questionnaires for experts, teachers, administrators, and parents. Data collected from the questionnaires were analyzed

Table 1 Teachers perceptions on organizational commitments

	Very strong	Strong	Not so strong	Weak	Very weak
Organizational commitment	0.5			0.2	0.3

by Spss 18.0 software. Since the subjects of the study belong to purposive sampling, we utilizes the nonparameter method that includes Kruskal-Wallis one-way analysis of variance and Mann-Whitney U 2-Group Comparison to analyze the data.

Definition 3.1 (Fuzzy sample mean (data with multiple values)). Let U denote the universal set (a discussion domain), $L=\{L_1,L_2\ldots,L_k\}$ be a set of k-linguistic variables on U, and $Fx_i=\frac{m_{i1}}{L_1}+\frac{m_{i2}}{L_2}+\cdots+\frac{m_{ik}}{L_k}, i=1,2,\ldots n$ be a sequence of random fuzzy sample on U, whre $m_{ij}(\sum_{j=1}^{k} m_{ij})$ is the membership with respect to L_j. Then, the fuzzy sample mean is defined as

$$F\overline{x_i}=\frac{\frac{1}{n}\sum_{i=1}^{n} m_{i1}}{L_1}+\frac{\frac{1}{n}\sum_{i=1}^{n} m_{i2}}{L_2}+\cdots+\frac{\frac{1}{n}\sum_{i=1}^{n} m_{ik}}{L_k}$$

Definition 3.2 (Fuzzy weight (FW)). We consider universe of discourse $S=\{S_1,S_2\ldots,S_k\}$utility sequence $r_1\prec r_2\prec\cdots\prec r_f$ and S_i in r_f membership is μ_{si}f. Then the fuzzy weight $FW=(FW_{s1},\ldots,FW_{sk})$ is defined as

$$FW_{s_i}=\frac{\sum_{i=1}^{f}\mu_{s_i1}}{L_1}+\frac{\sum_{i=1}^{f}\mu_{s_i2}}{L_2}+\cdots+\frac{\sum_{i=1}^{f}\mu_{s_if}}{L_k}; i=1\ldots,k$$

In the fuzzy set, membership ranges from 0 to 1, and every language variable, such as shape, represents a possible distribution. The results of the distribution might be different from different subjects. We can average the answers from the subjects to make the utility sequence r of universe of discourse S membership reasonable distribution (Wu 2005).

Definition 3.3 (Fuzzy relative weight analysis). If we consider utility sequence $r=\{\gamma_1,\gamma_2\ldots,\gamma_f\}$, then define $r_1\prec r_2\prec\cdots\prec r_f$ and S_i in r_f as utility increasing sequence; otherwise $r_1\succ r_2\succ\cdots\succ r_f$ is utility decreasing sequence. According to the sort of utility sequence, the computing of the fuzzy relative weight is: Consider universe of discourse $S=\{S_1,S_2,\ldots,S_k\}$, *utility sequence* $r=\{\gamma_1,\gamma_2,\ldots,\gamma_f\}$, *and* $\mu_{si}f$ *is the membership of* γ_f *in* S_i. *Then the fuzzy weight for element of universe of discourse* $FRW=(FRW_{s1},\ldots,FRW_{sk})$ *is defined as:*

If $r_1\prec r_2\prec\cdots\prec r_f$

$$FRW_{s_i}=\frac{\sum_{l=1}^{f} l\cdot\mu_{s_il}}{\sum_{i=1}^{k}\sum_{l=1}^{f} l\cdot\mu_{s_il}}, i=1,\cdots,k$$

Table 2 Dimensions and indicators of educational equity

Dimension	Indicators	FW
School resources	Class equipment	0.34
	Book amount	0.17
	Teacher's ICT ability	0.21
	Campus programming	0.28
School culture	Organizational commitment	0.31
	Organizational atmosphere	0.23
	Professional community	0.22
	Teacher-parent interaction	0.13
	Community connection	0.11
Curriculum and instruction	Muticultural concern curriculum	0.25
	Cultural response instruction	0.20
	Concerns about the disadvantage students	0.33
	The same expectation on all students	0.22
Appropriate development	Special education and services	0.15
	Multi-intellectual activities	0.32
	Multi-assessment measures	0.22
	Students clubs	0.31
Compensation measures	Grant for disadvantage students	0.21
	After-school child care service	0.22
	After-school alternative program	0.28
	In-class remedial teaching	0.29

If $r_1 \succ r_2 \succ \cdots \succ r_f$

$$FRW_{s_i} = \frac{\sum\limits_{l=1}^{f} (n-l+1) \cdot \mu_{s_i l}}{\sum\limits_{i=1}^{k} \sum\limits_{l=1}^{f} (n-l+1) \cdot \mu_{s_i l}}, i = 1, \cdots, k$$

3.3 Universe of Discourse and Fuzzy Weight

To capture critical elements for evaluating the educational equity in school contexts, the researchers design a questionnaire for experts to establish the fuzzy relative weight. There are five dimensions that involve *school resources*, *school culture*, *curriculum and instruction*, *appropriate development, and compensation measures*. The experts include two administrators of educational bureau, four elementary school principals, and two elementary directors. Table 2 displays the dimensions and indicators of educational equity. Besides, the results from experts about fuzzy weight are also listed in the right column of the table.

3.4 Constructing the Evaluation Model

Since the subjects contain administrators, teachers, and parents, we define the evaluation model as the following:

IA_t = Index of administrators
IT_t = Index of teachers
IP_t = Index of parents
IEE_t = Index of educational equity in certain school

According to indicators' significance, the experts define IA power with 0.4, IT power with 0.4, and IP power with 0.2. Hence, the formula is set up as

$$\mathrm{IEE}_t = \mathrm{IA}_t^{0.4}\,\mathrm{IT}_t^{0.4}\,\mathrm{IP}_t^{0.2}$$

4 Empirical Studies

4.1 Decision About the Subjects

In the study, we select three schools of the same size as the research targets. The subjects of each target school consist of ten teachers, administrators, and parents of single school, respectively. The total amount is 90. Hence, the study meets Gay's suggestion that the required amount of subjects in a quantitative study should be no less than thirty samples (Gay 1992).

As for the choice of target schools, they are located in Taichung City, Taiwan. However, considering the geographical difference of the city, we select one school as the representative from the mountain area, sea area, and field area.

4.2 Status Quo of Educational Equity in the Schools

Table 3 displays the fuzzy mean scores and standard deviation of educational equity from the stakeholders of the three schools. In school resources, school A is above the mean score, while school B and C are lower than the mean. In school culture, school C is higher than the mean. B and C school are under the mean score. As for curriculum and instruction, both school A and B are above the mean standard. With regard to compensation measures, only school A scores higher than the mean.

Table 3 Fuzzy mean of the three schools

	School A		School B		School C		Total	
	M	SD	M	SD	M	SD	M	SD
School resources	3.26	0.70	2.84	0.68	2.89	1.18	3.00	0.90
School culture	2.90	0.88	2.95	0.69	3.84	0.82	3.23	0.90
Curriculum and instruction	3.66	0.87	3.36	0.69	2.60	0.80	3.21	0.90
Appropriate development	2.46	0.60	3.05	0.42	3.62	0.64	3.04	0.73
Compensation measures	2.88	0.63	2.75	0.50	2.78	0.83	2.80	0.66

Table 4 Summary of kruskal-wallis one-Way analysis of variance for ranks to test for inter-scholastic differences of school equity

	Schools				
	A (n=30) Rank average	B (n=30) Rank average	C (n=30) Rank average	χ^2	P
School resources	55.17	42.27	39.07	6.39	0.041*
School culture	36.30	37.37	62.83	19.85	0.000***
Curriculum and instruction	59.17	49.23	28.10	22.15	0.000***
Appropriate development	24.17	46.20	66.13	38.77	0.000***
Compensation measures	49.63	44.63	42.23	1.254	0.534

4.3 Differences of Educational Equity Among the Three Schools

In order to understand whether the differences of educational equity lie in the three target schools, the study applies Kruskal-Wallis one-way analysis of variance for ranks as the test tool. The results in Table 4 show that, in the five subcategories, compensation measure is the only one without significant differences. Other four subcategories, including school resources, school culture, curriculum and instruction, and appropriate development, all express significant differences.

To further explore the differences among the three schools, we adapt Mann-Whitney U 2-Group Comparison Tests to determine which school is differed in school equity. As shown in Table 5, A school is superior to B and C school in school resources. As for school culture, school C is better than A and B school. When comparing curriculum and instruction, school A is better than B, whereas school C scores less than school B. With regard to appropriate development, however, it displays contrary results to curriculum and instruction. School C is the best, while school B and C stand for the second and third place. Among all of the three schools, no significant differences can be found in compensation measures. The possible reason could be that the educational authorities spend a lot of budgets on compensation measures for disadvantage students in recent year. The subjects or schools

Table 5 Summary of mann-whitney U 2-group comparison tests of school equity to determine which schools differed

	Schools	A (n=30)	B (n=30)	C (n=30)	U	Z	P
School resources	A-B	35.37	25.63		304.000	−2.160	0.031*
	A-C	35.30		25.70	306.000	−2.129	0.033*
	B-C		32.13	28.87	401.000	−0.725	0.469
School culture	A-B	30.43	30.57		913.000	−0.030	0.976
	A-C	21.37		39.63	176.000	−4.054	0.000***
	B-C		22.30	38.70	204.000	−3.640	0.000***
Curriculum and instruction	A-B	34.57	26.43		793.000	−1.805	0.071
	A-C	40.10		20.90	162.000	−4.260	0.000***
	B-C		38.30	22.70	216.000	−3.463	0.001**
Appropriate development	A-B	21.70	39.30		186.000	−3.905	0.000***
	A-C	17.97		43.03	74.000	−5.564	0.000***
	B-C		22.40	38.60	207.000	−3.596	0.000***
Compensation measures	A-B	32.37	28.63		394.000	−0.828	0.407
	A-C	32.77		28.23	382.000	−1.006	0.314
	B-C		31.50	29.50	420.000	−0.444	0.657

stakeholders do sense the policy effects that reflect high score on the subcategories. We have found that, according to the results, different schools possess advantages and disadvantages on the discussion of educational equity. School A has great performance in school resources and curriculum and instruction. However, it needs in-depth investigation into school culture and appropriate development. School B performs better in curriculum and instruction and appropriate development. The weakness lies in school environment/resources and school culture. School C expresses best performance in school culture and appropriate development. It should improve its curriculum design and instructional practice. Hence, how to correctly and precisely discover each schools strength and weakness has been an unavoidable mission. Educational authorities, principals, teachers, and school staffs all need to have a circumspect consideration on educational equity. Parents, as the stakeholders, ought to make elaborate efforts to facilitate educational equity at school level.

4.4 Evaluating Educational Equity of the Schools

Table 6 presents the index of school equity. Depending on the formula defined by the study, the higher value the index of educational equity represents, the lower equity the school would possess. As shown in the first row, school A have IA, IT, and IP index with 0.64, 0.64, and 0.80, respectively. The index of school equity (IEE) is 0.33. Concerning school B, the IA, IT, and IP index refer to 0.64, 0.64, and 0.80 respectively. The index of school equity in B school is the same with school A. Obviously, the IEE of school C is superior to the other schools with the IEE of 0.31. The IA, IT, and IP indices are 0.63, 0.62, and 0.80. In sum, it seems that school C has

Table 6 Index of school equity

	Administrators	Teachers	Parents	IEE
School A	0.64	0.64	0.80	0.33
School B	0.63	0.63	0.83	0.33
School C	0.63	0.62	0.80	0.31
IEE comparison		C > B = A		

best performance on educational equity than school A and B. However, the results also express an interesting fact that the IP value of the three schools is higher than IA and IT value. Whether the underlying meaning of the fact can refer to the possibility that stakeholders possess different opinions or perceptions need more proves.

5 Conclusions

The study aims to evaluate equity in education by means of fuzzy method, discover discrepancies from background variables, and establish an evaluating model at school level to conduct a interschool comparison. According to the empirical analysis, school C has the most IEE than schools B and A.

Each school has its own strength and weakness of educational equity. They can conduct further investigation to have a clear understanding about how to maintain their advantages and improve disadvantages.

As for the limitation, the study uses purposive sampling that cannot interfere the results to other schools. Besides, we focus on school equity that cannot cover the possible factors about cultural capitals. Finally, the researcher targets are elementary schools; the results might not be useful for secondary education.

Acknowledgements The research leading to these results is supported by Natural Science Foundation in China (Grant No.91024028, 71271069, 70903016), the Fundamental Research Funds for the Central Universities (Grant No.HIT.NSRIF.2010078), Social Science Foundation in Heilongjiang Province in China in 2011, and Humanities and Social Science Foundation of Ministry of Education (Grant No.10YJC860040).

References

B.D. Baker, R. Friedman-Nimz, Gifted children, vertical equity, and state school finance policies and practices. J. Edu. Finance **28**(4), 523–555

European group for research on equity in education systems, equity in education systems (2005), from http://www.aspe.ulg.ac.be/equite/fichier/pdf/2005PDF_ENGLISH.pdf. Accessed 22 May 2012

S. Field, M. Kuczera, B. Pont, No more failures: Ten steps to equity in education. Education and Training Policy, Organisation for Economic Cooperation and Development (2007)

L.R. Gay, *Educational Research Competencies for Analysis and Application*, 4th edn. (MacMillan Publishing Company, New York, NY, 1992)

OECD, School factors related to quality and equity: Results from PISA 2000, Paris: author (2005), from www. oecd.org/dataoecd/15/20/34668095.pdf. Accessed 11 May 2012

OECD, PISA 2009 at a glance, (OECD Publishing, 2010), http://dx.doi.org/10.1787/9789264095298-en. Accessed 12 May 2011

B. Wu, *Introduction to Fuzzy Statistics: Method and Applications* (Kluwer Academic, Taipei: Wunan, 2005)

The Information Efficiency of Stock Markets

Huiwen Zou

Abstract The efficiency of a stock market is principally measured by its information efficiency which is closely related to the information in stock markets. However, there is no uniform definition of information from the economy perspective since different researchers may have various opinions on the information of stock markets. In this research, a comparatively strict definition of information in economics is presented. Based on this definition, the optimal conditions to reach the maximum information efficiency of stock markets are derived. The conclusion is only when the markets operation and information transmission mechanisms are fully effective, and its information completeness degree is optimal, will the information efficiency of stock markets be optimal. Based on the conclusions, the information efficiency of reality stock markets is studied and the corresponding supervision countermeasures are suggested.

Keywords Information definition • Stock market • Information efficiency

1 Introduction

So far, there is no universally accepted definition on the information in sense of economics (Chen 1998). Marschak (1960) points out the posterior conditional distribution based on observed signals is generally different from the prior distribution and such probability difference is the consequence of information access. Arrow (1984) believes that information is observation results based on which the probability changes according to the principle of conditional probability. The later scholars make great efforts to agree on one viewpoint (Chen 1998): information

H. Zou (✉)
School of Management, Fuzhou University, Fujian 350108, China
e-mail: zhw_zc@yahoo.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_23,

in the economics, in essence, is probabilistic knowledge difference caused by difference among market participants and event states in economics. Inspired by this viewpoint, we consider that the economic information should include three aspects: the observed signal, the degree of consistency between signal and the natural state and recognition of the natural state implied by this consistency degree. In the following the three aspects are separately discussed, based on which a strict definition of economic information is presented.

2 Definition of Information in Economics

Assume the set of economic environment states is Ω, i.e., the set of all the natural states of factors and events which directly or indirectly influence the market. Market participants have a common objective prior probability with regard to the state of natural environment; it is represented by a given probability distribution P on Ω. When Ω is countable infinite, because $\sum_{k=1}^{\infty} P(\omega_k) = 1$, which is series convergence, $\lim \_k \to \infty(P(\omega_k)) = 0$ holds, (here $P(\omega) = P(\omega)$). For example, $\sum^{\infty} \_k = 1(P(\omega_k)) = \frac{1}{k(k+1)} = \frac{1}{k} - \frac{1}{k+1}$, $(k = 1, 2, \cdots)$, meets the requirement. When Ω is finite, assume $\Omega = \{\omega_k | k = 1, 2, \cdots, m\}$, we can expand Ω into $\Omega = \{\omega_k | k = 1, 2, \cdots\}$ by defining $P(\omega_k) = 0$, $k = m+1, m+2, \cdots$. By doing so, we only consider Ω as countable infinite in the following. In the economic sense, this assumption means that the market participants have known the objective probability distribution on natural states and have "roughly" ordered the objective probabilities where less objective probability is "roughly" put in the back. It should be noted that such order is not necessarily monotonous.

Define signal mapping $\varphi : \Omega \to S$, $\varphi(\omega) = s$. s is signal participants observe when natural state is ω. Typical signals include price, cost, and volume. S is the set of all possible values of φ, referred to as signal type set of participants. We assume that the participants assign each element of S with a subjective prior probability, i.e., $P(\varphi^{-1}(s)) > 0, \forall s \in S$, where $\varphi^{-1}(s) = \{\omega | \omega \in \Omega, \varphi(\omega) = s\}$. This assumption is reasonable as long as the participants are confident with their observed signal. Based on the property of probability, for $\omega \in \varphi^{-1}(s)$, $P(\omega) \le P(\varphi^{-1}(s))$ holds. Therefore if $\omega \in \varphi^{-1}(s)$ and $P(\omega) = 1, P(\varphi^{-1}(s)) = 1$ holds. Assume: (i) $P(\varphi^{-1}(s)) = 0$ when $P(\omega) = 0$, because $\{\omega\} = \phi$ implies $\varphi^{-1}(s) = \phi$; (ii) $P(\varphi^{-1}(s_1)) \le P(\varphi^{-1}(s_2))$ when $P(\omega_1) < P(\omega_2)$, where $\varphi(\omega_i) = (s_i)$, $i = 1, 2$ ($s_1 = s_2$ is possible), namely, a signal corresponding to natural state with larger possibility is assigned with a larger subjective prior probability. These assumptions are relatively reasonable. From the economic perspective, these assumptions denote that market participants have subjective (priori) knowledge on the possibility of natural states based on the observed signal. These assumptions also mean participants set the subjective probability of natural state as positive, and such setting satisfies monotonicity and boundary conditions of the objective probability.

If participants receive signal $s \in S$, they infer whether each state ω belongs to $\varphi^{-1}(s)$ and assign the state with a posterior probability:

$$P(\omega|s) = \begin{cases} P(\omega|s)/P(\varphi^{-1}(s)), & \omega \in \varphi^{-1}(s), P(\omega) > 0 \\ 0, & \omega \in \varphi^{-1}(s), P(\omega) > 0 \\ 1, & P(\omega) = 0 \end{cases} \tag{1}$$

In (1), the first equation is derived from the definition of conditional probability. The second equation is because such conditional event is impossible. The third equation holds because $P(\omega|s)/P(\varphi^{-1}(s))$ is of $0/0$ type; then according to the monotonicity assumption (ii), $P(\varphi^{-1}(s))$ scales down as $P(\omega|s)$ decreases, so we can assign it with 1. From an economic sense, formula (1) denotes that market participants have a new subjective (a posterior) knowledge on the probability of natural states according to the observed signal and determine the value of such probability according to the ratio of objective probability of natural state to subjective prior probability , meeting boundary conditions.

Define the degree of consistency of signal $\varphi(\omega) = s$ to natural state ω:

$d : \Omega \times S \to R$ (real set)

$$\begin{aligned} d(\omega, s) &= P(\omega|s) - P(\omega) \\ &= \begin{cases} [1 - P(\varphi^{-1}(s))]P(\omega|s)/P(\varphi^{-1}(s)), & \omega \in \varphi^{-1}(s), P(\omega) > 0 \\ -P(\omega), & \omega \in \varphi^{-1}(s), P(\omega) > 0 \\ 1, & P(\omega) = 0 \end{cases} \end{aligned} \tag{2}$$

Obviously, $-1 \leq d(\omega, s) \leq 1$.

In essence, the market participants recognize the real situation of natural states based on the difference between subjective posterior probability (based on the observed signal) and objective natural states probability. Such recognition may be consistent with or contrary to the real situation.

Based on the above analysis, we give a formal definition of information as follows:

Definition of Information. For given space $(\Omega, S, P, \varphi, d)$, when $d(\omega, s) > 0$, the increased recognition degree on the state $\{\omega\}$ appearance caused by observed signal s is known as information (positive information); when $d(\omega, s) < 0$, the opposite recognition degree on the state $\{\omega\}$ appearance induced by observed signal s is known as noise (negative information).

With terms in information theory, the significance of $d(\omega, s)$ can be re-explained as follows: $d(\omega, s) = 0$ denotes observed signal s does not convey any information of natural state $\{\omega\}$; $d(\omega, s) > 0$ means observed signal s represents information of natural state $\{\omega\}$ to some extent; $d(\omega, s) < 0$ indicates observed signal s reflects negative information of natural state $\{\omega\}$ to some extent. The closer $d(\omega, s)$ is to 1, the stronger information of natural state $\{\omega\}$ observed signal s conveys. The closer $d(\omega, s)$ is to -1, the stronger noise of natural state $\{\omega\}$ observed signal s conveys.

In sense of information theory, above assumptions on (Ω, P) denote that the information source of stock markets is open for all market participants (information users). The process of market participants' observing signal $\varphi(\omega) = s \in S$ is an information transmission and reception process. The process of market participants' assigning state ω with a posteriori probability $P(\omega|s)$ is an information judging process.

3 Information Efficiency of Stock Markets

To improve the information efficiency of stock markets, we should let the prices of stock fully reflect all information related to pricing and guide investors to reasonably anticipate relevant information, so that stocks' prices can dynamically approach to their intrinsic values. Here the stock's price is one of the observed signals and the stock's intrinsic value is determined by the natural state. If the observed stock price accurately reflects information of the natural state, it faithfully reflects the intrinsic value of the stock. Based on this idea, we redefine information efficiency of stock market based on our definition of information in Sect. 2.

Assume the set of stock market participants is N, s.t. $|N| = n$. For participant $i \in N$, let S_i, φ_i and d_i separately denote its signal type set, signal mapping, and coincidence degree. Define $S = \Pi_{i=1}^{n}(S_i)$ with its member $s = (s_1, s_2, \cdots, s_n) \in S$, where $s_i \in S_i$, $i = 1, 2, \cdots, n$. Hence, for $(\omega, s) \in \Omega \times S$, $d(\omega, s) = (d_1(\omega, s_1), d_2(\omega, s_2), \cdots, d_n(\omega, s_n))$.

Assume $B = \Pi_{i=1}^{n}[-1, 1] \subset R^n$ and f is a strictly monotonically increasing continuous function determined by information transmission mechanism of market on B:

$$f : B \to R, y = f(x_1, x_2, \cdots, x_n) s.t. |f(x)| \leq 1, \forall x \in B \tag{3}$$

Let D denote completeness degree of information in the stock market. D can be determined by following mapping:

$$\begin{aligned} &F : \Omega \times S \to R, \\ &D = F(\omega, s) = f(d(\omega, s)) = f((d_1(\omega, s_1), d_2(\omega, s_2), \cdots, d_n(\omega, s_n))) \end{aligned} \tag{4}$$

Because of the strict monotone of f, the stronger information on natural state $\{\omega\}$ signal s conveys, i.e., the better consistency between signal $\varphi(\omega) = s$ and natural state $\{\omega\}$, the greater is the completeness degree of information in the stock market.

Assume value range of f is R_f and g is a strictly increasing continuous function determined by operation mechanism of market on R_f

$$g : R_f \to R, z = g(y), s.t |g(y)| \leq 1, \forall y \in R_f \tag{5}$$

Let E_I denote information efficiency of the stock market. E_I can be determined by the following mapping:

$$F : \Omega \times S \to R,$$
$$E_I = G(\omega, s) = g(D) = g((d_1(\omega, s_1), d_2(\omega, s_2), \cdots, d_n(\omega, s_n))) \tag{6}$$

So the information efficiency of the stock market is determined by the completeness degree of market information, transmission mechanism of market information, and operation mechanism of markets.

According to the above analysis, within our information framework, the conditions for maximizing information efficiency E_I of a stock market are (1) the relevant information are fully disclosed and uniformly distributed to participants, i.e., there is no information asymmetry; (2) information transmission and operation mechanisms of the market are sufficiently effective; (3) market participants make rational judgments on the information; (4) the information completeness degree D achieves maximum.

However, in the practical stock market, the information contains noise, the information collection costs money and time, and different participants may possess different capabilities in information collection and analysis; therefore the information owned by market participants is incomplete and asymmetrical, i.e., $d(\omega, s_i) < 0$ for some $i \in N$, $\omega \in \omega$. Hence information efficiency E_I of practical stock markets cannot achieve maximum.

4 Conclusion

In this research, we formally define the information in sense of economy. Based on the information modeling, a stock market's information efficiency E_I is optimal when its transmission and operation mechanisms are sufficiently effective and its information completeness degree D reaches maximum. Optimal information efficiency of a stock market can ensure high effectiveness of the stock market and form a long-term stable dynamic equilibrium on the stock price.

In real stock markets, the real information efficiency values vary for the degrees of the information completeness and symmetry, as well as the rationality degree of market participants. When degrees of information asymmetry and incompetence and participant irrationality are pretty high, the information efficiency will be greatly impaired. The consequence is abnormal volatility in security price which is more frequent, and the market is very difficult to achieve stable dynamic equilibrium. In this research, from the perspectives of listed companies, state departments, media, and investors, we discuss feasible supervision countermeasures for real stock market to make information efficiency approach the optimal value.

References

Y. Chen *Lectures on Information Economics* (Tsinghua University Press, Beijing, 1998)

J. Marschak, Remarks on the Economics of Information[A], *Contributions to Scientific Research in Management [C]* (University of California Printing Department, Berkeley, 1960) p.79–98

K.J. Arrow *The Economics of Information [M]* (Belknap Press of Harvard University Press, Cambridge, 1984)

Fuzzy Decision Process in Parental School Choice

Ya-Ling Lu, Yi-Cheng Lin, and Berlin Wu

Abstract The main purpose of this research is to create strategies of school choices for educational quality of junior high school. We propose a strategy for making decisions of school choices. Adopt the approach of quantized research and select altogether 20 parents of two schools (schools A and B) to participate in studying. First of all, this research establishes the expert's fuzzy weight of educational quality with the fuzzy theory. We apply the expert's fuzzy weight to discuss the parents' satisfaction to quality of school education which their children studied. Moreover, we use the method of fuzzy relative weight to analyze. Hope that could understand parents' feeling to the quality satisfaction of school education. Finally, we propose the relevant suggestion according to the result of study.

Keywords Fuzzy evaluation • Educational quality • Parental school choice

1 Introduction

In the globalization, marketization, and pluralistic educational reform, various countries paid high attention to improve educational quality. In the USA, within the impact of the educational marketization, the concept of educational vouchers

Y.-L. Lu (✉)
Department of Education Policy and Administration, National Chi Nan University, Taichung City, Taiwan
e-mail: aling626@gmail.com

Y.-C. Lin
Graduate Institute of Education, National Chung Cheng University, Taiwan
e-mail: u8612007@gmail.com

B. Wu
Department of Math Sciences, National Cheng Chi University, Taiwan
e-mail: berlin@nccu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_24,

is first proposed. The meaning of educational vouchers is to give parents studying costs to choose a school for their children. It involves the improvement of school educational quality. The people all pay much attention to the competition among the schools. The focus of educational reform is educational quality of the school (Belfield and Levin 2002). In other words, educational quality is the key factor in competitiveness of schools, and educational quality is very important. In conclusion, a school needs to constantly pursue improving the quality of education, deal with the trend of educational reform, and raise effective strategies to respond to the educational market competition. Although the aspect of educational quality is extensive, we can sum up four aspects such as teacher, administration, environment, and curriculum according to literature research (Culver 2010; The Louisiana Association of Educators 2005; Yang and Chen 2010).

The concept of educational quality has changed the thinking of parental educational option. As we know, educational quality is an important basis for choice of schools. In 1948, the third item of Article 26 of the Universal Declaration of Human Rights explicitly stated that the parent has the priority right to choose education for their children (Liu 2000). Most of the Modern countries, such as the USA, Britain, and Australia, have viewed the parents' educational option as one of the crucial policies of the educational reform, in order to enhance educational quality of schools. As a consequence of this, most of the modern nations have viewed educational option as an important issue of educational reform. Since the policy of educational option is implemented, this issue continues without interruption. Educational option has become a popular research theme in the field of education (Kahlenberg 2003; Peterson 2001).

Analyzing education and psychology from the view of probability statistics is a shortened form in mathematics. When data are expressed in our natural language, they are fuzzy. Moreover, in human logic and recognition, the thinking behavior perceived is fuzzy and ambiguous; these processes often ignore these (Nguyen and Wu 2006; Wu 2005). Because it is very difficult for us to define educational quality accurately, we must set up the indicator aspect of the educational quality of school at first. In this research, we apply fuzzy statistics to develop a tool of study. We study the junior middle school student's parents by questionnaire investigation, in order to establish an educational option.

The purpose of this research is narrated as follows: (1) Understand what are parents' concerns when making decisions in the educational option. (2) Utilize fuzzy theory to establish strategies of fuzzy decisions in the educational quality.

2 Research Methods

2.1 Research Methods and Procedures

This research utilizes investigation method of the questionnaire and fuzzy evaluation and hopes to establish equation of fuzzy evaluation of selecting a school.

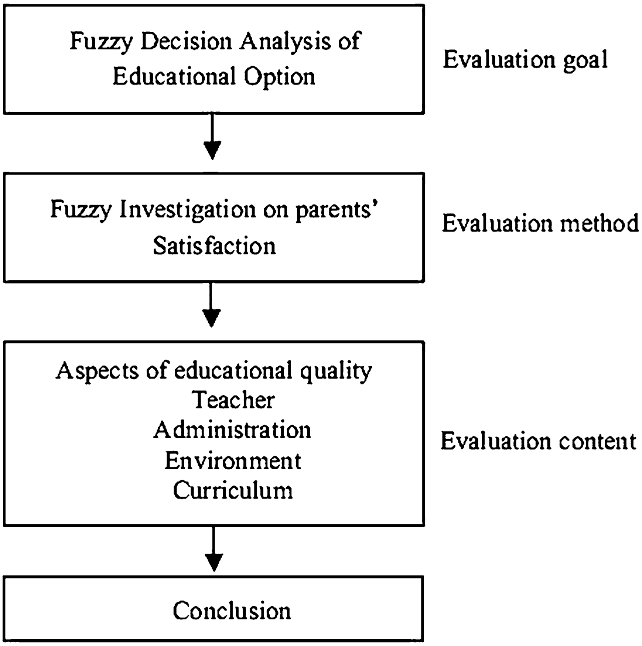


Fig. 1 Flowchart for the evaluation process

The evaluation procedure mainly includes three parts, such as goal, contents, and method and fuzzy decisions (as shown in Fig. 1). First of all, this research aims at the strategies of parents' educational option. We sum up four aspects of educational quality according to the literature, for instance, teacher, administration, environment, and curriculum. Secondly, collect realistic data from samples, namely, from parents' points of view. Thirdly, the research approach is to compile the questionnaires of parents' educational option. We collect altogether 20 parents of two junior high schools (named A and B school); six participants are deleted because of useless answering. The efficient percentage of participants is 70 %. Finally, we sum up the result of study.

2.2 Why We Use Fuzzy Statistics

Since fuzzy theory is generated by Zadeh, the application in every research field of fuzzy statistics grows vigorously like the mushrooms after rain. It regards fuzzy logic as theoretical foundation, extends the logic concept of the two-value logic of traditional mathematics, and breaks through the limitation of thinking of binary logic. Just as the fuzzy statistics scholar's concern, the human thinking can't be

Table 1 The Example of responding fuzzy questionnaire

Aspect	Very low	Low	Medium	High	Very high
Teacher			3	3	4
Administration	2	6	2		
Environment					10
Curriculum				5	5

measured or described with the single option. In other words, it should have membership of each option revealing its relative importance (Law 1997; Nguyen and Wu 2006; Wu 2005).

Different from the traditional quantized questionnaire, the fuzzy questionnaire can reflect possibility and feasibility of the human fuzzy thinking speciality even more (as shown in Table 1). Because human thinking and behavior nearly reflect the fuzziness of things, languages shown are all fuzzy languages too (Wu 2005). Apply the fuzzy logic to the analysis of questionnaire investigation and offer a novel idea of collecting and analyzing data; it's a concept of fuzzy theory which allows people to have multiple experiences.

Relative to traditional data, we can not only know the final option but also the fuzzy thinking of participant in fuzzy data. In other words, the participant's preference is reflected more accurately in fuzzy voting.

3 Fuzzy Decisions

Related concepts of fuzzy statistics used in this paper are illustrated as follows:

3.1 Fuzzy Relative Weight

Definition 3.1 (Fuzzy Relative Weight (FRW)). The fuzzy weight shows the self-weight of every factor. The main purpose of fuzzy weight analysis is to try to get fuzzy relative weight. We defined fuzzy relative weight for analyzing fuzzy weight.

Consider the universe of discourse $S = \{S_1, S_2, \ldots, S_K\}$, utility sequence $r = \{r_1, r_2, \ldots, r_f\}$, and $\mu_{S_i j}$ is the membership of r_j in S_i. Then fuzzy relative weight $FRW = (FRW_{S_1}, \ldots, FRW_{S_c})$ is defined by evaluation criterion of m grade. If $r = \{r_1, r_2, \ldots, r_f\}$ is the utility increasing sequence

$$r_1 \prec r_2 \prec \ldots \prec r_f, then\ FRW_{S_i} = \frac{\sum_{l=1}^{f} l \cdot \mu_{S_i l} \odot}{\sum_{i=1}^{k} \sum_{l=1}^{f} l \cdot \mu_{S_i l} \odot}, i = 1, \ldots, k;\ otherwise,$$

$$r_1 \succ r_2 \succ \ldots \succ r_f \quad FRW_{S_i} = \frac{\sum_{l=1}^{f} (n-l+1) j \cdot \mu_{S_i l} \odot}{\sum_{i=1}^{k} \sum_{l=1}^{f} (n-l+1) \cdot \mu_{S_i l} \odot}, i = 1, \ldots, k$$

Table 2 Fuzzy evaluation

	r_1	r_2	$\ldots$	r_f
S_1	$\mu_{S_1 1}$	$\mu_{S_1 2}$	$\ldots$	$\mu_{S_1 f}$
S_2	$\mu_{S_2 1}$	$\mu_{S_2 2}$	$\ldots$	$\mu_{S_2 f}$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$
S_k	$\mu_{S_k 1}$	$\mu_{S_k 2}$	$\ldots$	$\mu_{S_k f}$

Ps. r μ_A is the membership of A in utility sequence r

3.2 Calculate Procedure of Fuzzy Relative Weight

We design Table 2 as fuzzy evaluation table to calculate fuzzy relative weight.

Let $r_1 \prec r_2 \prec \ldots \prec r_f$, then the fuzzy weight of factor is defined.

$$\begin{aligned} FW_{S_1} &= \sum_{l=1}^{f} \mu_{S_1 l}/r_l = \mu_{S_1 1}/r_1 + \mu_{S_1 2}/r_2 + \ldots + \mu_{S_1 f}/r_f, \\ FW_{S_2} &= \sum_{l=1}^{f} \mu_{S_2 l}/r_l = \mu_{S_2 1}/r_1 + \mu_{S_2 2}/r_2 + \ldots + \mu_{S_2 f}/r_f, \\ &\ldots \\ FW_{S_k} &= \sum_{l=1}^{f} \mu_{S_k j}/r_l = \mu_{S_k 1}/r_1 + \mu_{S_k 2}/r_2 + \ldots + \mu_{S_k f}/r_f. \end{aligned} \tag{1}$$

Utilize the m grade evaluation criterion and calculate fuzzy relative weight FRW of each factor. The meaning of m grade evaluation criterion is that utility **sequence** r is regarded as f grade; fetch the quantity to this f grade. That is to say, let the value of r_1 be one $(r_1 = 1)$, r_2 be two $(r_2 = 2)$, and then r_f be $f(r_f = f)$. Then

$$FRW_{S_1} = \frac{\sum_{l=1}^{f} l\mu_{S_1 l}\odot}{\sum_{i=1}^{k}\sum_{l=1}^{f} l\mu_{S_1 l}\odot}, FRW_{S_2} = \frac{\sum_{l=1}^{f} l\mu_{S_2 l}\odot}{\sum_{i=1}^{k}\sum_{l=1}^{f} l\mu_{S_2 l}\odot}, \ldots, FRW_{S_k} = \frac{\sum_{l=1}^{f} l\mu_{S_k l}\odot}{\sum_{i=1}^{k}\sum_{l=1}^{f} l\mu_{S_k l}\odot} \tag{2}$$

3.3 Strategy: Emphasize One Certain Aspect

Let X be the universe set, $X = X_1, X_2, \ldots, X_N$, and X_i be a variable on X. The relative importance of X_i is higher than the other variables. The fraction that focuses on X_i is viewed as $S(X_i)$, and then the fuzzy multiple decisions for emphasis on a certain aspect are defined as

$$S(X_i) = X_i\left(\frac{\sum_{i \neq i, i=1}^{n} X_i}{n-1}\right) \tag{3}$$

4 Empirical Analysis

4.1 Fuzzy Relative Weight of Educational Quality: Calculation of Membership Grade of Expert

We establish fuzzy relative weight of educational quality from the membership grade of educational experts. We get the fuzzy weight from fuzzy data as follows:

$$
\begin{aligned}
FW_{Teacher} &= 0/very\ low + 0/low + 0/medium + 0.31/high + 0.75/very\ high \\
FW_{Administration} &= 0/very\ low + 0/low + 0.31/medium + 0.30/high + 0.40/very\ high \\
FW_{Environment} &= 0/very\ low + 0/low + 0.18/medium + 0.41/high + 0.43/very\ high \\
FW_{Curriculum} &= 0/very\ low + 0/low + 0.01/medium + 0.40/high + 0.65/very\ high
\end{aligned}
$$

We give the value of utility sequence as very $low = 1$, $low = 2$, $medium = 3$, $high = 4$, and $very\ high = 5$. The multiplier of membership and value of utility sequence is the fuzzy weight of every aspect. Then we calculate the fuzzy relative weight, as shown in Table 3.

The decreasing sequence of fuzzy relative weight is $FRW_{Teacher} = 0.273$, $FRW_{Curriculum} = 0.267$, $FRW_{Environment} = 0.235$, $and\ FRW_{Administration} = 0.226$. The difference of FRW of each aspect is not obvious.

The index of educational quality is defined as follows:

$$
\begin{aligned}
\mathbf{Index}_{Educational\ quality} = {} & 0.273 \times W_{Teacher} + 0.226 \times W_{Administration} \\
& + 0.235 \times W_{Environment} + 0.267 \times W_{Curriculum}
\end{aligned}
$$

Table 3 Fuzzy relative weight of experts' membership of educational quality

Aspect	Utility sequence					Fuzzy weight	Fuzzy relative weight
	Very low	Low	Midum	High	Very high		
Teacher	0	0	0	0.31	0.75	5	0.273
Administration	0	0	0.31	0.30	0.40	4.14	0.226
Environment	0	0	0.18	0.41	0.43	4.3	0.235
Curriculum	0	0	0.01	0.40	0.65	4.89	0.267

Table 4 Fuzzy weight of single aspect and fuzzy fraction of educational quality

Aspect	School	Utility sequence: Very low	Low	Midum	High	Very high	Fuzzy weight	Fuzzy fraction of educational quality	Sequence
Teacher	A	0	0.09	0.14	0.27	0.50	4.19	3.3761	2
	B	0.03	0.11	0.47	0.86	2.71	4.19	3.9868	2
Administration	A	0.10	0.21	0.50	0.14	0.04	2.87		4
	B	0	0	0.43	1.37	2.57	4.37		1
Environment	A	0.10	0.06	0.20	0.34	0.30	3.69		3
	B	0.03	0.31	1.20	1.37	0.35	3.27		4
Curriculum	A	0	0.01	0.16	0.33	0.50	4.31		1
	B	0	0	0.64	1.94	1.50	4.09		3

4.2 The Result on the Fuzzy Opinion of Parents' Satisfaction to Educational Quality: A and B Schools Are Two Examples

Our samples are parents of school A and school B. We utilize educational quality investigation of fuzzy satisfaction. The satisfaction in every aspect is averaged after the statistics as shown in Table 4. Thus we sequence fuzzy weight of parents of school A as Curriculum = 4.31, Teacher = 4.19, Environment = 3.69, and Administration = 2.87. Among them it is the highest with Curriculum satisfaction, of course and the lowest in Administration satisfaction. Sequence fuzzy weight of parents of school B as Administration = 4.37, Teachers = 4.19, Curriculum = 4.09, and Environment = 3.27. Among them it is the highest with Administration satisfaction and the lowest in Environment satisfactions. In addition, the fuzzy value of education quality of school A and B is that school B = 3.9868 > school A = 3.3761.

4.3 Analysis of Strategy: Emphasize One Certain Aspect of Satisfaction of Educational Quality of Parents

We research 14 parents of school A and school B, in order to understand their satisfaction opinion of educational quality. The satisfaction average in every aspect is shown in Table 5. According to 3.3 Strategy $S(X_i) = X_i(\frac{\sum_{i\neq i,i=1}^{n} X_i}{n-1})$, the value of emphasize one certain aspect is shown in Table 5. The computational process is shown as follows:

$$SX_{Teacher} = X_{Teacher} \cdot \frac{X_{Administration} + X_{Environment} + X_{Curriculum}}{3}$$

$$SX_{Administration} = X_{Administration} \cdot \frac{X_{Teacher} + X_{Environment} + X_{Curriculum}}{3}$$

Table 5 Fuzzy decisions: emphasize a certain aspect

Strategy	School	Value of fuzzy decisions	Sequence	Higher value
Strategy 1	A	15.76	1	
Emphasis on Teacher	B	16.18	2	◎
Strategy 2	A	11.61	4	
Emphasis on Administration	B	16.82	1	◎
Strategy 3	A	14.13	3	◎
Emphasis on Environment	B	14.01	4	
Strategy 4	A	15.63	2	
Emphasis on Curriculum	B	16.11	3	◎

$$SX_{Environment} = X_{Environment} \cdot \frac{X_{Teacher} + X_{Administration} + X_{Curriculum}}{3}$$

$$SX_{Curriculum} = X_{Curriculum} \cdot \frac{X_{Teacher} + X_{Administration} + X_{Environment}}{3}$$

Thus, from the result of calculation we **sequence** value of fuzzy decisions of school A as Teacher = 15.76, Curriculum = 15.63, Environment = 14.13, and Administration = 11.61. Among them it is the highest with Teacher satisfaction and the lowest in Administration satisfaction, as shown in Table 5.

In addition, we **sequence** value of fuzzy decisions of school B as Administration = 16.82, Teacher = 16.18, Curriculum = 16.11, and Environment = 14.01. Among them it is the highest with Administration satisfaction and the lowest in Environment satisfaction, as shown in Table 5.

5 Conclusion

In this research we utilize fuzzy statistics to fuzzy decisions in the school choices and expect to be able to establish appropriate model to educational option. According to literature research we sum up four aspects such as teacher, administration, environment, and curriculum. The study participants are parents of two schools. We utilize fuzzy data of their membership to four aspects to analysis proper educational quality.

The questionnaire of this study is different from the traditional questionnaire. It is developed by fuzzy theory. Traditional questionnaire ignores fuzzy thinking of human beings unavoidably and may explain it excessively. Thus, we can use fuzzy questionnaire to obtain more accurate information which can reflect experimenters' real opinion. We drew conclusions from the result of THE study:

1. Expert's fuzzy relative weight, obtained from the membership of four aspects of educational quality, is from 0.226 to 0.273; it shows difference slightly.

Table 6 Emphasize a certain aspect of relation from two schools

Strategy	School	Value of fuzzy decisions	Relation
Strategy 1	A	15.76	A<B
Emphasis on Teacher	B	16.18	
Strategy 2	A	11.61	A<B
Emphasis on Administration	B	16.82	
Strategy 3	A	14.13	A>B
Emphasis on Environment	B	14.01	
Strategy 4	A	15.63	A<B
Emphasis on Curriculum	B	16.11	

2. The fuzzy value of school's quality of School A is different from School B. school B parents' satisfaction compared with the overall quality of education of school A parents' satisfaction:

$$\mathbf{Index}_{qualityofA}(3.3761) < \mathbf{Index}_{qualityofB}(3.9868)$$

3. School A and B parents estimate the quality of education at all levels of satisfaction: If some parents select school A, they should give priority to the Curriculum; if some parents select school B, they should give priority to the Administration.
4. The comparative result of strategy is different from two schools in each aspect, as shown in Table 6. In strategy, we get the conclusion that school A is only superior to school B in Environment.

References

C.R. Belfieldm, H.M. Levin , The effects of competition between schools on educational outcomes: a review for the United States. Rev. Educ. Res. **72**, 279–341 (2002)

S. Culver, Educational quality, outcomes assessment, and policy change: the virginia example. Int. Educ. **40**(1), 6–20 (2010)

R.D. Kahlenberg, *The Problem of Taking Private School Voucher Programs to Scale*, ed. by R.D. Kahlenberg. Public school choice v. private school vouchers (The Century Foundation, New York, 2003) p. 51–60

C.K. Law, A fuzzy logical model to aggregate several heterogeneous educational grades from a reductionist grading scheme. Proceedings of 8th International Conference on the Teaching of Mathematical Modeling and Applications, 1997

S.M. Liu, A study of new directions in Taiwan education policy, Unpublished doctoral dissertation, New York University, 2000

H.T. Nguyen, B. Wu, *Fundamentals of Statistics with Fuzzy Data* (Springer, New York, 2006)

P.E. Peterson, in *Choice in American Education*, ed. by T.M. Moe. A primer on America's schools (The Hoover Institution, Stanford, CA, 2001) p. 249–283

The Louisiana Association of Educators, What is a quality school? (2005), http://www.lae.org/instructional/qualified/quality.html. Accessed 20 may 2012

B. Wu , *Introduction to Fuzzy Statistics: Method and Applications* (Wunan Taipei, 2005)

N.H. Yang, M.J. Chen, A study of the fitness among indicators of quality management and performance management for quality school. J. Educ. Admin. Eval. **9**, 1–26 (2010)

A Study on Internet Entrepreneurship Based on the Long Tail Theory

Minglin Zhang and Ronghua Zhou

Abstract Due to the gradual promotion of Internet technology, network entrepreneurship became a common phenomenon. This paper, firstly, summarizes the academic situation of the long tail theory, then analyzes the realization conditions of the long tail effect, and finally analyzes the significance of the long tail theory to the Internet entrepreneurship and makes suggestions on Internet entrepreneurship.

Keywords Internet entrepreneurship • The long tail theory • Study

The long tail concept is proposed by Chris Anderson, the the chief editor of the United States Wired magazine, in the long tail article in October 2004; it was used to describe business and economic models like Amazon, Netflix, and other website. Anderson believes that the basic principle of the long tail theory is the market share of low-demand or poor sales product can match with that of a small number of hot products and sometimes occupy even larger, as long as the storage and distribution channel are large enough.

1 A Literature Review of the Long Tail Theory

There is no formal definition of the long tail theory in academia. The definition of foreign scholars on the long tail theory focuses on describing from the characteristics angle. They think that the long tail theory in bad-selling products can also occupy a certain market share. Etic Akawic think that long tail is what you can get

M. Zhang (✉) • R. Zhou
Business College, Jiangxi Normal University, Nanchang, Jiangxi, China
e-mail: mlzhang03@163.com; binger120@126.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_25,

when the unremarkable become ubiquitous; Bob Baker thinks that the long tail is about a story: products which used to be considered to be marginalized, underground and stand-alone now jointly occupy a market share which is sufficient to compete with the best-selling goods.

Domestic scholars defined the long tail as a theory, such as Zhang Jinghong and Chen Zongnan believe that the long tail theory is a theory that in the conditions of network, electronic data management, to promote the products with the lowest cost and to search and find products in the highest quality, by changing marginal cost-effectiveness to affect the potential market profit margins and generate a new exchangeable market with differentiation and heterogeneity. Some scholars do not agree to name it the long tail theory; they often refer it as the long tail effect or long tail economy. Wu Lun believes that long tail economy is a combination of internal and external economies of scale, but it is not equal to the economies of scale and may not even be economies of scale but the differences in economy or personalized economy, creative economy, and other heterogeneous economy. Yu (2007) thinks that the "Pareto principle" which is considered by business circle as iron law may be broken with the rise of the Internet; 99 % of the products have the opportunity to be sold, this is the long tail effect. Tang and Li (2009) believe that the long tail should be understood as an economic phenomenon under the new economic rules.

In this paper, we agree with this view and refer the long tail as an economic phenomenon. This economic phenomenon states that non-popular products can also get some consumer recognition and occupy a certain market share.

2 Realization Conditions of the Long Tail Effect

Chris Anderson thinks that the six themes of the long tail era are the response, to possible mass customization.

2.1 The Low-Cost Production Makes the Tail Profitable

In today's society, with the improvement of technology, communications, and transport conditions, the production cost is significantly reduced.The low-cost production businesses can still make a profit even the sales volume is small.

2.2 The Significant Decline in Acquisition Costs or Marketing Costs Makes the Tail Rich Supply

Subject to the constraints of the operating costs of enterprises and the technical level, many bad-selling products are very difficult to get in the market. consumers' access cost is high, so many bad-selling products are very difficult to sell. With digital transmission, powerful search technology, and broadband penetration, many markets have ability to supply unprecedented products; consumers can buy the product quickly and easily.

2.3 The Processing of Demand Information Makes the Tail Longer Further

Just supply more of products cannot change the demand; the consumer must have a way to find suitable long tail products which meet their needs and interests. From automatically recommend to ranks, a series of tools and techniques can do this effectively.

2.4 Providing Services for Personal Choice

It seems that popular is no longer hot and unpopular (tail) is no longer cold. Now, consumer's demand is personalized and differentiated. The influence of scale products is declining, and personalized products began to win more and more consumer.

2.5 The Aggregate Tail Market Profit Is Not as Small as a Hot Market

In a single area, the sales of personalized products are limited and corporate profits are few, but in multiple areas, the sales of personalized product can reach a certain number and occupy certain market shares. Therefore, the aggregate sales of a single region will be expanded, and the profits of an enterprise are also relatively abundant.

2.6 The Formation of the Long Tail Phenomenon Has Changed the Demand Patterns

Previously, the consumer demand is convergence, relatively single. Now, consumer demand is gradually developed towards personalization and diversification.

3 Suggestions on Internet Entrepreneurship Based on the Long Tail Theory

3.1 Using Internet and Other Information Technology to Get Large-Scale Customization and Reduce Customers' Buying Cost

Customization is the mode of production in the agricultural society; in industrial society, customization is the opposite of mass production. In the information society, customization once again becomes a major high value-added mode. In the traditional economy, customization is difficult to achieve, the demand is too small, and there are diseconomies of scale. But information technology has changed production conditions; small-scale production can achieve the cost level that only mass production can do, sometimes even lower. Currently, the Internet is developed rapidly, people can use the Internet to start up business. Depending on the network, distribute product information and find sales leads. Once the customers have interests, they provide designs. After designs are recognized by customers, manufacturers place an order for outsourcing company.

Therefore, in Internet entrepreneurship, treat consumers who have the personality preferences as individual, regard popularization as substitute for mass market, and reduce the operating costs of enterprises.

3.2 Focus on Online Advertising, Filter Information for Customers, and Reduce Marketing Costs

For current consumers, what they lack is not the access to products but how to effectively obtain the required product information. Use the Internet, by selling degree rankings,by price rankings, by comment rankings, according to the manufacturer and other function, to obtain a clear and concise information to help customers filter and get the information they want.

Therefore, in the process of Internet entrepreneurship, paying attention to the use of recommending information can be a powerful tool in the process of marketing.

From the user comments to the specifications, all the full and accurate information can answer the question of consumers and avoid giving up products under consumers' doubts.

3.3 Maintain Good Interaction with Other Professional Service Providers, and Provide Customers with Smooth Operation

In the process of Internet entrepreneurship, in order to survive in the conditions of the network better, they must maintain good interaction with the related professional service providers, in order to ensure three "flows" are unimpeded.

3.3.1 Cooperating with Platform Service Providers

Logistics service providers and financial service providers cooperate in win-win strategic way for example, cooperating with telecom, China Netcom, cable TV, and other service providers to ensure smooth information channel; cooperating with the server space provider to ensure sufficient information space; cooperating with content providers to ensure that their own website has more characteristics and by good platform to ensure information smooth and security and allow customers to enjoy the pleasure of safe web anywhere.

3.3.2 Cooperating with Logistics Service Providers

To ensure the proper movement of distribution and transmission channels of goods and services and other materials, as logistics is the final link in direct contact with customers, clients usually use logistics service quality which can be directly felt to judge the quality of services to SMEs. So, from this angle, in the process of Internet entrepreneurship, choosing a logistics service provider which has professional quality assurance is the key to entrepreneurship.

3.3.3 Cooperating with Financial Service Providers

There are some business transactions on cash settlement. With the development of China's electronic financial industry, it is the inevitable trend of development. From the point that current customers are most worried about using electronic financial services, security and accuracy are the fundamental requirements for financial service providers. In the process of Internet entrepreneurship, people should make evaluation of the services of financial service providers in several aspects to ensure smooth funds flow and customer satisfaction.

4 Conclusions

There are two major trends of today's production market development, one is large-scale batch production and the other is personalized production for the needs of different consumers. As consumer demand is gradual turned from popular demand to the individual needs. Therefore, to realize the needs of individual consumers became the producer's focus. The growing segments of the market (long tail market) which are based on the individual needs have brought a lot of opportunities for entrepreneurship, and the development of information network technology creates a better environment for Internet entrepreneurship.

References

H. Tang, F. Li, The research review and prospect of long tail theory. Mod. Manage. Sci. **3**, 40–42 (2009)

B. Yu, in *The Long Tail Effect*, vol. 10 (Overseas Chinese Publishing House, Beijing, 2007)

Fuzzy Decision System for Course Demand-Supply Management in Community College

Yu-Lan Lee, Baiqing Sun, and Dian-fu Chang

Abstract This study is based on the course demand to reflect how the teachers respond to students' request properly in community college. In this study, we proposed an alternative demand-supply strategy for better managing this issue. The fuzzy decision system was used to evaluate the situation of course demand and supply in community college. We retrieve the related managerial features of community college and build up course management influencing indicators, such as students request, curriculum planning, teaching professional, considerate service, and interpersonal communication to interpret the issues. Finally, we propose the rule-based strategy for better managing the community college. The result reveals that the course management strategies may provide the teachers for enhancing their teaching performance in the community college.

Keywords Community college • Fuzzy decision system • Course management strategy • Course supply and demand

Y.-L. Lee (✉)
Department of Educational Policy and Administration, National Chi Nan University, Puli, Nantou, Taiwan
e-mail: aerylee@yahoo.com.tw

B. Sun
National Center of Technology, Policy and Management Harbin Institute of Technology, Harbin, China
e-mail: baiqingsun@hit.edu.cn

D.-f. Chang
Graduate Institute of Educational Policy and Leadership, Tamkang University, Taipei, Taiwan
e-mail: 140626@mail.tku.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_26,

1 Introduction

In recent years, numerous organizations have devoted themselves to promoting life-long learning and responding to the power of social change. The related demand and supply measures have affected the development of community colleges in many countries. Recently, the community colleges were asked to face their accountability in terms of educational goals, participants' needs, internal curriculum design, and teachers, course management. Huang (1999) categorized current courses in community college into three dimensions: exploring fundamental issues (academic programs), developing the social skills (club programs), and enriching life meanings (life skills programs). Knowles (1980) argued by way of self-directed learning model that many adult students enter the community college and take courses through market mechanism. Facing the pressure of market mechanism, teachers in community college must work actively to manage their classroom teaching to attract more students to elect their courses.

Generally, classroom management refers to teachers' "efforts to oversee the activities of the classroom, including learning, social interaction, and student behaviors". Classroom management is perceived to be dynamic and essential for academic success; therefore, "creating the best learning environment possible is the primary focus of the classroom teacher's responsibility" (Martin et al. 2006). Hoy and Weinstein (2006) termed this characteristic as an "unrealistic optimism" of their ability to manage classes. In contrast, the experienced teachers expressed more "realistic expectation" for classroom management and focused upon managing the classroom environment, where established routines and supervision of students performances permitted a focus on student learning. The primary purpose of classroom management is to gain control of the classroom; good classroom management results in high levels of student engaged time. Brophy (1983) also cited three theoretical orientations to classroom management, including self-concept/personal adjustment, insight (cognitive), and behavioral style. Evertson (1995) argued there are seven modules for classroom management program: (1) organize class, (2) rules and conventional, (3) the accountability of students, (4) design and organization of teaching, (5) maintaining good student behaviors, (6) maintain students motivation, and (7) expand the new beginning. The better classroom management might promise to increase the number of enrollees.

There is a difference between community colleges and universities in their purposes. Teachers, in community college, cannot use required courses to guide students to take their courses. They will take advantage of selecting an interesting course name to attract students. They master the skills of adult teaching and interactive mode. Therefore, the interaction between teachers and students becomes the key point of teaching and learning. However, community colleges have encountered the difficulties. Firstly, the participants tend to have low interests in academic and public affair courses. Secondly, the participants prefer practical courses and lead some market-oriented community colleges to provide too many life skills courses.

Thirdly, academic and public welfare-related courses are crowded by too many life skill courses. Hence, there is a great gap between ideal and reality, although the community college spirit of original is civic literacy.

This study, based on the teaching characteristics of community college, will build community college course management indicators by their demand and supply. We separate the issues into three dimensions: view of student request, view of interactive communication, and view of teaching leadership. Then we develop indicators for course management including students' request, curriculum planning, teaching professional, considerate service, and interpersonal communication. The purposes of this study are as follows:

- To evaluate the situation of course supply and demand in community college
- To establish the indicators of course management in community college
- To analyze the rule-based course management strategies for community college

2 Evaluating the Situation of Community College Courses Supply and Demand

In order to understand the relationship between supply and demand of the community college courses, firstly we use the concept of logistics in marketing, to analyze community college course demand and supply. When the market is not balanced there will be in short supply, oversupply two kinds of cases.

The goal of the courses' balanced development includes: (1) To find community college courses rule-based and multiple decision-making system. (2) If course demand is greater than supply, then we should promote the courses or subject to bridge the gap between course demand and supply. (3) When the course demand is less than supply, we should remove the class and consider as the potential courses to match between supply and demand.

2.1 What is a Rule-Based System?

In computer science, rule-based systems are used as a way to store and manipulate knowledge to interpret information in a useful way. They are often used in artificial intelligence applications and research. Rule-based systems can be used in an expert system and might help a doctor choose the correct diagnosis. Also known as the knowledge base, knowledge is stored as rules in the rule-base. Rules are of the form.

The rule-based system of community college management is a method of finding a rule in a rule-base. We can express the matching policies as follows:

- Consists of a *rule-base* (permanent data)
- If some condition, then some action (Ireson-Paine 1996; Gupta 1986)

Therefore, the rule-base of the community college course supply and demand model is set up as below:

Rule 1: If $|Demand - Supply| \leq 0.1$, we will maintain the courses or objects.
Rule 2: If $0.1 \leq |Supply - Demand| \leq 0.5$, we will minutely adjust the courses.
Rule 3: If $0.5 \leq |Demand - Supply| \leq 1$, we will substantially adjust the courses.

3 Fuzzy Methods

3.1 Research Process

This research establishes fuzzy decision system on community college course management. Figure 1 represents a fuzzy decision system dynamic process of course management in community college. Through the fuzzy rule-base of course demand and supply, we evaluate the courses to determine whether they need to be adjusted or not. The definition and example will be addressed in the following section.

Definition 3.1 (Fuzzy Sample Mode [Data with Multiple Values]). Let U be the universal set (a discussion domain), $L = L_1, L_2, \ldots L_k$ a set of k-linguistic variables on U, and $FS_i, i = 1,2,\ldots n$ a sequence of random fuzzy sample on U. For each sample FS_i, assign a linguistic variable L_j a normalized membership $m_{ij}(\sum_{j=1}^{k} m_{ij} = 1)$, and let $s_i = \sum_{j=1}^{k} m_{ij}, j = 1,2,\ldots,k$. Then, the maximum value of S_j (with respect to L_j) is called the fuzzy mode (FM) of this sample. That is, $FM = L_j | S_j = \max_{1 \leq i \leq k} S_i$.

Note: A significant level α for fuzzy mode can be defined as follows: Let U be the universal set (a discussion domain), $L = L_1, L_2, \ldots L_k$ a set of k-linguistic variables on U, and $FS_i, i = 1,2,\ldots n$ a sequence of random fuzzy sample. For each sample FS_i, assign a linguistic variable L_j a normalized membership $m_{ij}(\sum_{j=1}^{k} m_{ij} = 1)$, and let $S_j = \sum_{i=1}^{n} I_{ij}, j = 1,2,\ldots,kI_{ij} = 1$ if $m_{ij} \geq \alpha, I_{ij} = 0$ if $m_{ij} < \alpha$; α is the significant level. Then, the maximum value of S_j (with respect to L_j) is called the fuzzy mode (FM) of this sample. That is, $FM = L_j | S_j = \max_{1 \leq i \leq k} S_i$. If there are more than two sets of L_j that reach the conditions, we say that the fuzzy sample has multiple common agreement.

Definition 3.2 (Fuzzy Sample Mode [Data with Interval Values]). Let U be the universal set (a discussion domain), $L = L_1, L_2, \ldots L_k$ a set of k-linguistic variables on U, and $FS_i = [a_i, b_i], a_i, b_i \in R, i = 1,2,\ldots,n$ be a sequence of random fuzzy sample on U. For each sample, if there is an interval $[c,d]$ which is covered by certain samples, we call these samples as a cluster. Let MS be the set of clusters which contains the maximum number of sample, and then the fuzzy mode FM is defined as

$$FM = [a,b] = \bigcap [a_i, b_i | [a_i, b_i] \subset MS].$$

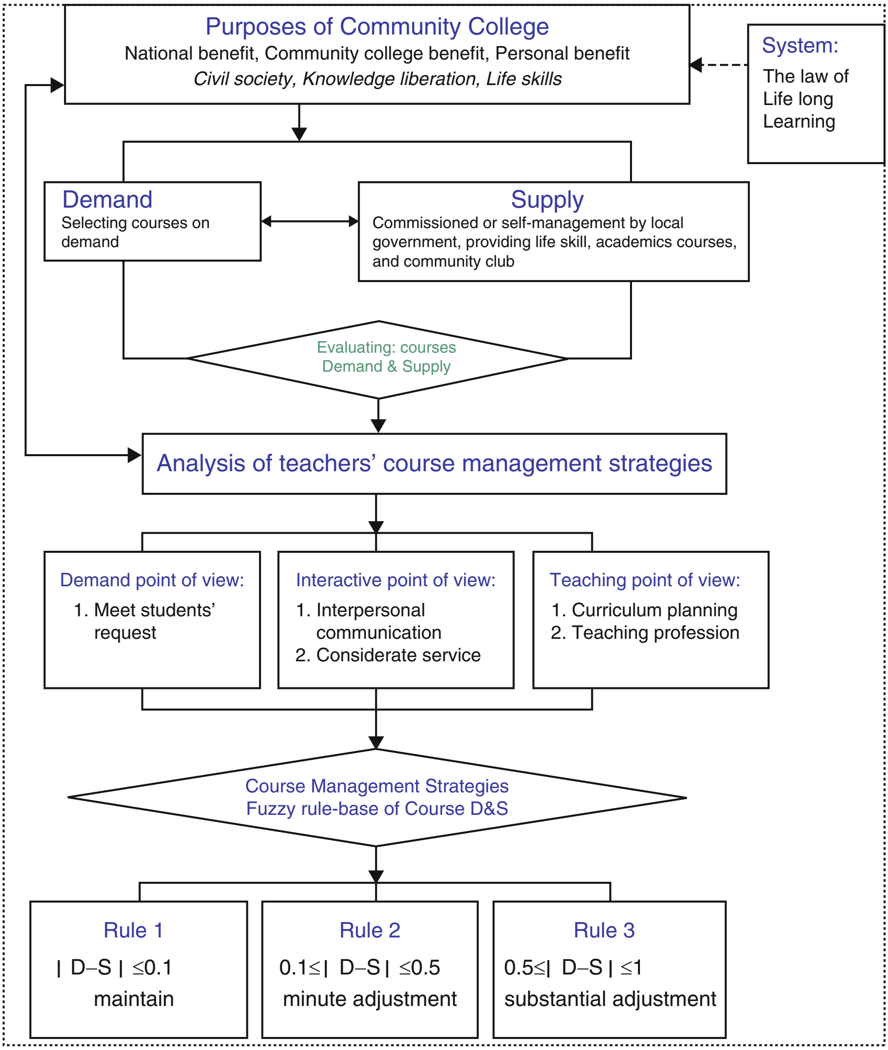


Fig. 1 Dynamic process course management of community college using fuzzy decision

If $[a,b]$ does not exist (i.e., $[a,b]$ is an empty set), we say this fuzzy sample does not have fuzzy mode.

Example 3.1. Suppose eight voters are asked to choose a chairman from four candidates. Table 1 is the result from the votes with two different types of voting: traditional response versus fuzzy response.

From the traditional voting, we can find that there are three persons who vote B. Hence, the mode of the votes is B. However, from the fuzzy response, B only gets a

Table 1 Response comparison for the eight voters

	Traditional response				*Fuzzy response*			
Voters Candidates	A	B	C	D	A	B	C	D
1		X				0.7	0.3	
2	X				0.5		0.4	0.1
3				X			0.3	0.7
4			X		0.4		0.6	
5		X				0.6	0.4	
6				X	0.4		0.4	0.6
7		X				0.8	0.2	
8			X				0.8	0.2
Total	1	3	2	2	1.3	2.1	3.5	1.6

total membership of 2.1, while C gets 3.4. Based on traditional voting, B is elected the chairperson, while based on the fuzzy response or membership voting, C is the chairperson. The voters' preference is reflected more accurately in fuzzy response in terms of the membership function. So, C deserves to be the chairperson more than B does.

3.2 Fuzzy χ^2-Test of Homogeneity

Consider a K-cell multinomial vector $n = n_1, n_2, \ldots, n_k$ with $\Sigma_i n_i = n$. The *Pearson chi-squared test* $(\chi^2 = \Sigma_i \Sigma_j n_{ij} - e_{ij}/e_i j)$ is a well-known statistical test for investigating the significance of the differences between observed data arranged in K classes and the theoretically expected frequencies in the K classes. It is clear that the large discrepancies between the observed data and expected cell counts will result in larger values of χ^2.

However, a somewhat ambiguous question is whether (quantitative) discrete data can be considered categorical and use the traditional χ^2-test. For example, suppose a child is asked the following question: *How much do you love your sister?* If the response is a fuzzy number (say, 70 % of the time), it is certainly inappropriate to use the traditional χ^2-test for the analysis. We will present a χ^2-test for fuzzy data as follows.

3.3 Procedures for Testing Hypothesis of Homogeneity for Discrete Fuzzy Samples

- Sample: Let Ω be a domain, $L_j, j = 1, 2, \ldots, k$ be ordered linguistic variables on Ω, and $a_1, a_2, \ldots a_m$ and $b_1, b_2, \ldots, b_n$ are random fuzzy sample from population A, and B with standardized membership function mA_{ij}, mB_{ij}.

- Hypothesis: Two populations A and B have the same distribution ratio, i.e., H_0 : $F_{\mu A =_F F_{\mu B}}$, where $F_{\mu A} = 1/mMA_1/L_1 + 1/mMA_2/L_2 + \cdots + 1/mMA_k/L_k, F_{\mu B} = 1/mMB_1/L_1 + 1/mMB_2/L_2 + \cdots + 1/mMB_k/L_k, MA_j = \Sigma_{i=1}^{m} A_{ij}, MB_j = \Sigma_{i=1}^{m} B_{ij}$.
- Statistics: $\chi^2 = \Sigma_{i \in A,B} \Sigma_{j=1}^{c} \frac{[Mi_j - e_i j]^2}{e_{ij}}$. (In order to perform the chi-square test for fuzzy data, we transfer the decimal fractions of Mi_j in each cell of fuzzy category into the integer Mi_j by counting 0.5 or higher fractions as 1 and discard the rest.)
- Decision rule Under significance level α, if $\chi^2 > \chi^2_{\alpha}(k-1)$, then we reject H_0.

4 An Empirical Study

4.1 Research Objects

In this study, we used quantitative survey to collect data from Nantou County Community College. The questionnaires were distributed to 100 students; the response rate is 75 %. There are 64 valid samples. The descriptive statistics are shown in Table 2.

The other questionnaires were for teachers in this community college. The questionnaires were distributed to 100 teachers; the response rate was 70 %. There are 68 valid samples in this study. The descriptive statistics for samples are shown in Table 3.

Female teachers in the majority are 51.1 %. The majority of community college faculty members got college degree. However, under high school education accounts for 28 %; it showed the community college teachers on the qualifications of teaching knowledge; we should encourage the teachers to enhance their professional knowledge and ability. Most of teachers age are 41–60 years old; it is up to 77 %. The majority of the blood type is O; it covers 45.6 % of participate teachers. Their constellations are widely different in this case study, for example, Aquarius and Scorpio are the majority; however, it is only 23 %.

Table 2 A descriptive statistics at students

Gender	Female 41(64.1 %), Male 23(35.9 %)			
Age	20–40	41–60	61+	
	6(9.4 %)	49(76.6 %)	9(14.1 %)	
Education	Under high school		Collage	Graduated school
	27(42.2 %)		37(73 %)	0 %

Table 3 A descriptive statistics for participating teachers

Gender		Female 35(51.1 %)		Male 33(48.5 %)	
School location		City 31 (45.6 %)		Country 37(54.4 %)	
Age	20-40 years old	41-60		61+	
	4(5.9 %)	53(77.9 %)		11(16.2 %)	
School size	(10-sclass)	11–30 (class)		30+ (class)	
	6(8.8 %)	38(55.9 %)		24(35.3 %)	
Blood type	A type 12(17.6 %)	B 21(30.9 %)	AB 4(5.9 %)	O 31(45.6 %)	
Education	Junior high school	Senior high	College	University	Graduated
	4(5.9 %)	15(22.1 %)	26(38.2 %)	10(14.7 %)	13(19.1 %)
Constellation	Aquarius Scorpio	Taurus/ Sagittarius	Pisces/Gemini/ Virgo	Capricorn	Aries/Leo/ Cancer
	8(11.8 %)	7(10.3 %)	6(8.8 %)	5(7.4 %)	4(5.9 %)

4.2 Fuzzy Statistical Analysis

In this study, we focus on three major dimensions of course management that involve students' request, curriculum planning, teaching professional, considerate service, and interpersonal communication teacher satisfaction as important indicators.

4.3 Rule-Base of Course

As we know, the rule-base of the community college course supply and demand model is set up as:

Life skill courses: $|0.660.55| = 0.11 \geq 0.1$. We will minutely adjust life skill courses.

Academic courses: $|0.160.3| = 0.14 \geq 0.1$. We will minutely adjust academic courses.

Community courses: $|0.160.14| = 0.02 \leq 0.1$. We will maintain club courses.

The present condition of curriculum status is supply exceeds demand in life skill classes and demand exceeds supply in academic courses. Therefore, life skill classes should reduce the course, academic courses should be promote to increase the courses to meet students' request, and club classes are balancing in the state of supply and demand (Tables 4 and 5).

Table 4 Fuzzy analysis of course management in community college

	Fuzzy member ships					Fuzzy mode
	Students' request	Teaching professional	Curriculum Planning	Interpersonal communication	Considerate service	Students' request (0.3)
The most important classroom management	0.45	0.22	0.14	0.15	0.14	Students' request (0.2)
The most difficult classroom management	0.34	0.13	0.21	0.15	0.10	Students' request (0.3)
The most time-consuming classroom management	0.30	0.21	0.18	0.15	0.11	Students' request (0.3)
The most effective classroom management	0.36	0.21	0.15	0.16	0.11	Students' request (0.3)
The most teaching classroom management	0.31	0.24	0.12	0.16	0.16	Students' request (0.3)
Sustainable registration	0.35	0.27	0.15	0.11	0.12	Students' request (0.3)

Table 5 Course demand and supply

	Fuzzy memberships		
	Life skill courses	Academic courses	Community courses
Current enrolling situation	0.550	0.307	0.143
Current teaching subjects	0.662	0.167	0.162

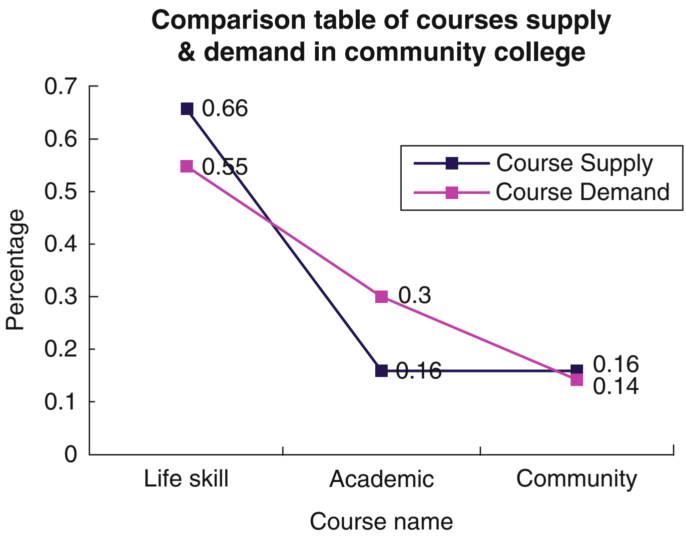


Fig. 2 Comparison of course supply and demand in community college

4.4 Chi-Square Test of Teachers with Different Background Variables on Course Management

When we examine the course management in community college by applying Chi-square test, we find there is no significant difference between gender, constellation, and age. The significant differences are shown as follows:

(1) From demand point of view: On “students’ request” as the most touching course management, there are significant differences perceived by different blood types of teachers. Typically, teachers with O blood type thought that students’ request was the most touching course management (Fig. 2).

(2) From teaching point of view: The “teaching professional” is the most touching course management. There are significant differences between the teachers from different size of schools. Teachers who belong to the school size with 11–30 classes will perceive that teaching professional is the most touching course management. “Curriculum planning” is the most important course management; there are significant differences showed on various education levels in those teachers. Teachers with college degree may perceive that

Table 6 Chi-square test of teachers with different background variables on course management ($\alpha = .05$)

Variables	Education (high school, college, university, graduate)	Blood type (A, B, AB, O)	Course Category (Life skills, Academic community)	School size (10-, 11–30, 30+)	School location (town, country)
Students' request is touching		Reject $H_0 X^2 = 37.370$			
Teaching professional is touching				Reject $H_0 X^2 = 27.891$	
Curriculum planning is important	Reject $H_0 X^2 = 30.957$			Reject $H_0 X^2 = 22.801$	
Curriculum planning is difficult	Reject $H_0 X^2 = 43.683$		Reject $H_0 X^2 = 27.515$	Accept $H_0 X^2 = 18.858$	
Considerate service is important	Reject $H_0 X^2 = 40.566$				
Considerate service let student keep register			Accept $H_0 X^2 = 14.222$		Reject $H_0 X^2 = 10.093$
Interpersonal communication is time-consuming				Reject $H_0 X^2 = 23.164$	Accept $H_0 X^2 = 12.074$
Interpersonal communication is touching			Accept $H_0 X^2 = 23.317$	Reject $H_0 X^2 = 25.050$	
Interpersonal communication is let student keep attending the courses		Reject $H_0 X^2 = 28.448$			Accept $H_0 X^2 = 9.371$

curriculum planning is the most important strategy for course management. However, “curriculum planning” is also perceived as the most difficult course management issue in community college (Table 6).

(3) From interactive point of view: The “considerate service” is the most important strategy for course management. Teachers, with college degree, will tend to perceive that considerate service is the most important strategy for course management. Teachers in city-type community college thought that the considerate service could maintain the students select the courses stably. However, “interpersonal communication” is the most time-consuming course management strategy. The result reveals there are significant differences between the teachers who come from different sizes of community colleges. Teachers belonging to the school size with 11–30 classes thought that interpersonal communication was the most time-consuming course management strategy.“Interpersonal communication” also lets student keep register. The finding shows there are significant differences between teachers with different blood types. Teachers with O blood type thought that interpersonal communication could let students keep register.

5 Conclusions

This study establishes the fuzzy decision system for better course management in community college. We set up a rule-base of course supply and demand model for the community college. According to results of the study, the meaningful findings are listed as follows:

(1) Although the largest number of students elective life skill courses, the present condition of curriculum status is supply exceeded demand in life skill classes and demand exceeds supply in academic courses. Therefore, life skill classes should reduce the course, academic courses should be promoted to increase the courses to meet student request, and club classes are balanced in the state of supply and demand.
(2) Moreover, “students’ request” is the most important indicator for successful classroom management that the teachers gave the highest recognition. Teachers also believed that “teaching professional” was the secondary important indicator for enhancing the course attraction.
(3) Teachers of life skill classes are very good at using interactive model of course management, just like interpersonal communication and considerate service.
(4) Teachers of countryside-type schools thought that interpersonal communication was the most time-consuming, but it can help keep students to join the class stably.

In this study, the designed fuzzy decision system and the practical case study may provide an example for better managing course demand and supply in community college.

References

J. Brophy, Effective classroom management. School Adm. **40**(7), 33–36 (1983)

C.M. Evertson, in *Classroom Management in the Learning Centered Classroom*, ed. by A. Ornstein. Teaching: Theory and practice. (Allyn & Bacon, Boston, 1995)

A. Gupta, etc., *Parallel Algorithms and Architectures for Rule-Based Systems*. ACM SIGARCH Computer Architecture News - Special Issue: Proceedings of the 13th Annual International Symposium on Computer Architecture (ISCA '86), vol. **14**(2), pp. 28C37, 1986. Accessed from http://portal.acm.org/citation.cfm?id=17356.17360. Retrieved June 6, 2012

W.S. Huang, A few questions, a dream, National Association for the Promotion of Community Universities, (1999). NAPCU, Retrieved from http://apcu.taconet.com.tw/html/intro.htm. Retrieved April 29, 2010

A. Hoy, C. Weinstein, in *Student and Teacher Perspectives on Classroom Management*, ed. by C.M. Evertson, and C.S. Weinstein. A Handbook of Classroom Management: Research, Practice, and Contemporary Issues. (Lawrence Erlbaum Associates, Mahwah, 2006), pp. 181–219

J. Ireson-Paine, What is a rule-based system? (1996). Accessed from http://www.j-paine.org/students/lectures/lect3/node5.html. Retrieved June 6, 2012

M. S. Knowles, *The Modern Practice of Adult Education: From Pedagogy to Andragogy*, 2nd edn. (Cambridge Books, New York, 1980)

N. Martin, Z. Yin, H. Mayall, *Classroom management training, teaching experience and gender: Do these variables impact teachers' attitudes and beliefs toward classroom management style?* Paper presented at the annual conference of the Southwest Educational Research Association. (Austin, TX, 2006)

Modeling and Forecasting the Textile Price Index Using Nonparametric Path Design

Jinghui He and Bing Xu

Abstract Textile price index is a kind of index that measures the textile prices traded in China Textile City in total as the stock index in the stock market. The index forecasting is important for both trade parties. In this investigation, we collect various factors which perhaps influence the textile price index from the industrial economy point of view and that brought out of stock market. Then, the nonparametric path design is employed. Based on time path, factors which influence significantly to the textile market among the collected factors are extracted and identified by their bandwidths in nonparametric regression estimation. Finally we forecast the textile price index by the nonparametric path design. And a comparison with parametric regression is done. The result is that the former is more accurate.

Keywords Local-constant least-squares • Local-linear Least-squares • Least-square Cross-validation • Path design • Forecasting

1 Introduction

Forecasting is of great importance in many areas, especially in economy. Besides economy theories, statistical tools like multiple regression techniques and time-series analysis are the very well built methodologies used for forecasting the series.

J. He (✉)
Research Institute of Quantitative Economics, Zhejiang Gongshang University, Hangzhou, China

Mathematical Information College, Shaoxing College of Arts and Sciences, 312000, Shaoxing, Zhejing, China
e-mail: hejh53@163.com

B. Xu
Research Institute of Quantitative Economics, Zhejiang Gongshang University, Hangzhou, China
e-mail: bingxu0@yahoo.com.cn

J. Watada et al. (eds.), *Innovative Management in Information and Production*, DOI 10.1007/978-1-4614-4857-0_27,

Ang et al. (2007), Atkeson and Ohanian (2001), Stock and Watson (1999), and Stock and Watson (2008) forecast inflation extensions of the Phillips curve. The general framework involves a dependent variable such as inflation (or the change in inflation) and explanatory variables, including lags of inflation, the unemployment rate, and other predictors (Koop and Korobilis 2012). Lee (2012) evaluates three alternative inflation forecasting models—univariate time-series (ARIMA) model, Phillips curve model, and naive model—and finds that these models generate more accurate forecasts of inflation rate for the period following the adoption inflation targeting policy.

Besides classical statistical methods, techniques used in engineering areas before and new proposed data mining techniques, such as neural network and support vector machine, are introduced in economy. Shin et al. (2009) predicted the movement of the Korean stock market using back-propagation neural network (BPN) and support vector machine (SVM). Huang and Wu (2008) propose a hybrid model that combines wavelet-based feature extractions with the relevance vector machine (RVM) models to forecast stock indices. Vaisla and Bhatt (2010) employ neural networks and statistical techniques to model and forecast the daily stock market prices and compare the two results of the two models by MAPE, MSE, and RMSE. Roodposhti et al. (2011) use the logit model, artificial neural network, and multiple discriminant analysis to forecast price manipulation of stocks of companies present in Tehran stock exchange.

Textile price index includes raw materials index, grey cloth index, apparel fabric index, home textile index, and fashion accessories index. There are many political, economical, and even climatic factors that may affect textile price index's trend and volatility directly or indirectly, but not all of them are statistically associated with the index's change. We try to select relevant ones as well as identify the mechanism how the factors work, linearly or nonlinearly, by nonparametric approaches that are introduced by Hall et al. (2007).

It is necessary to delete irrelevant variables for two reasons. First, any nonparametric method is affected by the so-called curse of dimensionality, caused by the sparsity of data in high-dimensional spaces, resulting in a decrease in fastest achievable rates of convergence of regression function estimators toward their target curve as the dimension of the regressor vector increases. Second, our final target is to forecast the textile price index with the selected model; less regressors will make the forecasting more efficient.

2 Proxy Variables and Methodology

Textile prices are influenced by many factors. From the point of view of the industrial economy, the factors include demand, cost, and technological innovation. The economic boom consistent index is used to stand for the demand for textile, cotton price, crude oil price and labor cost stand for the cost of textile industry, and labor productivity or investment in research and development for technological innovation. Moreover, as a part of the economy, textile industry is influenced by the macroeconomic environment inevitably. Similar to stock market, four aspects are considered to work in textile market; these are supply of money, inflation, interest rates, loan of financial enterprise, level of exchange rate, and so on. And the availability of observations must be under consideration. Finally, fourteen variables are chosen as initial ones to be determined whether relevant or irrelevant and linear or nonlinear. The variables are possible paths for the index to change along. Above all, time is the basic path. The proxies and notation are as listed below:

y Textile prices monthly average index
t Time
z_1 The economic boom consistent index (1996 = 100)
z_2 The monthly average crude oil price (dollars per barrel)
z_3 Cotton index A (cents per kg)
z_4 Supply of money (M1)
z_5 Consumer price index (a year earlier = 100)
z_6 Retail price index (a year earlier = 100)
z_7 Producer price index (a year earlier = 100)
z_8 Benchmark one-year deposit rate (annual percentage rate) %
z_9 Enterprise deposits in financial institutions (one hundred million yuan RMB)
z_{10} Saving deposits in financial institutions (one hundred million yuan RMB)
z_{11} Short-term loan from financial institutions (one hundred million yuan RMB)
z_{12} Medium- and long-term loans from financial institutions (one hundred million yuan RMB)
z_{13} Level of exchange rate, RMB/US\$100(yuan)
z_{14} Ending state foreign exchange reserves (one hundred million US dollars)

The independent variable is textile price index, which is a time series. The dependent variables are macroeconomic variables as cross-sectional data as well as lagged dependent variables. Putting lagged independent variables as linear variables in the model is an extension to classical semiparametric model in this paper. That is,

$$Y_i = a(t_i)Y_{i-1} + b(t_i)Y_{i-1} + g(Z_i) + \varepsilon_i, \tag{1}$$

where

$$g(Z_i) = \sum_{j=1}^{n} w_j(Z_i)\big(Y_j - a(t_j)Y_{j-1} - b(t_j)Y_{j-2}\big) \tag{2}$$

$\sum_{j=1}^{n} w_j(Z_i) = 1, w_j(Z_i) \geq 0, j = 1,2,\ldots,n, Y$ is the textile price index, and Z is a fourteen-dimensional vector standing for several macroeconomic factors called control variables. Y_i and Z_i are the ith observation. $g(.)$ is unknown and may be unknown forever so that it will be estimated by nonparametric regression. $a(t_i)$ and $b(t_i)$ are unknown functions. According to Taylor's theorem, they can be approximated by linear functions such that Fan and Huang (2005)

$$a(t_i) = a_1 + a_2(t_i - t_0),\ b(t_i) = b_1 + b_2(t_i - t_0) \tag{3}$$

put (2), (3) into (1), and let $Y_i^* = Y_i - \sum_{j=1}^n w_j(Z_i)Y_i$, $A_{1i} = \sum_{j=1}^n w_j(Z_i)Y_{i-1}$, $B_{1i} = \sum_{j=1}^n w_j(Z_i)Y_{i-2}$, $A_{2i} = \sum_{j=1}^n w_j(Z_i)(t_j - t_0)Y_{i-1}$, $B_{2i} = \sum_{j=1}^n w_j(Z_i)(t_j - t_0)Y_{i-2}$, then (1) can be rewritten as $Y_i^* = a_1(Y_{i-1} - A_{1i}) + a_2\big((t_i - t_0)Y_{i-1} - A_{2i}\big) + b_1(Y_{i-2} - B_{1i}) + b_2\big((t_i - t_0)Y_{i-2} - B_{2i}\big) + \varepsilon_i$.

We can estimate a_1, a_2, b_1, b_2 by minimizing the following:

$$\min_{a_1,a_2,b_1,b_2} \sum_{i=1}^n \left(\begin{array}{c} Y_i^* - a_1(Y_{i-1} - A_{1i}) - a_2((t_i - t_0)Y_{i-1} - A_{2i}) \\ - b_1(Y_{i-2} - B_{1i}) - b_2((t_i - t_0)Y_{i-2} - B_{2i}) \end{array} \right)^2 w_{h_n}(Z_i).$$

For simplicity, we place

$$X(t_0) = \begin{pmatrix} Y_2 - A_{12} & (t_2 - t_0)Y_2 - A_{22} & Y_1 - A_{21} & (t_1 - t_0)Y_1 - A_{21} \\ Y_3 - A_{13} & (t_3 - t_0)Y_3 - A_{23} & Y_2 - A_{22} & (t_2 - t_0)Y_2 - A_{22} \\ \vdots & \vdots & \vdots & \vdots \\ Y_n - A_{1n} & (t_n - t_0)Y_n - A_{n2} & Y_{n-1} - A_{2,n-1} & (t_{n-1} - t_0)Y_{n-1} - A_{2,n-1} \end{pmatrix}.$$

$W = \mathrm{diag}\{w_{hn}(Z_3), w_{hn}(Z_4), \ldots, w_{hn}(Z_n)\}, Y = (Y_3^*, Y_4^*, \ldots, Y_n^*)^T$. Then the solution is$(\hat{a}_1, \hat{a}_2, \hat{b}_1, \hat{b}_2) = \big(X(t_0)^T W X(t_0)\big)^{-1} X(t_0)^T W Y$.

But the bandwidth for every control variable is still unknown, so we use $h_j = 1.06\sigma_j n^{-1/(2l+p)}$ to calculate the jth bandwidth, in which σ_j is the jth variable's sample standard deviation (STDEV), l is the kernel function's order, p is the number of the control variables, and n is the sample size. $(a_1, a_2, b_1, b_2)^T$ is estimated first; its estimation is $(\hat{a}_1, \hat{a}_2, \hat{b}_1, \hat{b}_2)^T$. With the purpose for $g(.)$ we plug $(\hat{a}_1, \hat{a}_2, \hat{b}_1, \hat{b}_2)^T$ in (1), such that

$$\hat{y}_i = \hat{a}(t_i)y_{i-1} + \hat{b}(t_i)y_{i-2} + g(z_i). \tag{4}$$

Let $\hat{y}_i^* = \hat{y}_i - \hat{a}(t_i)y_{i-1} - \hat{b}(t_i)y_{i-2}$, and then (4) becomes

$$\hat{y}_i^* = g(z_i). \tag{5}$$

(5) can be estimated by local-constant least-square (LCLS) and the control variables' bandwidths are specified by least-square cross-validation (LSCV) method. As a result we get the bandwidths of Z in (1).

We use Theorem 2.1 in Hall et al. (2007) for nonparametric regression to select control variables relevant to the textile price index, and delete irrelevant ones simultaneously if the relative bandwidths are large enough, for example, larger than two times the STDEV. After that, (1) is reestimated, then (4) and (5) are got. After the irrelevant control variables are smoothed from (5), it is

$$\hat{y}_i^{**} = g(z_i^{'}), \tag{6}$$

we estimate (6) again using local-linear least-square (LLLS) and the bandwidths are specified by LSCV. If certain control variable's bandwidth is large enough, the relative variable is thought that its influence to the textile price index is linear.

3 The Empirical Results of Variable Selection and Identification

The sample period is from January 2008 to January 2012, such that the number of observations is 49. The textile price index data is downloaded from the website of Textile Index China Keqiao, the supply of money and benchmark one-year deposit rate are from People's Bank of China, and the others are from DRCNet Statistical Database System. A few of missing data are supplemented by cubic spline interpolation function method. Our bandwidths of every control variables for the sample are presented in Table 1. We note that the economic boom consistent index, cotton index A, supply of money, enterprise deposits in financial institutions, saving deposits in financial institutions, short-term loan from financial institutions, medium- and long-term loans from financial institutions, level of exchange rate, and ending state foreign exchange reserves are smoothed out because their bandwidths are large enough compared with two times the STDEV, respectively. The other variables are thus considered to be relevant in terms of the estimation of the textile price index.

Table 2 gives the bandwidths from the LLLS estimation. Here, we can determine that two variables, consumer price index and producer price index, are linear variables in the model, because they have bandwidths that are more than twice the size of their STDEV, respectively.

In this section, the empirical result is that there are five control variables relevant to textile price index, two out of the five are linear, and the others are non-linear.

Table 1 Bandwidths using local-constant least-square estimation

Varible	Bandwidth	Twice the STDEV
The economic boom consistent index	6.51e+6	5.98
The monthly average crude oil price	5.84	45.89
Cotton index A	3.69e+7	191.85
Supply of money	4.47e+9	94572.97
Consumer price index	2.10	5.83
Retail price index	0.61	5.97
Producer price index	1.92	10.98
Benchmark one-year deposit rate	0.30	1.36
Enterprise deposits in financial institutions	2.83e+11	187519.10
Saving deposits in financial institutions	3.75e+10	112811.08
Short-term loan from financial institutions	2.91e+11	100668.95
Medium- and long-term loans from financial institutions	3.22e+9	135880.06
Level of exchange rate	3.95e+6	44.80
Ending state foreign exchange reserves	1.65e+9	11036.01

Table 2 Bandwidths using local-linear least-square estimation

Varible	Bandwidth	Twice the STDEV
The monthly average crude oil price	5.84	45.89
Consumer price index	2.10	5.83
Retail price index	0.61	5.97
Producer price index	1.92	10.98
Benchmark one-year deposit rate	0.30	1.36

4 Further Empirical Results

In Sect. 3, the coefficients in model (1), $a(t_i)$, and$b(t_i)$ are time-varying; they are functions on t, but their analytic expressions are unknown, so that they have been approximated by linear functions, as shown in (3). In order for convenience in empirical study, t_0 is constant. In the previous section, t_0 is the median of the sample period. The problem is that the more the point is far away from t_0, the greater the error. As a mend, we let t_0 change with the time of sample point, such that the one-degree term in (3) is always zero and constant and a_1 and b_1 are different along with t_0. According to the results in Sect. 3, there are four linear variables—two lagged dependent variables, consumer price index, and producer price index—and four control variables: time, the monthly average crude oil price, retail price index, and benchmark one-year deposit rate, that is, time path and additional variable path.

To compare the nonparametric path design method with parametric one, we employ them to forecast the textile price index in June and July 2012 with the observations from January 2008 to May 2012. The textile price is the independent variable; two of its lagged variables and the initial 14 variables are the regressors. Adjusted R-squared = 0.97. The Pearson correlation coefficients between one-, two-, and three-lagged-independent terms and the residual series of the regression equation are 0.029, 0.074, and −0.010, respectively. It means that the random disturbance has no relation to the random independent variables, and the estimators of the coefficients are unbiased and consistent. We use the equation to forecast the index in June and July 2012. The result is shown in Table 3. Then we forecast the index in June and July 2012 by the nonparametric path design model. With the estimation of the coefficients of May 2012 to estimate those in August 2012 and 53, the estimation is (7).

$$\begin{aligned} \hat{y}_t &= 0.646048 y_{t-1} - 0.931149 y_{t-2} + 0.955555 z_{t5} + 0.179460 z_{t7} + g(Z_t, T) \quad (7) \\ Z_t &= (z_{t2}, z_{t6}, z_{t8})^T, t, T = 1, 2, \ldots, 53. \end{aligned}$$

The two forecasting results are presented in Table 3. We can find that nonparametric path design model's forecasting is more accurate than that of the parametric model.

Table 3 The forecasting with two models

Date	The real values	Forecasting with parametric model	Forecasting with path design
June 2012	105.075	103.8326	105.2272
July 2012	104.83	102.9030	104.6778

Table 4 The forecasting with nonparametric path design model

Situation	The monthly average crude oil price	Consumer price index	Retail price index	Producer price index	Benchmark one-year deposit rate	The textile price index
1	100.00	102.00	100.00	97.00	3.00	104.6017
2	100.00	103.00	100.00	97.00	3.00	105.0583
3	100.00	102.00	100.00	97.00	2.75	104.6017
4	100.00	103.00	100.00	97.00	2.75	105.0583

In order to forecast the index in August 2012, we use the observations from January 2008 to July 2012 to estimate the constants in July 2012, meaning t_0 is July 2012. (8) is the equation.

$$\begin{aligned} \hat{y}_t &= 0.751864y_{t-1} - 0.410953y_{t-2} + 0.449259z_{t5} + 0.018674z_{t7} + g(Z_t, T) \quad (8) \\ Z_t &= (z_{t2}, z_{t6}, z_{t8})^T, t, T = 1, 2, \ldots, 55. \end{aligned}$$

In July 2012, the five parts on the right side of (8) are 79.00210, −43.41619, 45.72563, 1.81382, and 24.75634, respectively, which means the linear part is more weighty than the nonlinear part. In light of the previous result, we do a situation simulation as a forecasting to the index value in August 2012 presented in Table 4. We use the estimation of the coefficients of July 2012 to estimate those in August 2012.

5 Conclusion

The principal goal of this research is to offer model to forecast the textile price index in China's textile market. Therefore, monthly average crude oil price, consumer price index, retail price index, producer price index, and benchmark one-year deposit rate are introduced as relevant factors with textile price index by nonparametric path design, and it is identified that consumer price index and producer price index influence the dependent in linear pattern still by nonparametric approach. Because of the lagged effect of the textile price index, the lagged is employed as linear independent variables. Therefore, we construct a path design model with four linear independent variables and four control variable, namely, nonlinear independent variables. Empirical tests show that the nonparametric path design model is much better than parametric model not only in statistical accuracy but also in the ability of forecasting in short term. At last, a situation simulation is put forward according to the structure of the model as an application.

References

A. Ang, G. Bekaert, M. Wei, Do macro variables, asset markets, or surveys forecast inflation better? J. Monet. Econ. **54**, 1163–1212 (2007)

A. Atkeson, L. Ohanian, Are phillips curves useful for forecasting inflation? Federal Reserve Bank Minneapolis Q. Rev. **25**, 2–11 (2001)

J.Q. Fan, T. Huang, Profile likelihood inferences on semiparametric varying-coefficient partially linear models. Bernoulli **11**, 1031–1057 (2005)

S.C. Huang, T.K. Wu, Combining wavelet-based feature extractions with relevance vector machines for stock index forecasting. Expert Syst. **25**, 133–149 (2008)

P. Hall, Q. Li, J. Racine, Nonparametric estimation of regression functions in the presence of irrelevant regressors. Rev. Econ. Stat. **89**, 784–789 (2007)

G. Koop, D. Korobilis, Forecasting inflation using dynamic model averaging. Int. Econ. Rev. **53**, 867–886 (2012)

U. Lee, Forecasting inflation for inflation-targeted countries: A comparison of the predictive performance of alternative inflation forecasting models. J. Bus. Econ. Stud. **18**, 75–95 (2012)

F.R. Roodposhti, M.F. Shams, H. Kordlouie, Forecasting stock price manipulation in capital market. World Acad. Sci. Eng. Technol. **80**, 151–162 (2011)

Y.G. Shin, S.S. Park, D.S. Jang, A comparison of forecasting the index of the korean stock market. Comput. Methods Sci. Eng. Adv. Comput. Sci. **2**, 225–228 (2009)

J. Stock, M. Watson, Forecasting inflation. J. Monetary Econ. **44**, 293–335 (1999)

J. Stock, M. Watson, Phillips Curve Inflation Forecasts. NBER Working Paper No. 14322 (2008)

K.S. Vaisla, A.K. Bhatt, An analysis of the performance of artificial neural network technique for stock market forecasting. Int. J. Comput. Sci. Eng. **2**, 2104–2109 (2010)

On Effectiveness Assessment of Promoting the Digital Learning Policy

Shih-Wen Wang, Chun-Ti Su, and Yen-Nan Lu

Abstract In this study, for the performance assessment program of Taiwan policy to promote subsidies of computer and information education to disadvantaged students, the fuzzy questionnaire survey was adopted for empirical research, and 15 computer recipient students were selected in purposive sampling. According to the 4 expected targets of the project, construct the questionnaire and adopt the Likert 5-point scale for obtaining discrete fuzzy data. The respondents' perception of the plan's expected benefits were "satisfaction," "progressive," and "very helpful" toward the three projects, "own computer and Internet equipment," "enhance information literacy," and "improve learning quality." The exception was "learn free software applications." Prefer not to use accounted for the majority of recipients, and the difference in views was quite high.

Keywords Effectiveness assessment • Digital learning • Fuzzy theory

1 Introduction

Taiwan from 2007 to 2011 promoted the Computer and Information Education Subsidy policy and subsidized the installation of computers and network equipment for the vulnerable children of about 12,500 households to enjoy the information technology environment, create a fair digital opportunity, and enhance students'

S.-W. Wang (✉) • C.-T. Su
Department of Education Policy and Administration, National Chi Nan University No.1, Daxue Rd., Puli Township, Nantou County 545, Taiwan (R.O.C.)
e-mail: Wang621029@gmail.com; voodoobiker@gmail.com

Y.-N. Lu
Education Affairs Department, Miaoli County government, No.100, Sianfu Rd., Miaoli City, Miaoli County 360, Taiwan (R.O.C.)
e-mail: h21313@webmail.mlc.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_28,

information literacy, thereby shortening the digital divide and implementing the idea of equality of educational opportunity to turn the digital divide into the digital opportunity.

UNESCO believes that the management and control of the educational quality need to be strengthened (UNESCO 2006). Educational measures, such as educational hardware and software updates to enhance the quality and quantity of education, require special supervision and evaluation mechanisms to promote the education policy and the implementation's effectiveness and quality. A professional assessment mechanism was established to review the effectiveness of quality, and mechanisms to assess quality were established by the organizational self-assessment (Lycke 2004). Odden and Busch (1998) found from the study of the subsidy program that the main reasons subsidy programs cannot effectively achieve the objectives is that those in power do not understand the effective practice. As for how to evaluate the effective practice, Freeman and Marian (1981) Freeman and Soloman (1981) mentioned that the assessment studies should emphasize the relevance and feasibility of project and increase the possibility of improving the status quo of the program.

Macrae (1985) explains that the policy assessment process requires the indicator survey system to be built. For the purpose of this study, semantic variables of fuzzy theory and fuzzy computing were used to understand the degree of feelings of the subsidy-granted students toward the computer education policy. This study adopted 15 purposive sampling students according to the 4 expected targets of the project, "own computer and network, information literacy, learning quality, and applications of free software," and constructed the questionnaire Q&A mode to gather the relevant statistics data for building the integrity of the policy investigation and assessment systems to continue the policy performance of subsidies for disadvantaged students.

2 Overview of Fuzzy Theory

Human thinking can be divided into logical and sequential formal thinking and the overall and integrated fuzzy thinking. Fuzzy thinking is more suitable for assessment of multiple or relevant characteristics between objects, especially the attribute issues that are not easy to express perfectly by thinking and cognition. For example, the knowledge and language of humans contain ambiguity because of their subjective consciousness, time, environment, and different angles of judging things (Wu and Hsieh 2012).

Social science aims to study the internal motivation or feeling of human behaviors; traditional quantifiable statistics almost require the subject to express a single motivation or feeling and attempt to apply definitive quantified statistics to display abnormal behaviors of human beings and analyze psychological measurements from a probability perspective, mathematical pattern actually simplified complex issue, nevertheless the complicated subjective point of view and thinking were usually overlook (Wu 2005; Nguyen and Wu 2006). Simplified dichotomy method is really unable to accurately describe the multiple nature of human behavior; therefore, we consider using fuzzy classification in table analysis to resolve the problem of excessive simplification. Concepts such as fuzzy average, fuzzy median, and fuzzy mode in basic descriptive statistics are incorporated to present the research findings of human behavioral statistics (Wu 2000).

Membership grade function is the most basic concept in fuzzy theory; it is derived from the characteristic function of traditional set and it is used for expressing an elements membership grade in a fuzzy set; its range is between 0 and 1. It is not only able to describe the characteristics of fuzzy set; it is also able to quantify fuzzy set while using accurate mathematic method to analyze and process information of fuzzy nature. Membership grade function could be classified as discretization and continuous. Discretization-type membership grade function directly assigns membership grade to each element in a limited fuzzy set and presents the result in a vector format. Continuous-type membership grade function could use several frequently used functions to describe a fuzzy set.

3 Research Methods

3.1 Research Design and Implementation

To promote the subsidies to disadvantaged students' computer policy, Taiwan sets its four targets: to own a computer and network, enhance information literacy, improve the learning quality, and learn free software applications. This study modified these four targets to phrases expressed as performance assessment indication, in order to understand whether or not the subsidized can feel the tangible benefits of access to computer, and adopted the Likert 5-point scale for obtaining discrete fuzzy data. The indicator structure is as shown in Fig. 1.

According to the effectiveness of policy assessment indication, the Q and A part of the constructed questionnaire referred to Wang et al. (2010) research to gather relevant statistics data for the amendments of integrity of the policy investigation assessment system.

3.2 Fuzzy Statistical Analysis

Definition 3.1. Fuzzy Sample Mean (Data with Multiple Values) Let U be the universal set (a discussion domain), $L = L_1, L_2, \ldots, L_k$ be a set of k-linguistic variables on U, and $Fx_i = m_{i1}/L_1 + m_{i2}/L_2 + \ldots + m_{ik}/L_k, i = 1, 2, \ldots, n$ be a

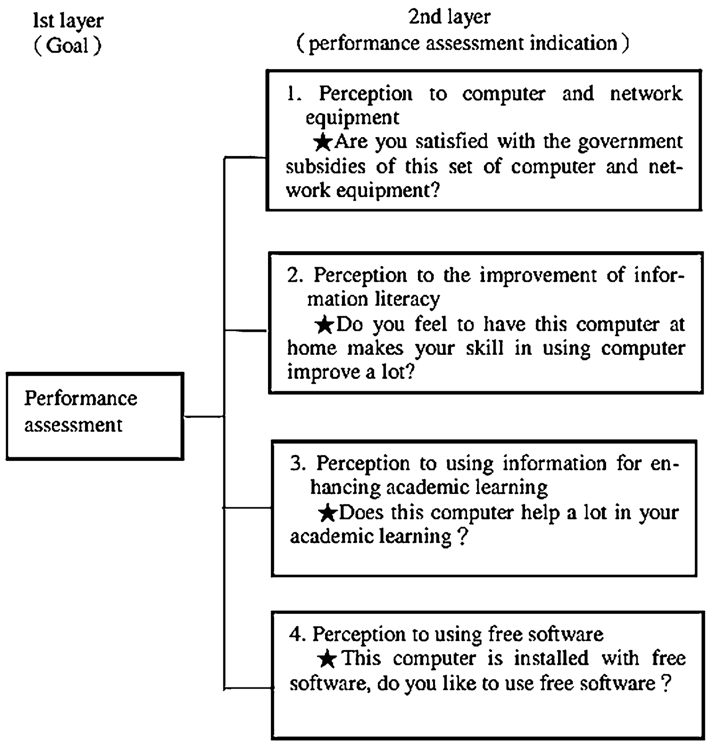


Fig. 1 Assessment indicator structure

Table 1 Response for the seven sample

	Very low = 1	Low = 2	Medium = 3	High = 4	Very high = 5
F_1	0.7	0.3	0	0	0
F_2	0	0.9	0.1	0	0
F_3	0	0	0.7	0.3	0
F_4	0	0	0	0.3	0.7
F_5	0	0	0	0.9	0.1
F_6	0	0	0.4	0.6	0
F_7	0	0	0	0.2	0.8

sequence of random fuzzy sample on U, is the memberships with respect to L_j. Then, the fuzzy sample mean is defined as (Table 1)

$$F\bar{x} = \frac{1/n\sum_{i=1}^{n} m_{i1}}{L_1} + \frac{1/n\sum_{i=1}^{n} m_{i2}}{L_2} + \ldots + \frac{1/n\sum_{i=1}^{n} m_{ik}}{L_k}$$

Example 3.1. The fuzzy value of x_1 is $F_1 = (0.7, 0.3, 0, 0, 0)$. Similarly, we get the other fuzzy samples as follows:

Table 2 Fuzzy opinions of the respondents

Your satisfaction with the ruling party's 2005 policy	1 = Very dissatisfied	2 = Dissatisfied	3 = Common	4 = Satisfied	5 = Very satisfied
x_1	0	0	0	0	1
x_2	1	0	0	0	0
x_3	0	0	1	0	0
x_4	0	0.5	0	0.5	0
x_5	0	0	0.5	0	0.5
x_6	0	0	0.8	0	0.2

Table 3 Fuzzy respondents views distances

	x_1	x_2	x_3	x_4	x_5	x_6
x_1	0	1.00	0.50	0.44	0.19	0.36
x_2		0	0.50	0.56	0.81	0.64
x_3			0	0.06	0.31	0.14
x_4				0	0.25	0.08
x_5					0	0.17
x_6						0

Definition 3.2. The distance between two discrete fuzzy samples. Set U as a domain, $L = L_1 = 1, L_2 = 2, \ldots, L_k = k$ as a set of k-linguistic ordered variables distributed in the domain. If $x_i = m_{i1}/L_1 + m_{i2}/L_2 + \ldots + m_{ik}/L_k, i = 1, 2, \ldots, n$ and $\sum_{j=1}^{k} m_{ij} = 1$ are the two fuzzy samples drawn from the domain, the denominator k is the range of the ordered linguistic variables. Then the distance between two discrete fuzzy samples is defined as

$$dfi = c_i + \frac{\sum_{j=1}^{k} m_{ij}|L_j - c_j|}{k-1}, c_i = \sum_{j=1}^{k} m_{ij} L_j$$

$$d(df_1, df_2) = \frac{1}{k-1}|c_i + \frac{\sum_{j=1}^{k} m_{ij}|L_j - c_j|}{k-1} - c_i + \frac{\sum_{j=1}^{k} m_{ij}|L_j - c_j|}{k-1}|$$

From the definition, the maximum distance d is 1, and the minimum is 0. The smaller the d value is, the more approximate the two fuzzy samples; the higher the d value is, the less approximate the two fuzzy samples.

Example 3.2. The fuzzy magnitude of the relative distance can be seen from each sample's differences in the preferences of different linguistic variables, as shown in Tables 2 and 3.

4 Empirical Studies and Findings

The analysis of the descriptive statistics and sample structure of the students' conditions of Internet usage is as shown in Table 4.

Table 4 Descriptive statistics of samples

Students' background		Frequency	Percentage
Gender	Girl	8	53.00
	Boy	7	47.00
Grade of students	Seventh grade	6	40.00
	Eighth grade	6	40.00
	Ninth grade	3	20.00

Table 5 The perceptions of computer and internet equipment

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0	0.08	0.09	0.13	0.17	0.16	0.21	0.07	0.00	0.07	0.19	0.32	0.17	0.20	0.18
X2		0	0.18	0.05	0.25	0.07	0.30	0.02	0.08	0.15	0.27	0.23	0.25	0.29	0.27
X3			0	0.22	0.07	0.25	0.12	0.16	0.09	0.03	0.09	0.41	0.07	0.11	0.09
X4				0	0.30	0.03	0.34	0.06	0.13	0.20	0.32	0.19	0.30	0.33	0.31
X5					0	0.32	0.05	0.23	0.17	0.10	0.02	0.48	0.00	0.04	0.02
X6						0	0.37	0.09	0.16	0.22	0.34	0.16	0.32	0.36	0.34
X7							0	0.28	0.21	0.15	0.03	0.53	0.05	0.01	0.03
X8								0	0.07	0.13	0.25	0.25	0.23	0.27	0.25
X9									0	0.07	0.19	0.32	0.17	0.20	0.18
X10										0	0.12	0.38	0.10	0.14	0.12
X11											0	0.50	0.02	0.01	0.00
X12												0	0.48	0.52	0.50
X13													0	0.04	0.02
X14														0	0.02
X15															0

The views of X7 and X12 are least approximate, and d value is 0.53

4.1 The Perceptions of Computer and Internet Equipment (Questionnaire: Are You Satisfied with the Government for Subsidizing This Set of Computer and Network Equipment?)

We can calculate the relative distance between each sample, as shown in Table 5:

4.2 Perception to the Improvement of Information Literacy (Questionnaire: Do You Feel to Have this Computer at Home Makes Your Skill in Using Computer Improve a Lot?)

We can calculate the relative distance between each sample, as shown in Table 6:

Table 6 Perception to the improvement of information literacy

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0	0.22	0.36	0.25	0.28	0.09	0.37	0.22	0.31	0.25	0.02	0.31	0.36	0.36	0.34
X2		0	0.58	0.47	0.06	0.31	0.59	0.45	0.53	0.03	0.25	0.09	0.58	0.58	0.56
X3			0	0.11	0.64	0.27	0.01	0.14	0.05	0.61	0.33	0.67	0.00	0.00	0.02
X4				0	0.53	0.16	0.12	0.03	0.06	0.50	0.23	0.56	0.11	0.11	0.09
X5					0	0.37	0.65	0.50	0.59	0.03	0.30	0.03	0.64	0.64	0.62
X6						0	0.28	0.13	0.22	0.34	0.07	0.40	0.27	0.27	0.25
X7							0	0.15	0.06	0.62	0.35	0.68	0.01	0.01	0.03
X8								0	0.09	0.47	0.20	0.53	0.14	0.14	0.12
X9									0	0.56	0.29	0.62	0.05	0.05	0.03
X10										0	0.27	0.06	0.61	0.61	0.59
X11											0	0.33	0.33	0.33	0.32
X12												0	0.67	0.67	0.65
X13													0	0.00	0.02
X14														0	0.02
X15															0

The views of X7 and X12 are least approximate, and *d* value is 0.68

Table 7 Perception to using information for enhancing academic learning

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0	0.50	0.12	0.23	0.02	0.03	0.30	0.00	0.18	0.30	0.02	0.52	0.02	0.15	0.03
X2		0	0.62	0.27	0.52	0.54	0.80	0.50	0.68	0.21	0.48	0.02	0.52	0.65	0.54
X3			0	0.35	0.10	0.08	0.18	0.12	0.06	0.41	0.14	0.64	0.10	0.03	0.08
X4				0	0.25	0.27	0.53	0.23	0.41	0.06	0.21	0.29	0.25	0.38	0.27
X5					0	0.02	0.28	0.02	0.16	0.31	0.04	0.54	0.00	0.13	0.02
X6						0	0.26	0.03	0.14	0.33	0.06	0.56	0.02	0.12	0.00
X7							0	0.30	0.12	0.59	0.32	0.82	0.28	0.15	0.26
X8								0	0.18	0.30	0.02	0.52	0.02	0.15	0.03
X9									0	0.47	0.20	0.70	0.16	0.03	0.14
X10										0	0.27	0.23	0.31	0.45	0.33
X11											0	0.50	0.04	0.17	0.06
X12												0	0.54	0.67	0.56
X13													0	0.13	0.02
X14														0	0.12
X15															0

The views of X7 and X12 are least approximate, and *d* value is 0.82

4.3 Perception to Using Information for Enhancing Academic Learning (Questionnaire: Does This Computer Help a Lot in Your Academic Learning?)

We can calculate the relative distance between each sample, as shown in Table 7:

Table 8 Perception to using free software

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0	0.22	0.09	0.12	0.06	0.22	0.07	0.65	0.19	0.03	0.14	0.28	0.09	0.28	0.67
X2		0	0.31	0.10	0.28	0.00	0.15	0.87	0.03	0.19	0.08	0.07	0.31	0.50	0.89
X3			0	0.21	0.03	0.31	0.16	0.56	0.28	0.12	0.23	0.37	0.00	0.20	0.58
X4				0	0.18	0.10	0.05	0.77	0.07	0.09	0.02	0.17	0.21	0.40	0.79
X5					0	0.28	0.13	0.59	0.25	0.09	0.20	0.34	0.03	0.22	0.61
X6						0	0.15	0.87	0.03	0.19	0.08	0.07	0.31	0.50	0.89
X7							0	0.72	0.12	0.04	0.07	0.21	0.16	0.35	0.74
X8								0	0.84	0.68	0.79	0.93	0.56	0.37	0.02
X9									0	0.16	0.05	0.09	0.28	0.47	0.86
X10										0	0.11	0.25	0.12	0.32	0.70
X11											0	0.14	0.23	0.42	0.81
X12												0	0.37	0.57	0.95
X13													0	0.20	0.58
X14														0	0.39
X15															0

The views of X7 and X15 are least approximate, and *d* value is 0.95

4.4 Perception to Using Free Software (Questionnaire: This Computer Is Installed with Free Software; Do You Like to Use Free Software?)

We can calculate the relative distance between each sample, as shown in Table 8:

5 Conclusion

This study finds “Prefer not to use” as their perception of the using free software, and the fuzzy membership degree of sample mean was 0.45, the least approximate, and d value is 0.95. The respondents’ perception of the plan’s expected benefits were “satisfaction,” “progressive,” and “very helpful” toward the three projects, “own computer and Internet equipment,” “enhance information literacy,” and “improve learning quality.” The exception was “learn free software applications,” for which “Prefer not to use” accounted for the majority of recipients, and the difference in views was quite high. This study inferred that the recipients majored in Microsoft Office software when learning computer at school. For the recipient, the installation of the free software is inconvenient for use, thus the low acceptance of the free software, which is what the policy plan needs to promote and to overcome.

References

H.E. Freeman A.S. Marian, Evaluating and the uncertain ’80s. Eval. Studies Rev. **6**, 1–23 (1981)

K. H. Lycke, Perspective on quality assurance in higher education in Norway. Qual. High. Educ. **10**(3), 220–229 (2004)

D. J. Macrae, *Policy Indicators: Links Between Social Science and Public Debate* (University of North Carolina Press, Chapel Hill, 1985)

H.T. Nguyen, B. Wu, *Fundamentals of Statistics with Fuzzy Data* (Springer, New York, 2006)

A. Odden, C. Busch, *Financing Schools for High Performance* (Jossey-Bass, San Francisco, 1998)

UNESCO, *Global Monitoring Report Summary*. (UNESCO, Paris, 2006)

B. Wu, *Modern Statistics* (Chien Chen, Taipei, 2000)

B. Wu, *An Introduction to Fuzzy Statistics* (Wu Nan, Taipei, 2005)

B. Wu, M.C. Hsieh, *Practice of Market Survey-Questionnaire Design and Analysis of the Research* (Shin Lou, Taipei, 2012)

S.-W. Wang, D.-f.Chang, B. Wu, Does the digital natives technologies really help? A fuzzy statistical analysis and evaluation with students’ learning achievement. Int. J. Innov. Manag. Inform. Prod. **1**(1), 18–30 (2010)

The Application and Test on Distance Decay Theory of Tourism

Wei Li

Abstract This study attempts to examine the business overnight visitors' profile, trip patterns, and tourism demand in Hong Kong with the distance decay theory. This study examines the impact of the distance decay effect on Hong Kong business overnight visitors from thirteen major source markets empirically. Another contribution of this study is that it identifies the distance decay curve with two peaks in the Hong Kong case. The research findings still confirm that distance decay effect may have influence on some aspects of business visitors' profiles.

Keywords Distance decay theory • Tourism • Business visitors' profiles

1 Introduction

Distance decay theory suggests that demand declines when the distance from the source market increases. Distance decay has been employed for the behavior examination in a wide range, such as crime (Rengert et al. 1999), commuting (Drezner and Drezner 1996), and recreation research (Greer and Wall 1979; Zhang et al. 1999). However, the empirical studies on complete distance decay in the context of tourism are relatively rare. This empirical study attempts to apply distance decay theory in the context of tourism. Firstly the study will focus on analysis of the profiles and trip patterns of the business overnight visitors of Hong Kong from seven short-haul source markets, including the Philippines, Thailand, South Korea, Malaysia, Singapore, Japan, and Indonesia, and six long-haul source markets,

W. Li (✉)
Department of Statistics and Mathematics, Zhejiang Gongshang University, Hangzhou, Zhejiang, 310018, China
e-mail: Liwei0220@gmail.com

Department of Mathematics and Statistics, Zhejiang University of Finance and Economics, Hangzhou, Zhejiang, 310018, China

J. Watada et al. (eds.), *Innovative Management in Information and Production*, 271
DOI 10.1007/978-1-4614-4857-0_29, © Springer Science+Business Media New York 2014

including Australia, Germany, the UK, France, the USA, and Canada. Meanwhile, the distance decay effect will be examined with regard to the visitors' profiles and trip patterns from these thirteen source markets.

2 Empirical Study

This study employs the data from the Visitor Profile Report published by the Hong Kong Tourism Board for the empirical analysis. In this publication both vacation overnight visitors and business overnight visitors from seven main short-haul markets (the Philippines, Thailand, South Korea, Malaysia, Singapore, Japan, and Indonesia) and six main long-haul markets (Australia, Germany, the UK, France, the USA, and Canada) of Hong Kong are presented, respectively. This study attempts to examine the patterns between profiles of the business overnight visitors of Hong Kong among these thirteen countries from a perspective of short-haul and long-haul visitors; then basing on these data the distance decay theory is further examined.

The brief demographic profiles, including gender, age, and marriage status, of the visitors from the three source markets are indicated in Fig. 1. The countries on the x-axis are sorted increasingly by the distance from origins to Hong Kong. The dashed in the figure divides the graph into two parts: short-haul visitors and long-haul visitors.The curve of "Married" cannot indicate there is any difference between short-haul and long-haul visitors in marriage status. However, it is observed that the percentage of male of the long-haul visitors is slightly larger than the one of short-haul visitors, with the ranges of 69–84 % and 80–89 % respectively. To some extent, it may indicate that more males have long-haul business travel to Hong Kong than females.

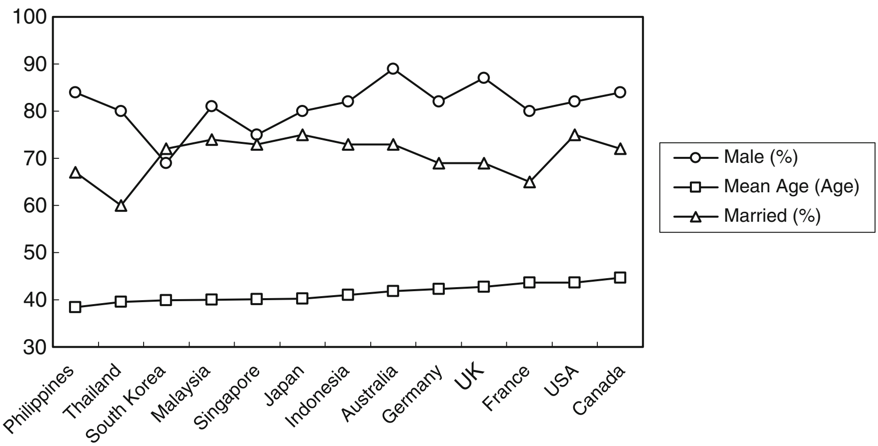


Fig. 1 Demography profiles of the source markets

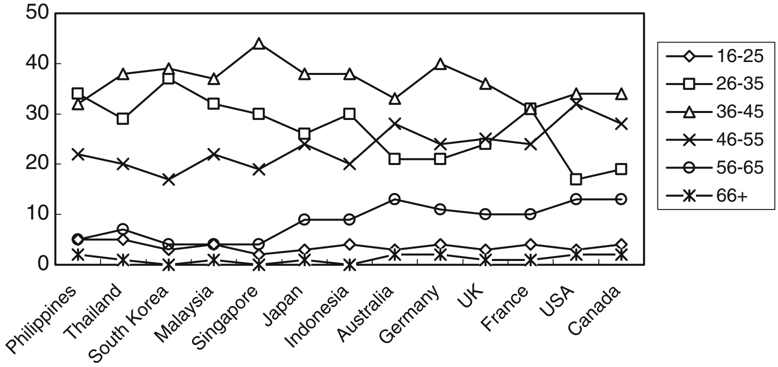


Fig. 2 The age distribution of the visitors

It is also observed in Fig. 1 that the line of "mean age" has a positive slope. The average age of the long-haul visitors is higher than of the short-haul visitors, with the ranges of 38.4–41 years old and 41.8–44.7 years old, respectively. This finding reflects that for business visit to Hong Kong, long-haul visitors are to some extent more mature or experienced than short-haul visitors.

The positive slope of the "mean age" line means that in Hong Kong, elder visitors are more likely for longer distance business travel. Therefore it is proved that distance decay effect has impact on the ages of the visitors. The average age increases when the distance from origin to Hong Kong increases. However, the distance decay effect cannot be found in gender or marriage status obviously from the figure.

The detailed categories of age shown in Fig. 2 further examine the age distributions of the business visitors in Hong Kong. From the figure it is found that in all source markets the largest proportion of age phase is 36–45, which indicates that the business visitors in Hong Kong with this range of ages are potentially major markets. Then the ages of 26–35 and 46–55 year-old business visitors also have high proportions, followed by the age range of 56–65 years old. This finding will benefit the marketing as well as strategies planning for both tourism industry and government.

Besides age distribution, stay duration and per capita expenditure are further examined. Figure 3 indicates the average nights the visitors stay in Hong Kong for business trip and their corresponding per capita spending. Comparing the left and the right sides of the dashed, it is found that long-haul visitors have more per capita expenditure than short-haul visitors. Also, the figure shows that the stay duration of long-haul visitors is on average longer than of the short-haul visitors. These conclusions can be understood considering that for long-haul visitors they have to spend more time and money for the travel.

From Fig. 3 it can also be found that for business visitors in Hong Kong, there is a positive correlation between stay duration and per capita spending. The movement of these two variables is on average in the same direction. Therefore it can be

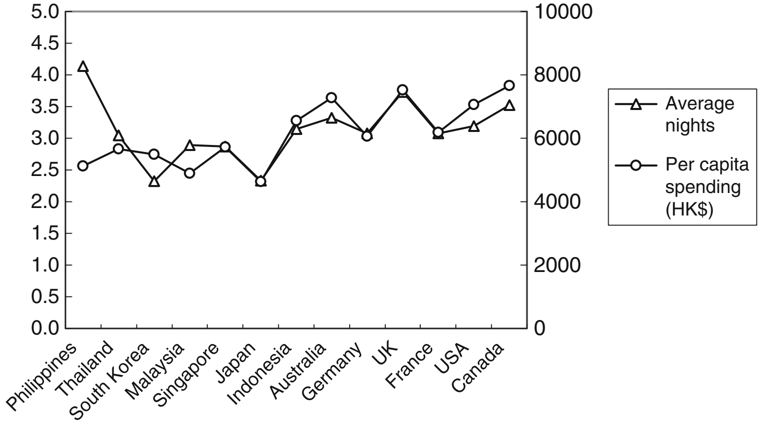


Fig. 3 Stay duration and per capita spending of business visitors

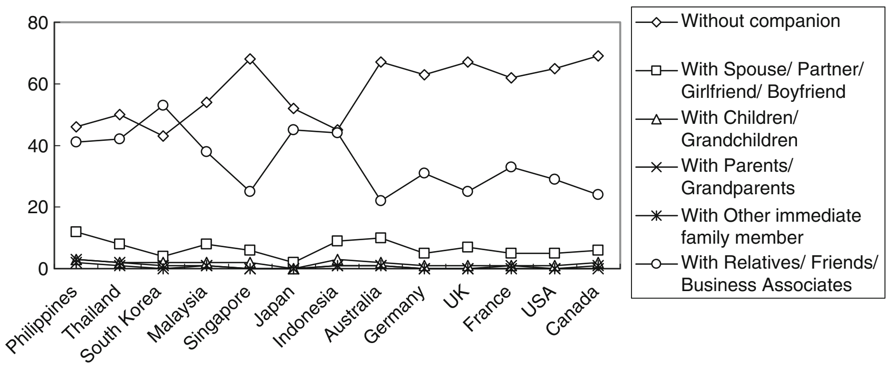


Fig. 4 Travel companions of business visitors

concluded that for business trip in Hong Kong, the longer the visitors stay in destination, the more they spend.

Further considering the trip pattern of the business visitors in Hong Kong, the travel companion is focused on. Figure 4 indicates that generally the largest proportion of business visitors come to Hong Kong by themselves, followed by with relative, friends, and business associates. The third largest group is with spouse, partner, girlfriend, and boyfriend. This finding is very useful for practitioners. For example, the marketing or promotion on business trip to Hong Kong should not put more efforts on the ability of providing wonderful care for business visitors' children because business visitors seldom come to Hong Kong with their children.

Another finding basing in Fig. 4 is that in the largest groups "without companion," when the distance from origin to destination increases, on average the percentage of the visitors in this group increases. The positive slope of this group, shown in Fig. 4, can lead to the conclusion that as the distance increases,

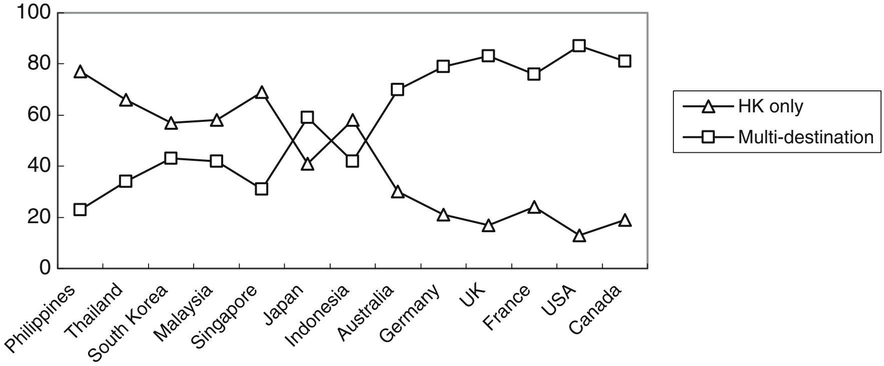


Fig. 5 Itinerary of business visitors (%)

visitors are more likely to take the trip by themselves. In other words, business visitors prefer without companion in long-haul travel than in short-haul travel.

Itinerary of a visitor is another important factor the market practitioners are interested in. According to different itinerary of visitors, such as single destination or multi-destination, the market planners can establish different strategies of marketing correspondingly. In Fig. 5 the itinerary of business visitors of Hong Kong is examined and the result is very interesting. In Fig. 5 it is shown that the proportion of the visitors with Hong Kong as the single destination decreases continuously as the distance from the source market to Hong Kong increases. On the other hand, the proportion of the multi-destination visitors increases continuously as the distance from origin increases. These significant changes prove that the distance decay effect may have impact on tourists' decision on the itinerary choice of single destination travel or multi-destination travel.

3 Conclusions

This study attempts to examine the business overnight visitors' profile, trip patterns, and tourism demand in Hong Kong. The distance decay theory is also combined into the analysis. In the existing literature, distance decay theory has been widely applied into a variety of areas such as crime, retail shopping, commuting, and recreation research. However, the theoretical and empirical studies in the context o tourism are still rare. This study examines the impact of the distance decay effect on Hong Kong business overnight visitors from thirteen major source markets empirically. Another contribution of this study is that it identifies the distance decay curve with two peaks in the Hong Kong case which is firstly advanced by McKercher and Lew (2003). The research findings still confirm that distance decay effect may have influence on some aspects of business visitors' profiles, such as whether having travel companion, average age, single destination or multi-destination, and per capita expenditure.

References

T. Drezner, Z. Drezner, Competitive facilities: Market share and location with random utility. J. Reg. Sci. **36**, 1–15 (1996)

T. Greer, G. Wall, Recreational hinterlands: A theoretical and empirical analysis. in *Recreational Land Use in Southern Ontario (Department of Geography Publication Series)*, ed. by Wall, G. Waterloo, vol. 14 (Waterloo University, Canada, 1979), pp. 227–246

B. McKercher, A.A. Lew, Distance decay and the impact of effective tourism exclusion zones on international travel flows. J. Travel Res. **42**, 159–165 (2003)

G.F. Rengert, A.R. Piquero, P.R. Jones, Distance decay reexamined. Criminology **37**, 427–445 (1999)

J. Zhang, G. Wall, K. Du, M.Y. Gan, X. Nie, The travel patterns and travel distance of tourists to national parts in China. Asia Pac. J. Tourism Res. **4**, 27–34 (1999)

The Design Model of Plant Service Products Based on Value Chain

Sanfa Cai, Zejiao Feng, and Bin Zou

Abstract The plant service products are intangible products in the form of labor, technique, and knowledge, which exist in producer service outsourcing. For plant service providers, they need to attach great importance to the value links in the design of plant service products. To realize maximum value, plant service providers should firstly make a reasonable orientation for the value chain of service products and highly aware of each value link in the designing process of plant service products. Therefore, based on the value chain theory, the paper constructs and analyzes an effective design model for plant service products, makes the whole products design truly clear and applicable, and also provides enlightenment for plant service providers to create high service value.

Keywords Value chain • Plant service products • Design model

1 Introduction

During enterprises' value creation, not every link of enterprises' operation can create effective value, and actually only some specified activities can achieve that. These activities are usually called "strategic links." So the core of enterprise' management is to locate strategic links in value chain. This article mainly talks about enterprises from producer service outsourcing industry which provide intangible plant service products in the form of labor, technique and knowledge. To realize maximum value, plant service providers should firstly make a reasonable orientation for the value chain of service products and be highly aware of each value link in the designing process of plant service products. If there is much trouble in the strategic links

S. Cai (✉) • Z. Feng • B. Zou
School of Economics and Management, Tongji University, Shanghai, China
e-mail: csf@tongji.edu.cn; zjiaof@gmail.com; bilare@163.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_30,

of plant service products design, the company will reduce product value, lose competitiveness, and appear to be in a mass. Therefore, based on the theory of value chain, this paper constructs and analyzes a scientific and effective design model for plant service products.

2 Analyze the Relationship Between Value Chain and Plant Service Products Design

Value chain theory has already been applied to manufacturing and engineering field. And some scholars have studied manufacturing value chain or engineering value chain. Shi (1998) points out that manufacturing starts with the market understanding, then product design, production, operation, and finally distribution. Chunli and Ming (2008) divide manufacturing value chain into three sections, including product development, manufacturing, and sales. Zhang and Gregory (2011) put forward the structure of engineering value chain and consider that it begins with the formation and selection of thoughts, product development, production, delivery, service provision, and finally product disposal. There are common recognition of value activities in these studies, but all of them only concern about physical products. But we can learn from it and turn to consider service products. Based on the general value chain, we can construct the value chain of plant service products design, which will make value activities fully realize. In such a designing value chain, under the consideration of every subject's interests, all parties cooperate and create value by a series of main activities and auxiliary activities.

3 Construction of Plant Service Products Design Model

According to Porter (1985) theory of value chain and all the discussion above, this paper will divide value activities of plant service products design into basic activities and auxiliary activities. And also we surely consider supplier's activities and customer's activities. So, we, respectively, use Ai, Bi, S, C for basic activities, auxiliary activities, supplier's activities, and customer's activities. Assuming that operation environment is fixed, the model of plant service products design (or DM) is a subset of muster A, B, S, C ($I = 5, j = 4$) (not including empty set). This means that the model of service products design can be made up of service activities of the whole value chain, or in part. If considering to improve and optimize the designing value activities, we can get the formula

$$\mathrm{DM} = f(\mathrm{SVC}) \tag{1}$$

From formula (1), SVC means service value chain. We can further consider that a certain model of plant services design is a function of service value chain and it is also regarded as a kind of effective combination of service value activities based on the creation of value chain and the optimization of interested parties involving these value activities. The concept of f in the formula can be defined as the mapping relationships in designing value activities of service value chain. But there are various ways of mapping which reflect different levels of value activities; thus we should ensure the model is rational and scientific.

Since the plant service products design model involves the mapping between service value activities and designing activities, what the value activities are and how to divide them are the primary problems. There are many researches on the value activities, and we list some representative opinions here. Payne and Holt (2001) studied the model of relationship value management and pointed out four processes of relationship value: defining value, creating value, delivering value, and assessing value. Bower and Garda (1986) believed that the three value processes are the process of value selection, the process of value provision, and the process of value exchange. Using the value chain theory and combining characteristics of plant service products, this paper argues that the value activities of plant service products design can be divided into four elements as follows.

3.1 Value Definition

A clear and consistent definition is the key to design service products successfully. Enterprises shall fully consider its strategic resources and core competence in terms of value definition and also what kinds of value should be provided to target customers based on these service products. At the same time, the enterprise must also consider how to maintain, strengthen, and develop its core capability and strategic resources constantly through value innovation. And in fact, main contents of value definition belong to the formation and determination of plant service philosophy.

3.2 Value Creation

Value creation is the value an enterprise creates to meet its customers' demands. Sustained and effective value creation can make the enterprise transfer value contents. Specifically, it is the development of plant service products, including identifying features of plant service products and determining the quality of plant services products.

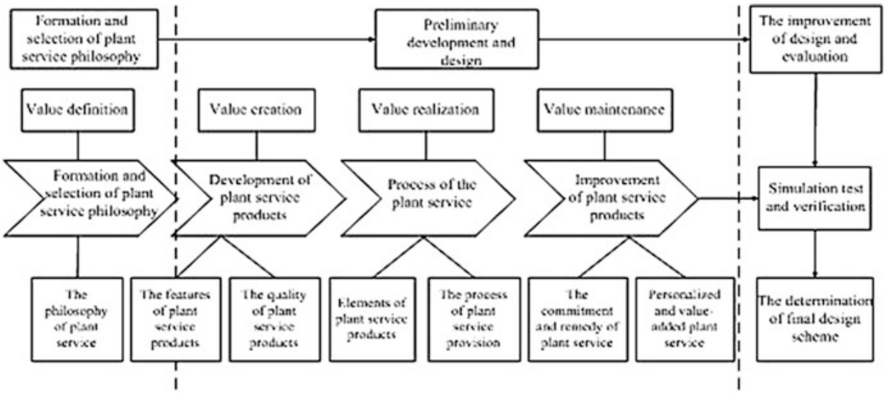


Fig. 1 Plant service products design model

3.3 Value Realization

The design of plant service products is the last step to realize its value. With good value definition and creation, it must use reasonable methods and process to realize the utility of products. So the design of plant services product is to answer the problem of "how to provide service." Specifically, value realization is to design good plant service process and complete each element that service process requires. The two aspects together constitute service supply process effectively and completely.

3.4 Value Maintenance

Effective and novel plant service products may lose value and fail completely because of competitors' rapidly imitation or not getting strong supports from partners. Thus it needs value maintenance. Specifically, value maintenance is to improve plant service products, including plant service commitment and remedy and personalized and value-added service design. Therefore, the elements of plant service products design model are value definition, value creation, value realization, and value maintenance. And each process has its more specified content. This paper constructs plant service products design model based on value chain theory, refined value activities, and the design steps of general service products, as it is shown in Fig. 1.

4 Analysis Value Activities of Plant Service Products Design

By the analysis of last section, we know the model of plant service products design mainly consists of three levels, namely, steps module, value process module, and value activities module. Every process has its own specific value activities, and each value activity has specific segments. So this section will further analyze value activities.

4.1 Formation and Selection of Plant Service Philosophy

Service philosophy is the core of service products and the starting point of plant service products design. The rationality of the design determines the effectiveness of a proposed scheme and finally affects plant service provision and customer satisfaction. The formation of plant service philosophy can come from many sources, including external and internal channels. The selection of plant service philosophy is to check the feasibility and risks. And from different functions of plant service providers, we can investigate every aspect and screen or filter out some not suitable service philosophy, finally to choose the most appropriate philosophy.

4.2 Development of Plant Service Products

The development of plant service products is to study features and contents of plant service products to meet customers' needs that can reflect plant service philosophy meanwhile. The features of plant service products include availability, price, service quality, and service speed. We can specifically analyze demands of the target market and competition situation to determine competitive advantages of plant service products. The contents of plant service products include various service elements, like invisible "pure" service, and also required visible elements during service provision.

4.3 Process of Plant Service

The process of plant service is the entire process to provide customers with plant service and the utility and combinations of elements to finish the process. From the whole system of plant service, we determine service process and then determine ways and characteristics of service provision. The design of plant service process roughly includes four aspects: (1) types of provide service process, (2) basic ways of service provision, (3) system descriptions of plant service provision, and (4) technology involved in service process.

4.4 Improvement of Plant Service Products

The improvement of plant service products refers to service commitment and remedy. It could not only attract customers and eliminate the worries of customers by meeting their personalized requirements, but also ensure service competitive power and enrich contents of plant service product through exploring value-added service and satisfying the customer's edge demand. Plant service commitment and remedy is to fully consider service quality and customer satisfaction, and also is a necessary supplement to plant service process. We should fully consider customer's needs and cost problems to design appropriate individualized service process. Value-added service can also be a way to enhance competitiveness of products. It is by offering customers additional plant service to increase value which is related to core plant service.

5 Conclusion

The paper applied manufacturing and engineering value chain theory to study the value chain of plant service products design. We analyzed design activities of plant service products and specifically explained these value activities. And then the design model of plant service products based on value chain theory, refined value activities, and steps of general service design was constructed. In the future, we can apply this model with plant service providers by combining some methods to create high products value and improve companies' competitiveness.

References

M.R. Bower, R.A. Garda, The role of marketing in management, *Hand book of Modern Marketing* (McGraw-Hill, New York, 1986)

L. Lin, G. Wu, *Service Management* (Tsinghua University Press, Beijing, 2008), pp.121–135

A. Payne, S. Holt, Diagnosing customer value: Integrating the value process and relationship marketing. British J. Manag. **12**(2), 159–182 (2001)

M.E. Porter, Competitive advantage. Free Press, New York (1985)

Y. Shi, International manufacturing networks to develop global competitive capabilities. J. Operations Manag. **16**(2), 195–214 (1998)

Y. Chunli, Y. Ming, Productive service and the analysis of value chain changes of manufacturing industry. Comput. Integr. Manuf. Sys. **14**(1), 153–159 (2008)

Y. Zhang, M. Gregory, Managing global network operations along engineering value chain. Int. J. Operations Prod. Manag. **31**(7), 736–763 (2011)

The Application of Fuzzy Interval Correlation Evaluating the Relationship Between Transportation Engineering and Air Pollution

Yu-Ting Cheng and Chih-Ching Yang

Abstract To evaluate a proper correlation coefficient with fuzzy data is an important topic in the transportation engineering, especially when the data illustrate uncertain, inconsistent, and incomplete type. In general, we use Pearson's correlation coefficient to measure the correlation of data with real values. However, when the data are composed of fuzzy interval values, it is not feasible to use such a classical approach to determine the correlation coefficient. This study proposes the computation of fuzzy correlation coefficient with fuzzy interval data. Empirical studies are employed to explain the application for evaluating fuzzy correlation. More related practical phenomena can be explained using the application of fuzzy correlation.

Keywords Fuzzy correlation • Fuzzy interval data • Evaluation • Air pollution • Transportation engineering

1 Introduction

In classical statistics, the two-valued logic will be reflected. Investigating the phenomena of nature, socials, or economics, fuzzy logic should be applied to account for the full range of possible values. Since Zedah (1965) developed fuzzy set theory, its applications have been extended to traditional statistical inferences and methods in social or engineering or economics, including medical diagnosis or stock investment systems. For example, a continuing series of studies displayed approximate reasoning methods for econometrics (Lowen 1990; Ruspini 1991; Dubois and Prade 1991) and a fuzzy time series model to overcome the bias of

Y.-T. Cheng (✉) • C.-C. Yang
Department of Statistics National Chengchi University, Muzha, Taipei, Taiwan 116
e-mail: ting@nccu.edu.tw; 96354502@nccu.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_31,

stock markets was developed (Wu and Hsu 2002). In traditional statistical theory, the observations should be observated under probability distribution. In practice, the observations are sometimes explained by linguistic terms such as "Very important," "Important," "Normal," "Unimportant," "Very unimportant," or "Maximum value and Minimum value," which are only approximately known, rather than equating with randomness. Measuring the correlation coefficient between two variables including fuzziness is a challenge to the classical statistical theory. A lot of studies investigate the topic of the fuzzy correlation analysis and its application in the social or economic science fields (Bustince and Burillo 1995; Yu 1993; Liu and Kao 2002; Hong 2006). For example, Hong and Hwang (1995) and Yu (1993) define a correlation formula to measure the interrelation of intuitionist fuzzy sets. However, the range of their defined correlation is from 0 to 1, which contradicts with the conventional awareness of correlation which should range from -1 to 1. In order to overcome this issue, Chiang and Lin (1999) take random sample from the fuzzy sets and treat the membership grades as the crisp observations. Their derived coefficient is between -1 and 1; however, the sense is that the fuzziness is gone. Liu and Kao (2002) calculated the fuzzy correlation coefficient based on Zadeh's extension principles. They used a mathematical programming approach to derive fuzzy measures based on the classical definition of the correlation coefficient. Their derivation is very probable; however, in order to use this scheme, the mathematical programming should be required.

In addition, formulas in these studies are quite complicated or required some mathematical programming which really limited the access of some researchers with no strong mathematical background. In this thesis, we propose a simple solution of a fuzzy correlation coefficient without programming. In addition, the provided solutions are based on the classical definition of Pearson correlation which is quite easy and straightforward. The definitions provided in this study can also be used for interval-valued fuzzy data.

The remainder of the paper proceeds as follows. The fuzzy interval correlation is introduced in Sect. 2. Section 3 presents its results of the relationship of the simulation. Section 4 presents its empirical results. Finally, the conclusions are drawn in Sect. 5.

2 Fuzzy Interval Correlation

In general, we need to study the relationship between the variables x and y; the most direct and simple way is to draw a scatter plot, which can approximately illustrate the relationship between these variables such as positive correlation, negative correlation, or noncorrelation. Pearson's correlation coefficient is often considered to evaluate that presents a measure of how two random variables are linearly related in a sample. The population correlation coefficient, ρ, is defined for two variables x and y by the formula:

$$\rho = \frac{\sigma_{X,Y}}{\sigma_X \sigma_Y} = \frac{\mathrm{Cov}(X,Y)}{\sigma_X \sigma_Y},$$

where (x_i, y_i) is the ith pair observation value, $i = 1,2,3,\ldots,n.\bar{x},\bar{y}$ are sample mean for x and y, respectively.

In this case, the more positive ρ is, the more positive the association is. This also indicates that when ρ is close to 1, an individual with a high value for one variable will likely have a high value for the other and an individual with a lower value for one variable will likely to have a low value for the other. On the other hand, the more negative ρ is, the more negative the association is, this also indicates that an individual with a high value for one variable will likely have a low value for the other when ρ is close to -1 and conversely. When ρ is close to 0, this means there is little linear association between two variables. In order to obtain the correlation coefficient, we need to obtain σ_x^2, σ_y^2, and the covariance of x and y. In practice, these parameters for the population are unknown or difficult to obtain. Thus, we usually use r_{xy}, which can be obtained from a sample, to estimate the unknown population parameter. The sample correlation coefficient r_{xy} is expressed as:

$$r_{xy} = \frac{\Sigma_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\Sigma_{i=1}^{n}(y_i - \bar{y})^2}}. \tag{1}$$

Pearson correlation coefficient is a straightforward approach to calculate the relationship between two variables. However, if the variables considered are not real numbers, but fuzzy data, the formula above is problematic. For example, Mr. Smith who is a new graduate from college expected salary ranges from [45,000, 50,000] and his expected working hours are [8, 10]. If we collect this kind of data from many new graduates, then the correlation between expected salary and working hours cannot be calculated by us from these data. Suppose IX is the expected salary for each new graduate and IY is the working hours they desired, then the scatter plot for these two sets of fuzzy interval numbers would approximate that shown in Fig. 1.

For the interval-valued fuzzy number, we consider to pick out samples from population X and Y. Each fuzzy interval data for the centroids and length of the sample X and sample Y will be considered to calculate the correlation coefficient. In addition, we also employ the maximum value and minimum value of fuzzy interval data to evaluate the correlation coefficient.

In this paper, there are two kinds of fuzzy correlation which are based on the Person's correlation as well as the extension principle definitions 1 and 2; the advantages are that we can compute various samples with fuzzy interval type for the continuous sample.

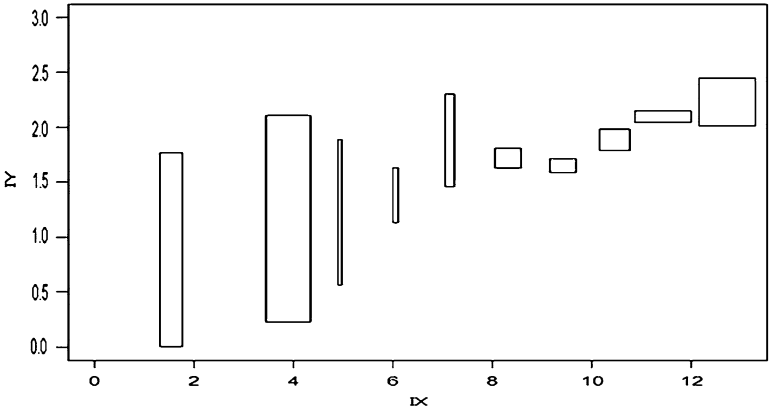


Fig. 1 Fuzzy correlation with interval data

2.1 Definition 1

Let $(X_i = [a_i, b_i, c_i, d_i], Y_i = [e_i, f_i, g_i, h_i]; i = 1, 2, \ldots, n)$ be a sequence of paired trapezoid fuzzy sample on population Ω with its pair of centroid (cx_i, cy_i) and pair of area $\|x_i\| =$ area $(x_i), \|y_i\| =$ area (y_i).

$$r_{xy} = \frac{\Sigma_{i=1}^{n}(cx_i - \bar{cx})(cy_i - \bar{cy})}{\sqrt{\Sigma_{i=1}^{n}(cx_i - \bar{cx})^2}\sqrt{\Sigma_{i=1}^{n}(cy_i - \bar{cy})^2}}, \lambda ar_{xy} = 1 - \frac{\ln(1 + |ar_{xy}|)}{|ar_{xy}|},$$

where

$$ar_{xy} = \frac{\Sigma_{i=1}^{n}(\|x_i\| - \|\bar{x}_i\|)(\|y_i\| - \|\bar{y}_i)\|}{\sqrt{\Sigma_{i=1}^{n}(\|x_i\| - \|\bar{x}_i\|)^2}\sqrt{\Sigma_{i=1}^{n}\|(y_i\| - \|\bar{y}_i)^2}}. \tag{2}$$

Then *fuzzy* correlation is defined as:

1. $When\ cr_{xy} \geq 0, \lambda ar_{xy} \geq 0,$ *fuzzy correlation* $= (cr_{xy}, \min(1, cr_{xy} + \lambda ar_{xy}))$
2. $When\ cr_{xy} \geq 0, \lambda ar_{xy} < 0,$ *fuzzy correlation* $= (cr_{xy} - \lambda ar_{xy}, cr_{xy})$
3. $When\ cr_{xy} < 0, \lambda ar_{xy} \geq 0,$ *fuzzy correlation* $= (cr_{xy}, cr_{xy} + \lambda ar_{xy})$
4. $When\ cr_{xy} < 0, \lambda ar_{xy} < 0,$ *fuzzy correlation* $= (\max(-1, cr_{xy} - \lambda ar_{xy}), cr_{xy})$

2.2 Definition 2

Let $X_{ji} = [a_{1i}, a_{2i}]$ and $Y_{ji} = [b_{1i}, b_{2i}]$ be a sequence of paired fuzzy sample on population Ω. Let

$$r_{jk} = \frac{\Sigma_{i=1}^{n}(a_{ji} - \bar{a}_j)(b_{ki} - \bar{b_k})}{\sqrt{(a_{ji} - \bar{a}_j)^2}\sqrt{(b_{ki} - \bar{b_k})^2}}, j = 1, 2, k = 1, 2.$$

Then *fuzzy correlation* is $[r_{\text{low}}, r_{\text{up}}]$ with $r_{\text{low}} = \bar{r} - s_r$ and $r_{\text{up}} = \bar{r} + s_r$,where

$$\bar{r} = \frac{\Sigma_{j=1}^{2}\Sigma_{k=1}^{2} r_{jk}}{4} \text{ and } s_r = \frac{\Sigma_{j=1}^{2}\Sigma_{k=1}^{2}(r_{jk} - \bar{r})^2}{4}.$$

A correlation coefficient is a number between -1 and 1 which measures the degree to which two variables are linearly related. If there is perfect linear relationship with positive slope between the two variables, we have a correlation coefficient of 1; if there is positive correlation, whenever one variable has a high value. Thus, based on the measure of evaluation, the degree of the population correlation coefficient, we will be considered for the correlation of fuzzy interval. As the correlation of fuzzy interval, $[r_{\text{low}}, r_{\text{up}}]$, is computed, then the value of fuzzy correlation can be evaluated that is defined as:

1. $When[r_{\text{low}}, r_{\text{up}}] \in [-0.10, 0.10]$, *the fuzzy correlation is not significant.*
2. $When[r_{\text{low}}, r_{\text{up}}] \in [-0.39, -0.11]$ *or* $[0.11, 0.39]$, *the fuzzy correlation is low value.*
3. $When[r_{\text{low}}, r_{\text{up}}] \in [-0.69, -0.40]$ *or* $[0.40, 0.69]$, *the fuzzy correlation is middle value.*
4. $When[r_{\text{low}}, r_{\text{up}}] \in [-0.99, -0.70]$ *or* $[0.70, 0.99]$, *the fuzzy correlation is high value.*

3 Simulation Studies

In this section, we will employ the Mote Carlo simulation to generate several sequence of fuzzy interval data set and then compare their correlations coefficient with different definition as proposed in Sect. 2. The distribution for the centroid and area is generated by the normal, uniform, gamma, and Cauchy distribution, respectively. The procedure to computate correlation coefficient is described below: Table 1 illustrates the result.

Step 1. Generate fuzzy set of sequence X with successive 4 points and error term from the underlying distribution.

Step 2. Let $Y = aX + e$ calculate the fuzzy data set Y by the fuzzy data set X and error term.

Step 3. Find the correlation coefficient from the fuzzy data set by the above definitions.

In Table 1, there are some results that will be described as follows: (1) when a $= 0.2$, the interval of the correlation coefficient is very close, (2) when a $= 0.5$, the interval of correlation coefficient is close except the distribution of Cauchy, (3) when a $= 0.8$, the estimated interval from definition 3 is bigger than definition 4 did if the center distributions come from gamma, normal, and uniform. While if the distribution comes from Cauchy distribution, we will get a very odd estimation.

Table 1 The fuzzy interval correlation coefficient for various center and area model with Definitions 1 and 2

a	Center area	Normal(0,1)	Uniform(0,1)	Gamma(2,2)	Cauchy(0,1)
0.2	Normal	(0.16, 0.20)[1]	(0.05, 0.09)[1]	(0.21, 0.25)[1]	(0.94, 0.98)[1]
		(0.13, 0.18)[2]	(0.04, 0.08)[2]	(0.17, 0.22)[2]	(0.93, 0.94)[2]
	Uniform	(0.18, 0.21)[1]	(0.08, 0.12)[1]	(0.21, 0.25)[1]	(0.94, 0.98)[1]
		(0.19, 0.22)[2]	(0.07, 0.09)[2]	(0.23, 0.25)[2]	(0.94, 0.95)[2]
	Gamma	(0.15, 0.19)[1]	(0.01, 0.04)[1]	(0.19, 0.23)[1]	(0.94, 0.98)[1]
		(0.11, 0.18)[2]	(0.03, 0.07)[2]	(0.15, 0.21)[2]	(0.93, 0.94)[2]
	Cauchy	(–0.02, 0.00)[1]	(–0.02, 0.00)[1]	(0.00, 0.03)[1]	(0.33, 0.36)[1]
		(–0.00, 0.11)[2]	(0.00, 0.06)[2]	(0.00, 0.14)[2]	(0.30, 0.63)[2]
0.5	Normal	(0.33, 0.38)[1]	(0.11, 0.15)[1]	(0.41, 0.45)[1]	(0.95, 0.98)[1]
		(0.25, 0.39)[2]	(0.08, 0.18)[2]	(0.31, 0.45)[2]	(0.97, 0.98)[2]
	Uniform	(0.42, 0.46)[1]	(0.19, 0.23)[1]	(0.49, 0.52)[1]	(0.95, 0.99)[1]
		(0.40, 0.46)[2]	(0.15, 0.22)[2]	(0.47, 0.53)[2]	(0.98, 0.99)[2]
	Gamma	(0.26, 0.30)[1]	(0.06, 0.10)[1]	(0.36, 0.40)[1]	(0.98, 1.00)[1]
		(0.21, 0.37)[2]	(0.06, 0.17)[2]	(0.26, 0.43)[2]	(0.97, 0.98)[2]
	Cauchy	(–0.02, 0.00)[2]	(–0.02, 0.00)[2]	(–0.02, 0.00)[1]	(0.34, 0.37)[1]
		(0.00, 0.26)[3]	(0.00, 0.14)[3]	(0.00, 0.28)[2]	(0.30, 0.66)[2]
0.8	Normal	(0.38, 0.42)[1]	(0.15, 0.19)[1]	(0.50, 0.53)[1]	(0.95, 0.99)[1]
		(0.30, 0.50)[2]	(0.10, 0.26)[2]	(0.36, 0.56)[2]	(0.98, 0.99)[2]
	Uniform	(0.60, 0.64)[1]	(0.29, 0.33)[1]	(0.63, 0.67)[1]	(0.99, 1.00)[1]
		(0.52, 0.62)[2]	(0.22, 0.32)[2]	(0.59, 0.68)[2]	(0.99, 1.00)[2]
	Gamma	(0.37, 0.41)[1]	(0.08, 0.12)[1]	(0.41, 0.44)[1]	(0.95, 0.99)[1]
		(0.25, 0.48)[2]	(0.07, 0.24)[2]	(0.31, 0.54)[2]	(0.98, 0.99)[2]
	Cauchy	(0.00, 0.03)[1]	(–0.03, 0.00)[1]	(–0.02, 0.00)[1]	(0.34, 0.37)[1]
		(0.01, 0.35)[2]	(–0.00, 0.21)[2]	(0.01, 0.37)[2]	(0.30, 0.66)[2]

Note: 1 denotes the result by Definition 1; 2 denotes the result by Definition 2

4 Empirical Studies

In general, the transportation engineering will affect the quality of air or climate. Hence, the passenger counts of Taipei MRT system could be considered to investigate the correlation between passenger counts of Taipei MRT system and air pollution, where air pollution include total suspended particles (TSP), air-suspended particles (ASP), sulfur dioxide (SO2), ozone(O3), and fallout.

We examined the passenger counts of the Taipei MRT system and air pollution in Taiwan with 170 week samples between January 1998 and February 2012. And the form of collected data, maximum and minimum observation, will be showed by fuzzy interval data. The results show the correlation for the passenger counts and air pollution with two approaches of evaluation of correlation coefficient. The results are listed in Table 2.

Table 2 Correlations interval based on passenger counts and the air pollution in Taiwan

Fuzzy correlation	TSP	ASP	SO_2	O_3	Fallout
By definition 1	(–.178, –.142)	(.325, .420)	(.356, .379)	(.370, .425)	(–.181, –.153)
By definition 2	(–.187, –.073)	(.273, .335)	(.166, .552)	(.285, .437)	(–.163, –.150)

In Table 2, we have the following findings. First, besides the correlation of passenger counts, the TSP and fallout are low significance negative by schemes of definition 1 and definition 2, and this result denotes that the passenger counts of Taipei MRT system increase; then that can reduce the value of TSP and fallout. Second, the correlation coefficient is middle level for passenger counts and the ASP, SO_2, and O_3 by the approach of definition 1; this means the values of ASP, SO_2, and O_3 have a lot of effect to the passenger counts. Third, the correlation coefficient is of low significance for passenger counts and the ASP, SO_2, and O_3 by the approach of definition 2; this means the values of ASP, SO_2, and O_3 have a little effect to the passenger counts; this result shows that the passenger counts will affect the air pollution, such as the air pollution of ASP, SO_2, and O_3, can be affected by the passenger counts of Taipei MRT system.

5 Conclusions

In the progress of the scientific research and analysis, the uncertainty in the statistical numerical data is the important point of the problem where the traditional mathematical computation is hard to be established. If we achieve this artificial accuracy to do causal analysis or measurement, it may lead to the deviation of the causal judgment, the misleading of the decision strategy, or the exaggerated difference between the predicted result and the actual data. As the pattern of data of interval occurred in transportation engineering or energy environment, our proposed methods can be applied to make management strategy and decision as the two variables that illustrate this kind of fuzzy interval data. In other words, this paper employs a simple approach to derive from fuzzy interval measures based on the traditional definition of Pearson correlation coefficient which are easy and straightforward. In the formula we provided, when all observations are real numbers, the developed model becomes the classical Pearson correlation formula. In practice, many applications are fuzzy in nature. We can absolutely ignore the fuzziness and make the existing methodology for crisp values. However, this will make the researcher overconfident with their results. With the methodology developed in this paper, a more realistic correlation is obtained, which provides the decision maker with more knowledge and confidence to make better strategies.

References

H. Bustince, P. Burillo, Correlation of interval-valued intuitionistic fuzzy sets. Fuzzy Sets Syst. **74**, 237–244 (1995)

D.A. Chiang, N.P. Lin, Correlation of fuzzy sets. Fuzzy Sets Syst. **102**, 221–226 (1999)

D. Dubois, H. Prade, Fuzzy sets in approximate reasoning, part 1: Inference with possibility distributions. Fuzzy Sets Syst. **40**, 143–202 (1991)

D. Hong, Fuzzy measures for a correlation coefficient of fuzzy numbers under Tw (the weakest t norm)-based fuzzy arithmetic operations. Fuzzy Sets Syst. **176**, 150–160 (2006)

D. Hong, S. Hwang, Correlation of intuitionistic fuzzy sets in probability space. Fuzzy Sets Syst. **75**, 77–81 (1995)

R. Lowen, A fuzzy language interpolation theorem. Fuzzy Sets Syst. **34**, 33–38 (1990)

S. Liu, C. Kao, Fuzzy measures for correlation coefficient of fuzzy numbers. Fuzzy Sets Syst. **128**, 267–275 (2002)

E. Ruspini, Approximate reasoning: Past, present, future. Inform. Sci. **57**, 297–317 (1991)

B. Wu, Y. Hsu, The use of kernel Set and sample memberships in the identification of nonlinear time series. Soft Comput. J. **8**(3), 207–216 (2002)

C. Yu, Correlation of fuzzy numbers. Fuzzy Sets syst. **55**, 303–307 (1993)

L.A. Zedah, Fuzzy sets. Inform. Control. **8**, 338–353 (1965)

On Efficiency of Time Management for School Leaders with Fuzzy Data

Chiu-Ying Chao, Chih-Wei Chang, and Ko-Liang Chen

Abstract Social science research, a variety of statistical methods, has become the important core, but in the process of application of statistical analysis, the respondents in completing the questionnaires generally encounter a problem, that is, the answer of the respondents had is not necessarily the absolute value of the real.This study analyzes the differences of time management among educators by applying fuzzy statistics that incorporate natural features of vagueness and uncertainty into conventional statistical issues. Survey data with fuzzy characteristics from elementary school principals are collected. In this article of the elementary principal's time management for the study, through the process of defuzzification, we transform fuzzy-valued data into non-fuzzy data set and test the correlation of two independent samples by Wilcoxon rank-sum test. In conclusion, further academic suggestions for time management in education field are advised.

Keywords Fuzzy values • Interval data • Time management

1 Introduction

Human beings are most familiar with time. Circle (2005) believes that time cannot be stored or earned like money and that it is finite. School affairs operate according

C.-Y. Chao (✉)
Cheng-Kung Elementary School, Taichung City, Taiwan
e-mail: ckes027@ckes.tc.edu.tw

C.-W. Chang
Division of Zhong-Zheng Elementary School, Nantou Country, Taiwan
e-mail: re5151@ms24.hinet.net

K.-L. Chen
Division of Da-lin Elementary School, Taichung City, Taiwan
e-mail: vancow2000@gmail.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_32,

to time, and time is an important resource for implementing education in schools (Chien-Min, Kao). If time is managed and used properly, it creates a sense of personal achievement. How to effectively use time and improve its quality is an issue that we, as modern people, must work to achieve. A principal's control and planning of overall time in a school affects the success or failure of educational goal achievement. Therefore, understanding, appropriately implementing, and planning time are important issues about management in the field of education; it is also a necessary skill or type of wisdom that principals should possess to enhance performance of school. Slezak (1984) found that almost all principals admit to wasting at least 25 % of their time. When reviewing the time they spent, it was clear that their time could have been used more effectively. Because principals have to control both performance and principle and are constantly devoting time to a plethora of people and tasks in the workplace, it then becomes even more important to understand issues of time management for principals in the face of postmodern school management.

Famous in the time management field, Peter Drucker one stated that time is the scarcest resource, and unless it is managed, nothing else can be managed. Every school is given a principle to manage the affairs of the entire school. In Linda (2004), a study on leaders, one school day was divided into the following portions: (1) Appropriately performing internal leadership functions for teaching and administration. (2) Appropriately performing external public relations functions as well as joining the work of professional communities of principals. (3) Other routine tasks, including administrative leadership regarding the authorization of official documents, handling correspondences, reviewing budgetary uses, verifying expenditures, holding meetings, participating in various types of gatherings and activities, constructing projects and equipment purchasing requiring various funds, overseeing and testing construction projects, student counseling and disciplinary measures, and fostering a friendly campus environment. In addition, Sergiovanni (1984) showed that there are nine types of school activities, including project development, human resources, school management, participating in student management, interaction with the department of education, interaction with the community, planning, conducting professional development, and handling student behavior. There may also be crises that have to be dealt with when previously hidden and unknown dangers occur in schools, such as the crisis response or crisis coping described by Mackenzie (1972). Therefore, we identified the affairs that must be handled by principals daily, and divided them into the following five categories: teaching courses, administrative tasks, public relations development, crisis management, and miscellaneous affairs. We used these categories to investigate the time-management differences among principals.

Traditional opinion survey methods ask the public to make single choices regarding issues. This use of a dualistic logic thinking model is an inhuman method by which to process human thought-related issues. This is because if we express agreement with an issue, dualistic logic dictates that we should completely disagree with other issues. The attitudes and thoughts of the average person, however, are not as clearly defined as yes or no. Furthermore, there may be other thoughts that participants are unable to express. The fuzzy theory was proposed nearly 40 years ago. The results of many studies have shown that using the fuzzy theory to investigate issues regarding human thought more closely reflects actual conditions and the actual thought processes of humans than traditional dualistic logic methods. We used fuzzy number statistics to more realistically reflect peoples thoughts. We designed a questionnaire and instructed the participants to report the time they had spent on the five teaching course categories, that is, administrative tasks, public relations development, crisis management, and miscellaneous affairs. These were presented as a range of values, which we used to compare time-management differences.

In summary, we investigated the time management of elementary school principals in two groups based on gender and whether outstanding leadership awards have been won. We examined the range of fuzzy sample data values and then used defuzzification to convert them into real numbers. Finally, we employed the Wilcoxon rank-sum test to the independent samples of the two groups based on gender and whether outstanding leadership awards had been won to understand the time-management differences among principals executing various tasks.

2 Method of Research

2.1 Interval Fuzzy Numbers

The concept of interval fuzzy numbers is familiar in our daily lives. In certain circumstances, the real value cannot be confirmed using the available information. Therefore, we asked participants to write down or fill in an interval. Using fuzzy interval numbers, we developed more appropriate explanations. For example, we are most familiar with time. However, the time required by each person to complete various tasks or the expected time distribution for these tasks differs. For example, one person may assign approximately one hour of time to a task, but the actual time spent on the task may be reduced by the physical condition of the person for that day or by decreased numbers of interfering external environmental factors. Therefore, required time is a range, rather than a concrete number. The amount of time that an individual plans to spend is located within an interval $[1,2]$. Considering the interval $[1,2]$ is more reasonable than using a specific, fixed number. In addition, an individual is probably unable to provide a concrete number, and determines time based on the requirements of work amounts. Using the time interval $[1,2]$ not only provides a more flexible and realistic answer reference for time distributions when managing affairs, but it also provides workers with a clearer index for measuring or considering working time. We can consider the fuzzy interval numbers as shown below.

An interval-type fuzzy number is a fuzzy number with a uniform membership function. It is represented by a closed interval symbol [ ]. If $a, b \in R$ and ab, then

$[a, b]$ represents an interval-type fuzzy number in which a is the lower bound of $[a, b]$, and b is the upper bound of $[a, b]$. If $a = b$, then $[a, b] = [a, a] = [b, b] = a = b$ represents a real number $a(or\ b)$. Similarly, a real number k can be represented as $[k, k]$.

2.2 *Interval Fuzzy Calculated*

2.2.1 The Definition of 2.1 Continuous Fuzzy Sample Mean

Let U be a domain, $L = \{L_1, L_2, \ldots, L_k\}$ of K-language variables is distributed in the domain U.$\{x_i = [a_i, b_i], i = 1, \ldots, n\}$ is a set of fuzzy sample in the domain U.

Fuzzy sample mean as

$$F\bar{x} = \left[\frac{1}{n}\sum_{i=1}^{n} a_i,\ \frac{1}{n}\sum_{i=1}^{n} b_i\right]$$

2.2.2 Empirical Analysis

First, the results from 13 principles to answer the questionnaires were organized, have five categories, teaching courses, administrative tasks, public relations building, crisis management, and miscellaneous affairs, and are a group of fuzzy sample. $I_1, I_2, I_3 \ldots$ refer to the respondent ID, whereas numbers 1 and 2 in the gender field represent male and female. Whether outstanding leadership awards have been won is denoted by placing $a\surd$ in the field.

By definition 2.1 the fuzzy number of sample was calculated as follows:

$$F\bar{x} = \left[\frac{0+1+1+1+1+1+1+1+0+1+2+2+3}{13},\right.$$
$$\left.\frac{2+3+3+2+3+2+2+2+3+3+4+3+5}{13}\right] = [1.2, 2.8]HR$$

$$F\bar{x} = \left[\frac{1+1+3+2+2+2+3+3+0+3+3+2+2}{13},\right.$$
$$\left.\frac{4+3+5+4+3+3+5+5+3+5+5+3+6}{13}\right] = [2.1, 4.2]HR$$

$$F\bar{x} = \left[\frac{0+2+0+1+1+1+3+2+0+0+1+2+3}{13},\right.$$
$$\left.\frac{4+3+2+2+2+2+4+3+4+1+3+3+6}{13}\right] = [1.2, 3]HR$$

$$F\bar{x} = \left[\frac{0+3+1+1+1+1+1+1+0+0+1+1+3}{13},\right.$$
$$\left.\frac{4+4+3+3+2+2+2+2+2+1+3+2+6}{13}\right] = [1.1, 2.8]HR$$

$$F\bar{x} = \left[\frac{0+3+2+1+1+0+1+1+0+2+2+2+2}{13},\right.$$
$$\left.\frac{2+4+5+2+2+2+3+2+3+4+4+3+6}{13}\right] = [1.3, 3.2]HR$$

This information gives us average value references for the amount of time currently spent by principals on teaching courses, administrative tasks, public relations building, crisis management, and miscellaneous affairs (Table 1).

2.2.3 The Definition of 2.2 Fuzzy Sample Median for Continuous Type

U is set as a domain. Make $\{xi = [a_i, b_i], i = 1, 2, \ldots, n\}$ a set of fuzzy interval samples obtained from U. Make c_i a point in x_i. Make l_i the length of x_i. *Median* $\{ci\}$ is then the center of the fuzzy median. The median of l_i is the diameter range. That is,

$$F \text{ median} = (c; r), c = \text{median}\{c_j\}, r = \frac{\text{median}\{l_i\}}{2}$$

2.2.4 Empirical Analysis

The definition of 2.2 can obtain teaching courses, administrative tasks, public relations building, crisis management, and miscellaneous affairs. Interval is (2; 1), (2.5; 1), (2; 0.5), (1.5; 0.5), and (2; 1) hours. This range is the sought fuzzy sample median (Table 2).

2.2.5 The Definition of 2.3 Interval Fuzzy Numbers of Defuzzification Numerical Computation Equation

Make $X = [a, b]$ be **interval fuzzy numbers** and $c = \frac{b+a}{2}$ be the center of the range. $r = b - a$ is its interval range. **Interval fuzzy number** of defuzzification numerical computation equation is: $Rx = c + \left(1 - \frac{\ln(1+r)}{r}\right)$. If $a \to b$, then this interval is close to the center of $\frac{a+b}{2}$.

The data were calculated using the defuzzification numerical computation equation $Rx = (a+b)/2 + [1 - \ln(1 + (b-a))/(b-a)]$. The values in the above

Table 1 Time intervals for 13 principles that correspond to each task

ID	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}	I_{13}
Gender	1	1	1	1	1	2	2	1	2	1	2	1	2
Awarded with leadership excellence award									√	√	√	√	√
Teaching courses, time intervals	(0, 2)	(1, 3)	(1, 3)	(1, 2)	(1, 3)	(1, 2)	(1, 2)	(1, 2)	(0, 3)	(1, 3)	(2, 4)	(2, 3)	(3, 5)
Administrative tasks, time intervals	(1, 4)	(1, 3)	(3, 5)	(2, 4)	(2, 3)	(2, 3)	(3, 5)	(3, 5)	(0, 3)	(3, 5)	(3, 5)	(2, 3)	(2, 6)
Public relations building, time intervals	(0, 4)	(2, 3)	(0, 2)	(1, 2)	(1, 2)	(1, 2)	(3, 4)	(2, 3)	(0, 4)	(0, 1)	(1, 3)	(2, 3)	(3, 6)
Crisis management, time intervals	(0, 4)	(3, 4)	(1, 3)	(1, 3)	(1, 2)	(1, 2)	(1, 2)	(1, 2)	(0, 2)	(0, 1)	(1, 3)	(1, 2)	(3, 6)
Miscellaneous affairs, time intervals	(0, 2)	(3, 4)	(2, 5)	(1, 2)	(1, 2)	(0, 2)	(1, 3)	(1, 2)	(0, 3)	(2, 4)	(2, 4)	(2, 3)	(2, 6)

Table 2 Time intervals for 13 principles that correspond to each task

ID	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}	I_{13}
Gender	1	1	1	1	1	2	2	1	2	1	2	1	2
Awarded with leadership excellence award									√	√	√	√	√
Teaching courses, time intervals	(0, 2)	(1, 3)	(1, 3)	(1, 2)	(1, 3)	(1, 2)	(1, 2)	(1, 2)	(0, 3)	(1, 3)	(2, 4)	(2, 3)	(3, 5)
c_i	1	2	2	1.5	2	1.5	1.5	1.5	1.5	2	3	2.5	4
l_i	2	2	2	1	2	1	1	1	3	2	2	1	2
Administrative tasks, time intervals	(1, 4)	(1, 3)	(3, 5)	(2, 4)	(2, 3)	(2, 3)	(3, 5)	(3, 5)	(0, 3)	(3, 5)	(3, 5)	(2, 3)	(2, 6)
c_i	2.5	2	4	3	2.5	2.5	4	4	1.5	1	1	2.5	4
l_i	3	2	2	2	1	1	2	2	3	2	2	1	4
Public relations building, time intervals	(0, 4)	(2, 3)	(0, 2)	(1, 2)	(1, 2)	(1, 2)	(3, 4)	(2, 3)	(0, 4)	(0, 1)	(1, 3)	(2, 3)	(3, 6)
c_i	2	2.5	1	1.5	1.5	1.5	3.5	2.5	2	0.5	2	2.5	4.5
l_i	1	2	1	1	1	1	1	4	1	2	1	3	4
Crisis management, time intervals	(0, 4)	(3, 4)	(1, 3)	(1, 3)	(1, 2)	(1, 2)	(1, 2)	(1, 2)	(0, 2)	(0, 1)	(1, 3)	(1, 2)	(3, 6)
c_i	2	3.5	2	2	1.5	1.5	1.5	1.5	1	0.5	2	1.5	4.5
l_i	4	1	2	2	1	1	1	1	2	1	2	1	3
Miscellaneous affairs, time intervals	(0, 2)	(3, 4)	(2, 5)	(1, 2)	(1, 2)	(0, 2)	(1, 3)	(1, 2)	(0, 3)	(2, 4)	(2, 4)	(2, 3)	(2, 6)
c_i	1	3.5	3.5	1.5	1.5	1	2	1.5	1.5	3	3	2.5	4
l_i	2	1	3	1	1	2	2	1	3	2	2	1	4

tables were converted into the values in the tables below following the defuzzification numerical calculations (Table 3).

2.2.6 Empirical Analysis

2.3 Fuzzy Sample Sorting Applied to the Wilcoxon Rank-Sum Test

A Wilcoxon rank-sum test was used to test the two groups of independent samples to determine whether the median of the population they were obtained from were the same. This is the most widely used non-parametric statistic test. The Wilcoxon rank-sum test is based on the same principle as the Mann–Whitney test. However, the Mann–Whitney test is more complicated than the Wilcoxon rank-sum test, regarding both test amounts and the table lookup process. Therefore, we used the Wilcoxon rank-sum test.

Let m, n samples be randomly selected from two independent populations X, Y; then, the $m+n=N$ mixed samples are sorted by value from the smallest to the largest, according to the size of sample values. That is, within the mixed samples, the smallest mixed value is denoted as 1, and the second smallest sample is denoted as 2, and so on. The largest mixed value was denoted as N in this study. If some of the mixed values were identical, the average value of the corresponding rank under different values was obtained. If $R(X_i)$ and $R(Y_j)$ represent the ranks X_i and Y_j correspond to in the mixed sample, respectively, then the sum of the ranks for the two sample sets is as follows:

$$W_X = \sum_{i=1}^{m} R(X_i) \; W_Y = \sum_{i=1}^{m} R(_i)$$

This shows that the smallest possible value of W_X is $1+\cdots+m$, whereas the largest possible value is $(n+1)+\cdots+(n+m)$. The smallest possible value of W_Y is $1+\cdots+n$, whereas the largest possible value is $(m+1)+\cdots+(n+m)$.

Therefore, if the sample value of population X is larger than the sample value of population Y, or if the sample values of population X are concentrated in a region with a high rank, then the value of W_X is greater. If the sample value of population X is smaller than the sample value of population Y, or the sample values of population X are concentrated in a region with a low ranking, then the value of W_X is smaller. Under these two conditions, the statistical hypothesis is rejected. The process of the Wilcoxon rank-sum test is as follows.

2.3.1 Multiple Regression

1. Data: The random samples of two independent populations X, Y:

$$X_1, \ldots, X_m, \ldots, Y_1, \ldots, Y_n \;\; m+n=N$$

Table 3 Time Rx for the 13 principals that correspond to each task

ID	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}	I_{13}
Gender	1	1	1	1	1	2	2	1	2	1	2	1	2
Awarded with leadership excellence award									√	√	√	√	√
Teaching courses, time intervals	(1.45)	(2.45)	(2.45)	(1.81)	(2.45)	(1.81)	(1.81)	(1.81)	(2.04)	(2.45)	(3.45)	(2.81)	(4.45)
Administrative tasks, time intervals	(3.04)	(2.45)	(4.45)	(3.45)	(2.81)	(2.81)	(4.45)	(4.45)	(2.04)	(4.45)	(4.45)	(2.81)	(4.6)
Public relations building, time intervals	(2.6)	(2.81)	(1.45)	(1.81)	(1.81)	(1.81)	(3.81)	(2.81)	(2.6)	(0.81)	(2.45)	(2.81)	(5.04)
Crisis management, time intervals	(2.6)	(3.81)	(2.45)	(2.45.)	(1.81)	(1.81)	(1.81)	(1.81)	(1.45)	(0.81)	(2.45)	(1.81)	(5.04)
Miscellaneous affairs, time intervals	(1.45)	(3.81)	(4.04)	(1.81)	(1.81)	(1.45)	(2.45)	(1.81)	(0.54)	(2.6)	(2.6)	(2.81)	(4.6)

Table 4 Teaching activity supervision and course planning and design

Time management	1.45	1.81	1.81	1.81	1.81	2.04	2.45	2.45	2.45	2.45	2.81	3.45	4.45
Population	X	X	X	Y	Y	Y	X	X	X	X	X	Y	Y
ranking	1	3.5	3.5	3.5	3.5	6	8.5	8.5	8.5	8.5	11	12	13

Table 5 Administrative affairs, authorizing official documents, chairing school meetings, and the planning and supervision of construction projects

Time management	2.04	2.45	2.81	2.81	2.81	3.04	3.45	4.45	4.45	4.45	4.45	4.45	4.6
Population	Y	X	X	X	Y	X	X	X	X	X	Y	Y	Y
ranking	1	2	4	4	4	6	7	10	10	10	10	10	13

Table 6 Administrative affairs, authorizing official documents, chairing school meetings, and the planning and supervision of construction projects

Time management	0.81	1.45	1.81	1.81	1.81	2.45	2.6	2.6	2.81	2.81	2.81	3.81	5.04
Population	X	X	X	X	Y	Y	Y	X	X	X	X	Y	Y
ranking	1	2	4	4	4	6	7.5	7.5	10	10	10	12	13

2. Statistical Hypothesis: There was no difference between the medians for the distribution of the two populations (X, Y) or: $H_0 : M_x = M_y$.
3. Statistics:$T = W_x = \sum_{i=1}^{m} R(X_i)$.
4. Decision: Two-tailed tests under significance level α: if $W_L \leq T \leq W_U$, then H_0 is accepted.

2.3.2 Empirical Analysis

The Two sets of Independent Samples Were Tested to Determine if Principles of Different Genders Showed the Same Time Management in School Affairs at a Significance Level of $\alpha = 0.05$

From the table above, $W = 3.5 + 3.5 + 6 + 12 + 13 = 38$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21, 49)$ interval contained 38; therefore H_0 was accepted. This means that male and female principals were the same regarding the time management of teaching activity supervision and course planning and design (Table 4).

From the table above, $W = 1 + 4 + 10 + 10 + 13 = 38$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21, 49)$ interval contained 38; therefore H_0 was accepted. This means that male and female principals were the same regarding the time management of administrative affairs, authorization of official documents, chairing school meetings, and the planning and supervision of construction projects (Table 5).

Table 7 Unexpected or sudde *n* issues or conflict crisis management

Time management	0.81	1.45	1.81	1.81	1.81	1.81	1.81	2.45	2.45	2.45	2.6	3.81	5.04
Population	X	Y	X	X	X	Y	Y	X	X	Y	X	X	Y
ranking	1	2	5	5	5	5	5	9	9	9	11	12	13

Table 8 Miscellaneous affairs, including reflections and critical thinking, personal advanced study, studies away from school, attendance of meetings away from school, and phone conversations

Time management	0.54	1.45	1.45	1.81	1.81	1.81	2.45	2.6	2.6	2.81	3.81	4.04	4.6
Population	Y	X	Y	X	X	X	Y	X	Y	X	X	X	Y
ranking	1	2.5	2.5	5	5	5	7	8.5	8.5	10	11	12	13

Table 9 Teaching activity supervision and course planning and design

Time management	1.45	1.81	1.81	1.81	1.81	2.04	2.45	2.45	2.45	2.45	2.81	3.45	4.45
Population	X	X	X	X	X	Y	X	X	X	Y	Y	Y	Y
ranking	1	3.5	3.5	3.5	3.5	6	8.5	8.5	8.5	8.5	11	12	13

From the table above, $W = 4 + 6 + 7.5 + 12 + 13 = 42.5$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21, 49)$ interval contained 42.5; therefore H_0 was accepted. This means that male and female principals were the same regarding the time management of external public relations building, communication and negotiation of affairs with parents and the community, or the solicitation of external resources to help school projects (Table 6).

From the table above, $W = 2 + 5 + 5 + 9 + 13 = 34$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21, 49)$ interval contained 34; therefore H_0 was accepted. This means that male and female principals were the same regarding the time management of unexpected or sudden issues or conflict crisis handling (Table 7).

From the table above, $W = 1 + 2/5 + 7 + 8.5 + 13 = 31$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21, 49)$ interval contained 31; therefore H_0 was accepted. This means that male and female principals were the same regarding the time management of miscellaneous affairs, including reflections and critical thinking, personal advanced study, studies away from school, attendance of meetings away from school, and phone conversations (Table 8).

2.3.3 Determining Whether, When Testing the Two Sets of Independent Samples, Average and Excellent Principals Showed the Same Time Management in School Affairs at a Significance Level of $\alpha = 0.05$

From the table above, $W = 6 + 8.5 + 11 + 12 + 13 = 50.5$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) =$

Table 10 Administrative affairs, authorizing official documents, chairing school meetings, and the planning and supervision of construction projects

Time management	2.04	2.45	2.81	2.81	2.81	3.04	3.45	4.45	4.45	4.45	4.45	4.45	4.6
Population	Y	X	X	X	Y	X	X	X	X	X	Y	Y	Y
ranking	1	2	4	4	4	6	7	10	10	10	10	10	13

Table 11 External public relations building, communication and negotiation of affairs with parents and the community, or solicitation of external resources to help school projects

Time management	0.81	1.45	1.81	1.81	1.81	2.45	2.6	2.6	2.81	2.81	2.81	3.81	5.04
Population	Y	X	X	X	X	Y	Y	X	X	X	Y	X	Y
ranking	1	2	4	4	4	6	7.5	7.5	10	10	10	12	13

Table 12 Unexpected or sudden issues or conflict crisis management

Time management	0.81	1.45	1.81	1.81	1.81	2.45	2.6	2.6	2.81	2.81	2.81	3.81	5.04
Population	Y	Y	Y	X	X	X	X	X	X	Y	X	X	Y
ranking	1	2	5	5	5	5	5	9	9	9	11	12	13

$(21,49)$ interval contained 50.5; therefore H_0 was accepted. This means that the two sets of principals were not the same regarding the time management of teaching activity supervision and course planning and design (Table 9).

From the table above, $W = 1+4+10+10+13 = 38$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21,49)$ interval contained 38; therefore H_0 was accepted. This means that the two sets of principals were the same regarding the time management of administrative affairs, authorizing official documents, chairing school meetings, and the planning and supervision of construction projects (Table 10).

From the table above, $W = 1+6+7.5+10+13 = 37.5$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21,49)$ interval contained 37.5; therefore H_0 was accepted. This means that the two sets of principals were the same regarding the time management of external public relations building, communication and negotiation of affairs with parents and the community, or the solicitation of external resources to help school projects (Table 11).

From the table above, $W = 1+2+5+9+13 = 30$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21,49)$ interval contained 30; therefore H_0 was accepted. This means that the two sets of principals were the same regarding the time management of unexpected or sudden issues or conflict crisis management. (Table 12).

From the table above, $W = 1+8.5+8.5+10+13 = 41$. Based on the Wilcoxon rank-sum test probability table, when $m = 5, n = 8$, and $\alpha = 0.05$, the $(WL, WU) = (21,49)$ interval contained 41; therefore H_0 was accepted. This means that the two sets of principals were the same regarding the time management of

Table 13 Miscellaneous affairs, including reflections and critical thinking, personal advanced study, studies away from school, attendance of meetings away from school, and phone conversations

Time management	0.54	1.45	1.45	1.81	1.81	1.81	2.45	2.6	2.6	2.81	3.81	4.04	4.6
Population	Y	X	X	X	X	X	X	Y	Y	Y	X	X	Y
ranking	1	2.5	2.5	5	5	5	7	8.5	8.5	10	11	12	13

miscellaneous affairs, including reflections and critical thinking, personal advanced study, studies away from school, attendance of meetings away from school, and phone conversations (Table 13).

3 Conclusion and Suggestions

3.1 From the Above Calculation Results, the Following Conclusions Were Reached

3.1.1. The average values for the fuzzy samples of the time spent by principals on the five categories of teaching courses, administrative tasks, public relations development, crisis management, and miscellaneous affairs indicate that administrative tasks accounted for the most time spent.

3.1.2. Male and female principals showed no difference regarding item 1 (teaching activity supervision and course planning and design), item 2 (administrative affairs, authorizing official documents, chairing school meetings, and the planning and supervision of construction projects), item 3 (external public relations building, communication and negotiation of affairs with parents and the community, or the solicitation of external resources to help school projects), item 4 (unexpected or sudden issues or conflict crisis handling), and item 5 (miscellaneous affairs, including reflections and critical thinking, personal advanced study, studies away from school, attendance of meetings away from school, and phone conversations).

3.1.3. The two sets of principals (those who either had or had not been given leadership excellence awards) showed differences regarding item 1 (teaching activity supervision and course planning and design). They showed no difference regarding the other items, including item 2 (administrative affairs, authorizing official documents, chairing school meetings, and the planning and supervision of construction projects), item 3 (external public relations building, communication and negotiation of affairs with parents and the community, or the solicitation of external resources to help school projects), item 4 (unexpected or sudden issues or conflict crisis handling), and item 5 (miscellaneous affairs, including reflections and critical thinking, personal advanced study, studies away from school, attendance of meetings away from school, and phone conversations). Therefore, principals that have won outstanding leadership awards invest more time in the curricula and teachers compared to most principals. This indicates that the school curriculum and teaching are the core aspects of school education. School principals have a decisive influence on the school development and prospects under their management. To enable the impossible to become possible, effective time management is an essential leadership tool and topic.

3.2 This Section Provides Suggestions

Future studies can use these suggestions and directions as a reference to continue investigation on this topic. The number of samples in this study was relatively small, as was the scope of the study. Therefore, if future studies can expand the sampling size and increase the research content, the value of the research will be increased. In addition, a deeper understanding of the variations regarding the time management of principals when handling school affairs will be obtained.

References

T.F. Cheng, Time management in school management. Educ. Inform. Dig. **31**(4), 135–167 (1993)

D.T. Circle, Teaching. Music **3**(13), 5–8 (2005)

G.W. Li, *Full Range of Time Management* (Taipei, Xinyu Press 1996)

Y.H. Lin, Fuzzy correlation coefficient. J. Educ. Res. Educ. Discipline Classroom Psychol. Tests Stat. **122**(22), 148–149 (2004)

N. Linda, A day in the life of a school leader. Educ. Leadersh. **61**, 82–84 (2004)

R.A. Mackenzie, *The Time Trap* (Amacon, New York, 1972)

T.J. Sergiovanni, Leadership and excellence in schooling. Educ. Leadersh. **41**, 4–4 (1984)

J. Slezak, *Odyssey to Excellence: How to Build Effective Schools Through Leadership and Management Skills* (ERIC NO. ED266535 1984).

T.K. Tien-Liu, B. Wu, *Physical Education and Sports Assessment of New Technologies-Application of Fuzzy Statistics* (Southern District Statistics Seminar, Fu Jen Catholic University 2012)

B. Wu, *Introduction to Fuzzy Statistics: Methods and Applications* (Wu-Nan Books, Taipei, 2005)

B. Wu, H.T. Nguyen, *Fuzzy Mathematical and Statistical Application* (Junjie Bookstore, Taipei, 2000)

B. Wu, W.S. Yang, *Fuzzy Statistical Analysis in the Social Survey, The development and application of social science measurement methods* (Wen-Shan Yang: Research Center for Humanities and Social Sciences, 1997), pp. 289–316

Parent and Teacher Communication: A Case Study in Vietnam

Khanh M. Hoang, Hao T. Nguyen, and Thuy T. La

Abstract This article reports the survey results of parent viewpoints on parent-teacher communication in randomly selected Southern Vietnam elementary schools. During two months, 920 parents of students at four elementary schools in the city were contacted and agreed to respond to the survey. The survey focused on channels of communication, interested exchange subjects between parents and teachers, and parents evaluation of the communication channels. The results of data analysis indicate that traditional communication channels through the means of report cards, information sheets and via modern technology such as phone call, phone message, and electronic report cards are in the favor of majority of Vietnamese parents in this urban city. In particular, parents mostly communicate with teachers and schools about their children's academic results and learning activities. The result also shows significant differences in teacher-parent communication between parents of first grade students and those of students in other grade levels. Parents of first class students and their teachers exchange more frequently on the topics of familiarizing the newcomers in the schools with learning activities. Implications for improving the parent-teacher communication and parent involvement in Vietnam are discussed.

Keywords Parent-teacher communication • Vietnam primary education • Family school communication • Vietnamese parents and education

K.M. Hoang (✉) • H.T. Nguyen • T.T. La
University of Social Sciences and Humanities, VNU-HCM, 10-12 Dinh Tien Hoang, Ben Nghe Ward, District 1, HCMC, Vietnam
e-mail: maikhanhhoang@hcmussh.edu.vn; haonguyenpy2@yahoo.com; tthuy07@gmail.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_33,

1 Introduction

1.1 Theoretical Framework

A large number of researches have emphasized the importance of building school-family partnerships to improve parents' involvement in their children's schooling. Studies such as those by (Munk and William 2001; Tobolka 2006), show that effective communication between families and schools is necessary for students' success. Also, by having more contact with parents, teachers learn more about their students' needs and home environment. Parents who are involved tend to have a more positive view of teachers, which results in improved teacher morale (Vickers and Minke 1995). Former studies showed that parents' evaluation of teacher and their comfort with school were higher when they received more frequent and effective communication from teachers. The effectiveness and frequency of teacher-parent communication also positively influenced student motivation and the support parents gave to their children at home (Ames 1995; Freytag 2001). Previous studies show that the communication between school and family relies on print materials such as school newsletters to communicate schooling matter to parents and focuses on three main goals: to inform parents about their childrens' performance, to inform them on how to help with their children's homework, and to express the school's expectation of their roles as parents (Carey et al. 1998; Herrold and Kevin 2008). Overall, previous studies suggested the shortcomings of parent involvement in schools due to the limited written policies on how to get parents involved, and the limited training of teachers on working with parents (Hornby and Witte 2010). In short, previous studies suggested that effective communication needs to be consistent and that teachers should have opportunities to create the tools for communication with parents, collect the data about this interaction, and analyze it (Decker and Majerczyk 2000; Tuten 2007)

1.2 Research Questions

In the context of Vietnam, there is limited empirical study about the parent-teacher communication. Therefore, this exploratory study investigates the Vietnamese parents' perception of the communication channels between parent and teacher and the parents' evaluation of the modes of communication. In particular, these are the guiding questions for our exploration:

- What are the parents' perspectives on family-school communication?
- How do parents evaluate family-school communication?

2 Research Methods

2.1 Participants

Parent and teacher communication questionnaires were administered to 920 participants from a randomly selected sample of parents of students at four urban Southern Viet-nam primary schools. A total of 920 survey questionnaires were returned, 17 of which were dis-qualified because the forms were incomplete. The total return rate for the question-naire was 98 %. The high return rate indicates a representative sample of parents.

2.2 Instrumentation

The survey consists of 19 questions which were created to capture information from parents in an easy-to-complete format that includes 14 questions regarding purpose, content, method of parent-teacher communication, and their perceptions on using current parent-teacher communication forms. The other five questions are demography questions on occupations, relationships with children currently studying at these four elementary schools, their education level, student gender and their grades, student achievements over the last semester. The questionnaire includes multiple-choice question, open-ended question, and four-point Likert scale questions. Respondents were asked to rank preferred methods of communication and to answer open-ended questions pertaining to the effectiveness of home-school interactions. A draft of the instrument was field-tested with a group of primary-school parents that were led by research assistants. Based on respondent feedbacks some changes were made in order to enhance the comprehensiveness and clarity of the instrument.

2.3 Data Collection and Analysis

The survey was administered directly to four urban Southern Vietnam primary-school parents while they were waiting to pick their children up after schooltime or during parent-teacher meetings. Each participant received a pen and one questionnaire and was asked to answer the survey took approximately 6–8 min to complete. The questionnaire survey was conducted over the course of two month months (April and May 2012). Descriptive analysis was employed to describe parents' perceptions of teacher-parent communication channels and exchanged subjects and to evaluate those aspects. In addition, independent sample t test (inferential statistics) were applied to explore the differences of each item among various groups in terms of students grade and gender, parent education level, and parent occupation.

3 Results

3.1 Parents' Preference and Teachers' Frequent Usage of Communication Channels

Table 1 presents' the results of parents preference and teachers' frequent usage of communication channels.

Two communication channels that parents prefer using the most were Traditional report cards and Electronic report cards, accounting for 28.4 and 26.7 % . Furthermore, Phone call report is recommended for use by 20.8 % of parents. Other communication channels are negligible, accounting for from 1.9 % to 9.2 % . To draw a general picture on implementing parent-teacher communication channels, parents were asked to rate teachers' use of communication channels in a four-point Likert scale, of which one was the least and four were the most. Results re-veal that Traditional report cards, Scheduled notification, and Parent-teacher meeting are the three channels of communication used more frequently by teachers. Parent-teacher meeting is implemented more often by school although parents prefer Electronic report cards. This is similar to Scheduled notification (see Table 1 and Fig. 1).

3.2 Communicated Subject: Parents' Desire and Schools' Frequent Usage

The results show that parents are most interested in talking with the teachers and schools about their childrens' learning achievement. Learning achievement is the most important exchanged subject of parents (85 %). Following are Student learning activities (61 %) and Student moral conduct evaluation (56 %). Other subjects such as Student relationship, Student nutritional health, Student behaviors at schools, and Problems in psychophysiology changes of student have lower usage by parents.

Table 1 Parents' preference of the communication channels

Channels of communication	Frequency	Percentage
Traditional report cards	250	28.4
Electronic report cards	235	26.7
Phone call report	183	20.8
SMS	81	9.2
Parent-teacher meeting	53	6
Scheduled notification	38	4.3
Unscheduled notification	23	2.6
Others	17	1.9
Total	880	100

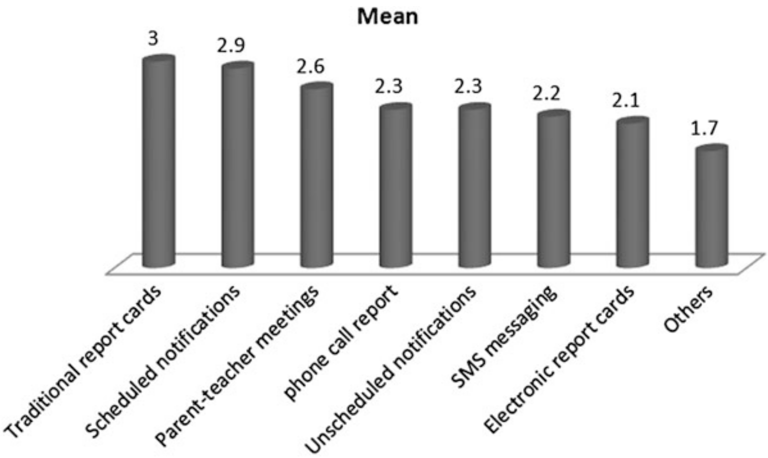


Fig. 1 Parents' rating of frequent usage of school communication channels

Table 2 Frequency of subjects parents are interested in during family-school communication

Subjects of family-school communication	Frequency	Percentage
Learning achievement	246	85
Students learning activities	175	61
Student moral conduct evaluation	162	56
Student relationship	139	48.3
Students nutritional health	138	48
Student behaviors at schools	107	37
Problems in psychophysiology changes of student	103	36
Parents financial contributions	69	24

Generally speaking, parents want to communicate on their childrens learning and conduct at elementary schools (Table 2).

In reality, Vietnamese teachers and parents pay more attention on Learning achievement, Student learning activities, and Student moral conduct evaluation. Parents are less interested in other exchanged subjects including Student behaviors at schools, Student relationship, Problems in psychophysiology changes of student, and Parent financial contributions. However to the teachers, there are no significant differences (see Fig. 2).

3.3 *Parent Evaluation of the Communication*

Parents were asked to rate their satisfaction of the communication in general. Parent satisfaction was evaluated by the four-point Likert scale (1 = completely unsatisfied, 4 = completely satisfied). The descriptive mean of 3.46 indicates that most parents

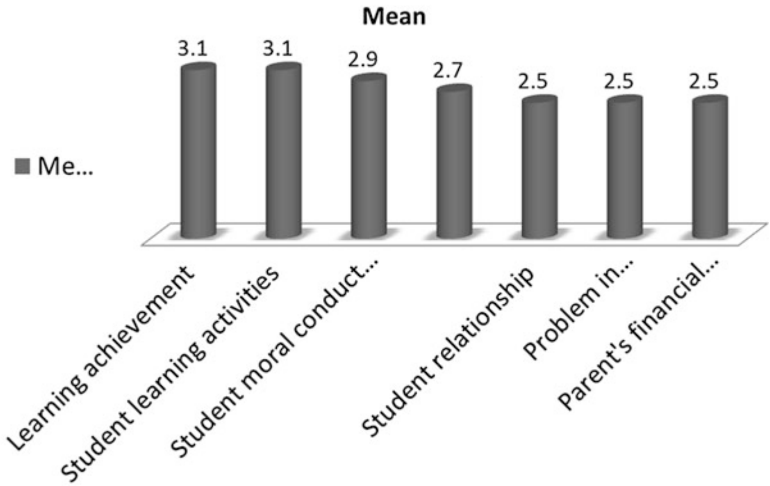


Fig. 2 Parent rating on schools' frequent usage of communicated subjects

are satisfied with teacher communication. The frequency statistic indicates that 97 % of parents were satisfied. The parents also agree that schools promptly communicate with them about their childrens' learning achievement and activities (mean = 3.4, SD = 0.61). The result shows that parents actively initiate the communications with teachers and schools. There are 21 % of parents do it very often and 46 % initiate the communication quite often. The parents also express their satisfaction with teachers' feedback and cooperation ($M = 3.53$, SD = .55).

3.4 Parent-Teacher Communication: Grade Level Differences According to the Parents' Perspective

Comparisons of independent means were computed on all parents' evaluation of the differences in teacher-parent communication for different grade levels. The results (Table 3) indicate the significant differences between parents of the first grade students and the parents of students in other grade levels in some communication channels.

According to the significant differences show in Table 3, teachers and parents of the first grade students need to communicate more often than teachers and parents of students in other grade levels. Phone call report, Scheduled notification, and Unscheduled notification are the communication strategies used by the teachers of the first grade students more frequently than the teachers in other grade levels. The phone call report helps teachers connect directly and immediately to parents. The information exchanged through this channel is prompt and teachers could also receive the parents' opinions and feedbacks. Teachers of the first grade students

Table 3 Communication channels used frequently by first grade teachers and upper grade teachers

	Groups				
	(first grade) $n = 241$		(second–fifth grades) $n = 553$		
Communication subjects	Mean	SD	Mean	SD	t
Phone call report	2.40	0.62	2.24	0.61	2.68 **
Scheduled notification	3.16	0.77	2.78	0.79	4.85 ***
Unscheduled notification	2.46	0.89	2.23	0.80	2.41 *

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 4 Family-school communicated subjects: grade level differences according to the parents' perspective

	Groups				
	(first grade) $n = 241$		(second–fifth grades) $n = 553$		
Communication subjects	Mean	SD	Mean	SD	t
Student learning activities	3.12	0.65	3.00	0.63	2.86 **
Student behavior at school	2.86	0.77	2.62	0.72	3.67 ***
Student relationship	2.71	0.84	2.37	0.79	4.70 ***
Student psychophysiological problems	2.68	0.84	2.36	0.86	4.22 ***
Parent financial contributions	2.60	0.72	2.48	0.65	2.02 *

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

seem to use the scheduled and unscheduled notifications more often than teachers in the upper grades. Besides the phone call reports, teachers of the first grade often use printed materials hat are sent home to parents.

Significant differences occurred not only in teachers' modes of communica-tions, but also in exchanged subjects with parents. The frequency of exchanged subjects was analyzed using the independent samples t test between two groups of the parents of first grade and upper grade students. Table 4 shows the means and the t-value for this analysis.

In comparison with the parents of upper grade students, the finding reveals that teachers and parents of first grade students are significantly interested in exchanged subjects re-levant to Student learning activities, Student behavior at school, Student relationship, Students psychophysiological problems' and Parent financial contributions.

4 Discussion and Conclusion

Besides the traditional report card—the usual mode of communication between parents and teachers—the Vietnamese parents preferred the new modes, which were more convenient and effective. Parents view that the use of electronic report card and phone call report provides prompt information and effective feedback between parents and teachers. However, teachers are using the traditional report card more frequently while the parents prefer the use of phone call and electronic report cards. There is similarity between the expectations of parents and the information provided by teachers. Academic results or performance is the topic that parents the most concerned about and also teachers are most communicated with. Through parent evaluation, teachers have incorporated many different kinds of communication for timely transferred information to parents. In general, parents are satisfied with the school-family communication. Parents of first grade students pay special attention to the subjects neglected by almost other parents: Student behavior at school, Students relationships, and Student psychophysiological problems.

Family-school communication is the topic considered of interest to all stakeholders in educa-tional settings. Traditional modes of communication (traditional report cards, meeting, notifications) are no longer sufficient in a digital and technological world. Parents have expressed their desire to receive information from school promptly by incorporating diverse communication channels.

The study has several implications for practice:

- Initiation: teachers as well as parents should initiate contact at the beginning of school year.
- Timelines: information promptly exchanged satisfies both parents and teachers, so a timely solution for all problems occurred can be found.
- Consistency and frequency: parents want frequent, ongoing feedback about how their children are performing.

This study has some limitations. As a case study, it cannot be generalized for all Vietnamese parents and teachers. The study only surveyed parents' perception on parent-teacher communication. Future studies should investigate other actors such as teachers and administrators' opinions about the use of school-family communication and its impact on improving family communication and collaboration for student schooling.

Acknowledgements We would like to thank the undergraduate students from the Faculty of Education, the University of Social Sciences and Humanities, Ho Chi Minh City for their tireless help with the data collection.

References

C. Ames, Teachers school-to-home communications and parent involvement: The role of parent perceptions and beliefs. Report 28 (1995)

N. Carey, L. Laurie, F. Elizabeth, Westat, Inc., Parent involvement in childrens education: Efforts by public elementary schools. Statistical Analysis Report, NCES January, (1998)

J. Decker, M. Diana, Increasing Parent Involvement Through Effective Home/School Communication, Dissertation, Saint Xavier University, Chicago, Illinois, 2000

C. Freytag, Teacher-parent communication: starting the year off right, in *Biennial Meeting of the Kappa Delta Pi International Honor Society in Education*, Orlando, FL, 2001

K. Herrold, O. Kevin, Parent and family involvement in education, 2006–07 school year, from the national household education surveys program of 2007. First Look. NCES August (2008)

G. Hornby, W. Chrystal, Parent involvement in rural elementary schools in new zealand: A survey. J. Child Family Stud. **19**(6), 771–777 (2010)

D. Munk, B.D. William, What report card grades should and do communicate: Perceptions of parents of secondary students with and without disabilities. Remedial Spec. Educ. **22**(5), 280–287 (2001)

D. Tobolka, Connecting teachers and parents through the internet. Tech. Dir. **66**(5), 24–26 (2006)

J. Tuten, Theres two sides to every story: How parents negotiate report card discourse. Lang. Arts **84**(4), 314–324 (2006)

H.S. Vickers, K.M. Minke, Exploring parent-teacher relationships: Joining and communication to others. School Psychol. Q. bf 10(2), 133–150 (1995)

Pricing the American Options from the Viewpoints of Traders

Ming Long Liu and Hsuan-Ku Liu

Abstract This paper proposes an arbitrage model, which involves trading the American option (AO) and asset in the frictionless market. The solution of this model provides a trading strategy to maximize the expected arbitrage profit when the market exists as an arbitrage opportunity. When there is no arbitrage opportunity in the market, we analyze the arbitrage model by using the duality theory of mathematical programming and show that the initial value of the AO is equal to the expectation of all this option's future possible payoffs. Our results can be used to construct probability recovering models from the observed market price of the AO.

1 Introduction

An American option (AO) is a contract that can be exercised prior to the maturity. However, an AO is always a tradable asset in the market. Instead of exercising the AO, investors holding the ACC will trade this option in the market to maximize the profit of the portfolio when its market price is greater than the early exercise profit.

In this paper, we will propose an arbitrage model, which involves short selling or long buying the AO and assets, from the viewpoint of investors. Namely, the investor in our model can reallocate the position of the AO at each state to maximize the arbitrage profit.

M.L. Liu
Department of Mathematical Sciences, National Chengchi University, Taipei, Taiwan
e-mail: mlliu@nccu.edu.tw

H.-K. Liu (✉)
Department of Mathematics and Information Education,
National Taipei University of Education, Taipei, Taiwan
e-mail: hkliu.ntue@gmail.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_34,

The alive AO always has a market price at each state and can be traded in the practical market. In the practical market, the investors always hold more than one unit of the AO and can reallocate the position of the AO at each state. Therefore, our arbitrage model is constructed by including a variable which indicated the position of the AOs. The objective function in the arbitrage model is defined as the expected arbitrage profit. When the market exists as an arbitrage opportunity, the solution of our model provides a trading strategy to maximize the expected arbitrage profit.

On the other hand, the optimal value of the arbitrage model is equal to zero when there is no arbitrage opportunity in the market. We analyze the arbitrage model by using the mathematical technique of duality theory. The dual problem turns out to require the existence of the probability measure. Furthermore, we show that the value of the AO at each state is equal to the conditional expectation of all the possible future payoff under the synthesis probability measures.

2 Notations and Assumptions

Following the notation of King (2002), we denote $\mathbb{F} = \{\mathscr{F}_t | t = 0, 1, 2, \ldots, T\}$ and $\mathbb{F}$ is called a filtration. The true state of the world is revealed to the investors at time t by the atoms of $\mathscr{F}_t$. For any t, let the set $\mathscr{N}_t$ be a partition of Ω which generates the algebra $\mathscr{F}_t$. Thus, $\mathscr{N}_{t+1}$ will be a refiner of $\mathscr{N}_t$, for all t. It is convenient to model the relation of $\{\mathscr{N}_t\}_{t=0}^{T}$ by a T-depth scenario tree, in which each atom in $\mathscr{N}_t$ corresponds to a unique node at the depth t in the tree. The leaf nodes $n \in \mathscr{N}_T$ of the scenario tree are one-to-one correspondence to the elements ω in the sample space Ω. The unique parent node of node $n \in \mathscr{N}_t$ for $1 \le t \le T$ is denoted as $a(n) \in \mathscr{N}_{t-1}$, and the set of child nodes of node $n \in \mathscr{N}_t$ for $0 \le t \le T-1$ is denoted as $c(n) \in \mathscr{N}_{t+1}$. Let the probability of each leaf node $n \in \mathscr{N}_T$ is weighted as p_n with $\sum_{n \in \mathscr{N}_T} p_n = 1$. Hence, the probability of the internal nodes $n \in \mathscr{N}_t$, $t = 1, 2, \ldots, T-1$ is obtained recursively by $p_n = \sum_{m \in c(n)} p_m$ and the conditional probability of the state n occurred under the information of state $a(n)$ is defined by $p_n / p_{a(n)}$.

Denoted $P = \{p_n\}_{n \in \mathscr{N}_t}$ for all t, the triple $(\Omega, \mathscr{F}, P)$ becomes a probability space. Suppose that $\{X_t\}_{t=0}^{T}$ is a stochastic process adapted by the filtration $\mathbb{F}$, then the condition expectation of X_{t+1} under the information of state $n \in \mathscr{N}_t$ and the probability P is defined as $\mathrm{E}^P[X_{t+1} | \mathscr{N}_t] \equiv \sum_{m \in c(m)} X_m \frac{p_m}{p_n}$, which is a random variable of states in $\mathscr{N}_t$.

In the market, there are $K+1$ traded securities indexed by $k = 0, 1, \ldots, K$ with the vector price process $\mathbf{S}_n$; $n \in \mathscr{N}_t$ are adapted by the filtration $\mathbb{F}$, that is, $\mathbf{S}_n$ is measurable in the algebra $\mathscr{F}_t$. The vector $\mathbf{S}_n$ can be represented as $(S_n^0, S_n^1, \ldots, S_n^K)$ where security 0 is chosen to be a numeraire which is essentially a bank account process. We introduce the discounted processes denoted by $\beta_n = \frac{1}{S_n^0}$. The discounted security prices relative to the numeraire are denoted by $Z_n^k = \beta_n S_n^k$ for $k = 0, 1, \ldots, K$. The price Z_n^0 of the numeraire will be exactly one in any state n.

Let θ_n^k denote the investment amount of the asset k at the state n from time t to time $t+1$. A trading strategy $\bar{\theta}_n = (\theta_n^0, \theta_n^1, \ldots, \theta_n^K)$ at state n, $n \in \mathscr{N}_t$ is a vector of decision variables. The total wealth at node n of the investor can be obtained by the inner product of the two vectors as follows:

$$\mathbf{Z}_n \bar{\theta}_n = \sum_{k=0}^{K} Z_n^k \theta_n^k \equiv \mathbf{V}_n.$$

Note that if θ_n^k is negative, it corresponds to borrow money from the bank or to sell the security k. In this representation, we need to note that the investment amount of each asset at the node n always decides after the asset's price is revealed. A trading strategy is called self-finance if $\mathbf{Z}_n \bar{\theta}_{a(n)} = \mathbf{Z}_n \bar{\theta}_n,\ n \in \mathscr{N}_t, t = 0, 1, 2, \ldots, T$, which states that time t investments are financed only from the proceeds of time $t-1$ holding.

3 An Arbitrage Model

In this section, we will propose an arbitrage model which involves short selling of δ_0 units of the AO and buying $\bar{\theta}_0$ units of the assets at the initial state. We then analyze the optimization dual problem of the arbitrage model in the arbitrage-free market. The definition of arbitrage is followed by Hunt and Kennedy (2000).

Definition 1. The economy ε admits arbitrage if there exists a portfolio ϕ such that one of the following conditions holds:

1. $\phi \cdot A_0 < 0$ and $\phi \cdot A_1(w_j) \geq 0$, for all j
2. $\phi \cdot A_0 \leq 0$ and $\phi \cdot A_1(w_j) \geq 0$, for all j, which strictly inequality for some j

If there is no such ϕ then the economy is said to be arbitrage-free.

Let δ_n and C_n denote, respectively, the holding number of units and the market price of the AO at state n. An AO is a contract which gives the buyer a right to receive a payoff F_n when he exercises his right at node $n \in \mathscr{N}_t$, $t = 1, 2, \ldots, T$. Hence, the possible payout for $\delta_{a(n)} < 0$ (or income for $\delta_{a(n)} > 0$) at the current state is $\beta_n F_n \delta_{a(n)}$, $n \in \mathscr{N}_t$.

The arbitrage opportunity in this paper is defined as the possibility of finding a self-financing trading strategy which can produce positive reward from nothing. Therefore, the arbitrage model should include the self-finance strategy constraint and the initial wealth constraint.

Hence, the arbitrage model is written as follows:

3.1 Arbitrage Model

$$\max \sum_{t=1}^{T} \sum_{n \in \mathcal{N}_t} p_n d_n \tag{1}$$

$$\text{s.t. } \mathbf{Z}_n \bar{\theta}_{a(n)} - \beta_n F_n \delta_{a(n)} \geq d_n, \qquad n \in \mathcal{N}_t, t = 1, 2, \ldots, T-1, \tag{2}$$

$$\mathbf{Z}_n(\bar{\theta}_n - \bar{\theta}_{a(n)}) - \beta_n C_n(\delta_n - \delta_{a(n)}) = 0, \qquad n \in \mathcal{N}_t, t = 1, 2, \ldots, T, \tag{3}$$

$$\mathbf{Z}_0 \bar{\theta}_0 - C_0 \delta_0 = 0, \tag{4}$$

$$d_n \geq 0, \qquad n \in \mathcal{N}_t, t = 1, 2, \ldots, T \tag{5}$$

$$\delta_n, \theta_n \text{ are unrestricted}, \qquad n \in \mathcal{N}_t, t = 0, 1, \ldots, T. \tag{6}$$

The following theorems show that the objective value of the arbitrage model will equal to zero when there is no arbitrage opportunity in the market.

Theorem 1. *A market has an arbitrage opportunity if and only if the objective value of the arbitrage model is strictly positive. Moreover, the optimal solution of the arbitrage model has at least a* $d_n > 0$ *for some* $n \in \mathcal{N}_t$*,* $t \leq T$*.*

Corollary 1. *A market has no arbitrage opportunity if and only if the objective value of the arbitrage model equals to zero, that is,* $d_n = 0$ *for all n.*

To obtain the main result of this paper, we begin with analyzing the dual problem of the above model. The first step in calculating the dual is to multiply all the constraints by the dual variables to form the Lagrangian function.

Let $(\theta, d; \eta, w)$ be an optimal solution of the Lagrangian function. We have $\mathcal{L}(\theta, d; \eta, w) = 0$ when there is no arbitrage opportunity in the market, namely, the objective value of the arbitrage (primal) model is equal to zero. As a result, the solution (η, w) satisfies the following necessarily conditions:

3.2 Feasibility Problem

$$w_n \geq p_n, \qquad n \in \mathcal{N}_t, \qquad t = 1, 2, \ldots, T, \tag{7}$$

$$\eta_n \mathbf{Z}_n = \sum_{m \in c(n)} w_m \mathbf{Z}_m, \qquad n \in \mathcal{N}_{T-1}, \tag{8}$$

$$\eta_n \beta_n C_n = \sum_{m \in c(n)} \beta_m F_m w_n, \qquad n \in \mathcal{N}_{T-1}, \tag{9}$$

$$\eta_n \mathbf{Z}_n = \sum_{m\in c(n)} (\eta_m + w_m)\mathbf{Z}_m, \qquad n \in \mathscr{N}_t, \qquad t = 0,1,2,\ldots,T-2, \quad (10)$$

$$\beta_n \eta_n C_n = \sum_{m\in c(n)} [\beta_m C_m \eta_m + \beta_m F_m w_m], \quad n \in \mathscr{N}_t, \qquad t = 0,1,2,\ldots,T-2. \quad (11)$$

Definition 2 (King 2002). A stochastic process $\{X_t\}$ is called a martingale process under the probability measure Q if

$$\mathrm{E}^Q[X_t|\mathscr{N}_n] = X_n, \text{ for all } n \in \mathscr{N}_s, s < t$$

and Q is called a martingale probability measure for the process.

Theorem 2. *Let $(\eta, \boldsymbol{w})$ be a feasible solution of the feasibility problem. We define $q_{m,n} = \frac{w_m}{\eta_n}$ for $m \in c(n)$, $n \in \mathscr{N}_T$, and $q_{m,n} = \frac{\eta_m + w_m}{\eta_n}$ for $m \in c(n)$, $n \in \mathscr{N}_t$, $t = 1,2,\ldots,T-1$ then, for all $n \in \mathscr{N}_t$, the collection $\{q_{m,n}\}_{m\in c(n)}$ is then interpreted as a conditional probability of the state $m \in c(n)$ under the state n. In fact, the discounted stock price process $\mathbf{Z}_n$ is a martingale under the probability measure $\{q_{m,n}\}_{m\in c(n)}$.*

Now, we produce the AO's price process from T backward to 0. At the maturity date, the holder of the AO receives final payoff F_n and the value C_n of the AO is equal to the final payoff F_n. At the earlier stage before the maturity, we have

$$C_n = \sum_{m\in c(n)} \frac{\beta_m}{\beta_n} F_m \frac{\eta_m}{\eta_n} = \sum_{m\in c(n)} \frac{\beta_m}{\beta_n} F_m q_{m,n}, \; n \in \mathscr{N}_{T-1}$$

by (9). This implies that AO's price at state $n \in \mathscr{N}_{T-1}$ is equal to the conditional expectation of the possible final payoff discounted to the time $T-1$.

At any time $t = 1,2,\ldots,T-1$, the holder of the AO has two possible decisions. One decision is the holder exercising the AO to receive the exercise payoff F_n. The other is the holder holding the AO with the market price C_n. Equation (11) describes this two cases: the first term in the brackets corresponds to the AO's market value and the second term corresponds to the AO's exercise payoff. The current value of the AO is equal to the weighted sum of the market value and the exercise payoff in (11). By analyzing (11), we obtain the following equation:

$$C_n = \sum_{m\in c(n)} \frac{\beta_m}{\beta_n}[C_m \frac{\eta_m}{\eta_n} + F_m \frac{w_m}{\eta_n}] = \sum_{m\in c(n)} \frac{\beta_m}{\beta_n}[C_m q_{n,m,1} + F_m q_{m,n,2}], \; n \in \mathscr{N}_t, \quad (12)$$

where $q_{m,n,1} = \frac{\eta_m}{\eta_n}$, $q_{m,n,2} = \frac{w_n}{\eta_n}$, and $t = 0,1,2,\ldots,T-2$. Here, $q_{m,n,1}$ and $q_{m,n,2}$ separate the conditional probability $q_{m,n}$ into two parts by using (10). The numbers $q_{m,n,1}$ and $q_{m,n,2}$ are interpreted as conditional probability of holding the AO and exercising the AO at the next stage under the stage n, respectively. Thus, we regard the collection $\{q_{m,n,1}\}_{m\in c(n)} \bigcup \{q_{m,n,2}\}_{m\in c(n)}$ as a conditional probability under the state n. By using (12), the current value of the AO is regarded as the conditional expectation under the state n in $\mathcal{N}_t$ of all possible outcomes, holding and exercising, at the next stage.

At any state n of time t_0, we obtain $\eta_n = \sum_{t=t_0+1}^{T} \sum_{m \in \mathcal{N}_t} w_n$ by deriving (8) and (10) from T backward to t_0. This implies $1 = \sum_{t=t_0+1}^{T} \sum_{m \in \mathcal{N}_t} \frac{w_n}{\eta_n}$. In order to describe the new probability measure, we denote a new symbol $\mathcal{T}_n$, $n \in \mathcal{N}_{t_0}$ defined as

$$\mathcal{T}_n \equiv \{m \in \mathcal{N}_t | \text{there exists a path } P \text{ connecting } n \text{ and } m, \text{ but } a(n) \notin P, t \geq t_0\},$$

that is, $\mathcal{T}_n$ is a set of nodes in the subtree of the scenario tree with the root n. For example, the set $\mathcal{T}_0$ contains all nodes on the scenario tree and

$$\eta_0 = \sum_{t=1}^{T} \sum_{n \in \mathcal{N}_t} w_n = \sum_{n \in \mathcal{T}_0} w_n. \tag{13}$$

We set $y_n = w_n \eta_0^{-1}$ and claim that the collection $Q = \{y_n\}_{n \in \mathcal{T}_0}$ is a probability measure.

Theorem 3. *Let (w, η) be an optimal solution of the feasibility problem, then the collection $Q = \{y_n\}_{n \in \mathcal{T}_0}$ is a probability measure.*

Proof. By (13), we have $1 = \sum_{n \in \mathcal{T}_0} \frac{w_n}{\eta_0} = \sum_{n \in \mathcal{T}_0} y_n$ and $\eta_0 \geq w_n \geq p_n$ for all $n \in \mathcal{T}_0$. So the collection Q is a probability measure. □

Imposing (8) into (10) and deriving (10) from T backward to 0, we have the following equation,

$$\beta_0 C_0 = \sum_{m \in \mathcal{T}_0} \beta_m F_m \frac{w_n}{\eta_0} = \sum_{m \in \mathcal{T}_0} \beta_m F_m y_m. \tag{14}$$

Thus, we conclude our discussion by the following theorem:

Theorem 4. *If the market exists as no arbitrage opportunity then there exists a probability measure such that the initial value of the AO equals to the expectation of all the possible future payoff. In fact, the discounted value of the AO at each state $n \in \mathcal{N}_t$ satisfies the following formula:*

$$\beta_n C_n = \sum_{m \in \mathcal{T}_n} \beta_m F_m \frac{w_n}{\eta_n} = \frac{\sum_{m \in \mathcal{T}_0} \beta_m F_m y_m}{\sum_{m \in \mathcal{T}_0} y_m}.$$

4 Conclusion

We have provided an arbitrage model which involves trading the AO and the assets. In our arbitrage model, the investor can reallocate the position of the AO at each state. Therefore, the arbitrage model is then constructed by including a crucial variable denoting the position of the AOs. By inspecting the dual properties of the arbitrage model, we obtain a new theorem in the arbitrage-free market. Namely, the initial price of AO is equal to the expectation of all the possible payoff at each state under the synthesis probability measure. The synthesis probability is endowed by the solution of the dual variables.

References

P.J. Hunt, J.E. Kennedy, *Financial Derivatives in the Theory and Practice* (Wiley, New York 2000)

A.J. King, Duality and martingales: a stochastic programming perspective on contingent claims. Math. Program. Ser. B **91**, 543–562 (2002)

Research of Decision Variables of Tax Revenue Based on Nonparametric Selection Approach

Zuiyi Y. Shen and Bing Xu

Abstract To ensure sustainable tax revenue growth, decision variables of tax revenue were researched in this paper by using mixed nonparametric kernel method based on a dataset of tax revenue containing both continuous and discrete data in Hangzhou; compared to parameters regression method, it can automatically reduce the dimension of model and possess high model fitting precision. The mean square error of mixed nonparametric kernel method reduces by 49.3 % after deleting 12 irrelevant variables, while it increases by line regression method and stepwise regression. In addition, it is found that the variables of real-estate investment are not a decision variable of tax revenue in nonparametric methods, which is different from stepwise regression. This conclusion provides the negative evidence of experience in tax revenues about whether it will produce decisive influence to tax revenues to control and regulate the real-estate investment.

Keywords Tax revenue • Decision variable selection • Mixed nonparametric kernel estimate

1 Introduction

The proportion of tax revenue to GDP reflects the relationship of possession and control of social resources between the government and microeconomic subject. It also reflects the degree and status of regulation of economic operation and

Z.Y. Shen (✉)
School of Math-physics & Information, Zhejiang Ocean University, ZhouShan, China

Research Institute of Quantitative Economics, Zhejiang Gongshang University, Hangzhou, China
e-mail: shenzuiyi@zjou.edu.cn

B. Xu
Research Institute of Quantitative Economics, Zhejiang Gongshang University, Hangzhou, China
e-mail: bingxu0@yahoo.com.cn

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_35,

influence of social resources allocation by the government. The level of economic growth determines the proportion of fiscal revenue to GDP; the government expenditure mainly supported by the increase of tax revenue has expanded further to every corner of the economy. Tax is the important lever to regulate national economy; also it is the important means to realize supervision to the national economy.

Wang (2008) thought that the high rapid growth of tax revenue depended on the centralization of state power; the positive role of central authorities is not consistent in different economic areas for the increase of tax revenue. Cao et al. (2009) found that the actual tax burden of listed company and the dependence of area finance on the central finance are on the contrary U relationship. Gupta (2007) analyzed that the decisive factors of the tax in the developing countries can significantly affect on tax levels of the country. Davoodi and Grigorian (2007) took the proportion of taxation to GDP as the dependent variable, per capita GDP and agency management quality and consumer price inflation index, agricultural GDP, opening-up, crude oil exports, urbanization level, and the underground economy to Armenia as the independent variables to regression analysis of low tax in Armenia using panel data. Lv and Guo et al. (2011) analyzed three factors of the source of tax growth based on the theoretical framework of tax effort and tax ability: tax incentive comes from the system of tax separation and the contract of tax decentralization; indirect taxation of value-added tax and business tax amplified the tax ability of taxpayer. Demographic dividend, technology imitating dividends, and industrialization and urbanization dividend released tax increase dividends. And it also points out that the role of the first factors will decrease, the same as part of the second factor, while the role of the third factor still exists in the future.

As the theoretical basis for research, whether the increase rapid growth of tax revenue is sustainable and different from existing studies, this paper is not from the theory perspective of tax system but from the empirical experience on decided variable of tax revenue, trying to answer:

Question 1: Among the five influence factors on tax revenue, which variables are decisive and which are not? How to avoid the errors produced by perceptual experience in the model?

Question 2: Which variables possibly have linear correlation in linear regression model with the many variables of five factors? Which variables are not linear relations with tax revenue? How to set up a reasonable model with decision variables of tax revenue?

The paper will apply the theory and method of Hall et al. (2007) to tax revenue model. This method can simultaneously estimate the discrete variables and continuous variables of model in theory and smooth out the discrete data, which can eliminate defects in the method application of the traditional estimation of the nonparametric frequency. More importantly, the method will automatically eliminate the unrelated variables in the asymptotic significance using CV method to choice bandwidth.

The paper is organized as follows. Section 2 is the confusion and problems in the choice of decision variables of tax revenues with parameters method. Section 3 is nonparametric methods of selection of decision variable. Section 4 is the result of the nonparametric selection. And the last section concludes.

2 Decision Variables Selected by Parameter Method: Confusion and Problems

Consider these dividends of tax increase such as population, technology imitating, industrialization, and urbanization will play an important role in sustainable increase tax. We choose the following 17 variables for recognizing the decision variables of tax revenue based on the characteristics of Zhejiang economy:

1. Per capita GDP, x_1
2. Population density, x_2
3. The fixed assets investment, x_3
4. Retail sales of consumer goods, x_4
5. Financial expenditure, x_5
6. The proportion of the agriculture to GDP, x_6
7. The proportion of the second industry to GDP, x_7
8. Long-term investments, x_8
9. Real estate investment, x_9
10. Area, x_{10}
11. The proportion of the third industry to GDP, x_{11}
12. Foreign direct investment, x_{12}
13. Industrial gross output index, x_{13}
14. Amount of imports, x_{14}
15. Amount of exports, x_{15}
16. Current assets, x_{16}
17. Total profit, x_{17}

Explanation variables in the model include the 16 continuous variables and discrete variable of area. The data comes from information nets of statistical investigation and tax bureau in Hangzhou from 2004–2009.

2.1 Variable Selection by Linear Method of Parameters

We use linear model (1) to estimate parameters β:

$$Y = \beta X + \varepsilon, \tag{1}$$

where $Y = T/GDP$ is the proportion of tax revenue to GDP, and ε is a random variable which represents the error. We selected nine decision variables of tax revenue using linear model of parameters method. The nine decision variables are as follows: the proportion of the agriculture to GDP x_6, per capita GDP x_1, Population density x_2, industrial gross output index x_{13}, foreign direct investment x_{12}, the proportion of the third industry to GDP x_{11}, The proportion of the second industry to GDP x_7, financial expenditure x_5, and area x_{10}.

2.2 *Variable Selection of Stepwise Regression Method*

Here we use the backward stepwise regression and start from the model containing all the variables; a variable would be taken out from the model every time. The method is to calculate the value of *AIC* after a variable is taken out and choose the model of the smallest value of *AIC* as the best model; remove any variables in the model until the value of *AIC* would not become smaller:

$$AIC(M) = -2l(M) + 2p, \tag{2}$$

where *l(M)* denotes logarithm likelihood function of training set of data and p is the number of variables in the model M.

By the stepwise regression method, we eliminated non significant variables one by one in the model with *AIC* criterion, eliminating the two variables of the real-estate investment and population density. We obtained 15 decision variables of tax revenue using parameters method of stepwise regression: per capita GDP x_1, the fixed assets investment x_3, retail sales of consumer goods x_4, financial expenditure x_5, The proportion of the agriculture to GDP x_6, the proportion of the second industry to GDP x_7, long-term investments x_8, area x_{10}, the proportion of the third industry to GDP x_{11}, foreign direct investment x_{12}, industrial gross output index x_{13}, amount of imports x_{14}, amount of exports x_{15}, current assets x_{16}, total profit x_{17}, area x_{10}.

The mean square error of the estimation obtained by the stepwise regression method, nearly unchanged after eliminating irrelevant variables, but the mean square error of linear regression increased by 14.3 %. It seems the method of stepwise regression is better than linear parameters method, but stepwise regression retained too much explanatory variables, and the calculation was relatively complex; it couldn't find out the main decision variables. Further, in these two methods, there are several regression variables in which the coefficient test is not significant; it implies that there is no necessary linear relationship between several explanatory variables and the explained variables of tax burden. Next we will consider nonparametric method and try to use the nonlinear method to study the decision variables of tax.

3 Nonparametric Method of Selection of Decision Variables

Suppose discrete variables X_i^d $(i = 1,2,\ldots,p)$ are q*1 vectors,$X_j^c \in R^p(j = 1,2,\ldots q)$ are continuous variables. Let $X_i = (X_i^d, X_i^c)$to estimate $E(Y_i|X_i)$ but in the actually applied settings not all of the q+p regressors in X_i are relevant with Y_i, We consider cases where one or more of the regressors may be irrelevant. Without loss of generality, we assume that only the first $p_1(1 \le p_1 \le p)$ components of X_i^d and the first $q_1(0 \le q_1 \le q)$ components of X_j^c are "relevant" regressors in the sense defined below. Note that we assume there exists at least one relevant continuous variable and the regression model case is quite different from the conditional density estimation case as considered in Hall et al. (2007) where one also smooths the dependent variable. This calls for substantial changes to the proofs.

Let $\overline{X}$consist of the first p_1 relevant components of X^c and the first q_1 relevant components of X^d. Let $\tilde{X} = X \setminus \{\bar{X}\}$ denote the remaining irrelevant components of X. The way of defining $\bar{X}$ to be relevant and $\tilde{X}$ to be irrelevant is to say that $(\bar{X}, Y)$ is independent of $\tilde{X}$ clearly, which implies that $E(Y|X) = E(Y|\bar{X})$ and so a standard regression model, of the form $Y = g(X) + \varepsilon$, may equivalently be written in the dimension-reduced form $Y = \bar{g}(\bar{X} + \varepsilon)$. We use $f(x)$ to denote the joint density function of X_i and we use $\bar{f}(\bar{x})$ and $\tilde{f}(\tilde{x})$ to denote the marginal densities of $\bar{X}$ and $\tilde{X}$, respectively. We shall assume that the true regression model is $Y_i = \bar{g}(\overline{X_i}) + \mu_i$ where $\bar{g}(\overline{X_i})$ is of unknown functional form and where $E(\mu_i|\overline{X_i}) = 0$. For the discrete regressors X_s^d, we define the kernel function for discrete variables as

$$l(X_i s^d, X_s^d, \lambda) = \begin{cases} 1, & if\ X_{is}^d = x_s^d, \\ \lambda_s, & if\ X_{is}^d \neq x_s^d, \end{cases}$$

For the continuous variables $x^c = (x_1^c, \ldots, x_p)$ we use the product kernel given

$$K^c(x^c, X_i^c) = \prod_{s=1}^{p} h^{-1} K\left(\frac{x_s^c - X_{is}^c}{h_s}\right), \tag{3}$$

where K is a symmetric, univariate density function, and where $0 < h_s < \infty$ is the smoothing parameter for X^c, the kernel function for the mixed regressor case $X = (X^c, X^d)$ is simply the product of K^c and K^d, i.e.,

$$K(x, X_i) = K^c(x^c, X_i^c) K^d(x^d, X_i^d), \tag{4}$$

Thus we estimate $E(Y|X = x)$ by

$$\begin{aligned} \hat{g}(x) &= \frac{\sum_{i=1}^n Y_i K(x, X^i)}{\sum_{i=1}^n K(x, X^i)} \\ &= \frac{\sum_{i=1}^n Y_i \prod_{s=1}^{p_1} K(\frac{X_{is}^c - x_s^c}{h_s}) \prod_{s=p_1+1}^{p} K(\frac{X_{is}^c - x_s^c}{h_s}) \prod_{s=1}^{q_1} l(X_{is}^d, x_s^d, \lambda_s) \prod_{s=q_1+1}^{q} l(X_{is}^d, x_s^d, \lambda_s)}{\sum_{i=1}^n \prod_{s=1}^{p_1} K(\frac{X_{is}^c - x_s^c}{h_s}) \prod_{s=p_1+1}^{p} K(\frac{X_{is}^c - x_s^c}{h_s}) \prod_{s=1}^{q_1} l(X_{is}^d, x_s^d, \lambda_s) \prod_{s=q_1+1}^{q} l(X_{is}^d, x_s^d, \lambda_s)} \cdot \end{aligned} \tag{5}$$

We choose (h,λ) by minimizing the cross-validation function given by

$$CV = (h,\lambda) = n^{-1}\sum_{i=1}^{n}(Y_i - \tilde{g}_{-i}(X_i))^2\omega(X_i), \tag{6}$$

where

$$\tilde{g}_{-i}(X_i) = \frac{\sum_{j\neq i}^{n} Y_j K(X_i,X_j)}{\sum_{j\neq i}^{n} K(X_i,X_j)} = \frac{\sum_{j\neq i}^{n} Y_j K^c(X_i^c,X_j^c)K^d(X_i^d,X_j^d)}{\sum_{j\neq i}^{n} K^c(X_i^c,X_j^c)K^d(X_i^d,X_j^d)} \tag{7}$$

is the leave-one-out kernel estimator of $E(Y_i|X_i), \omega(X_i)$ and is a weight function which serves to avoid difficulties caused by dividing by zero or by the slower convergence rate arising when X_i lies near the boundary of the support of X .

When the sample sizes are large enough, Hall et al. (2007) (Theorem 2.11) proved the results as follows

$$h_s \to^p 0, \quad 1 \le s \le p_1, \quad h_s \to^p \infty, \quad p_1+1 \le s \le p,$$
$$\lambda_s \to^p 0, \quad 1 \le s \le q_1, \quad \lambda_s \to^p \infty, \quad q_1+1 \le s \le q.$$

The result of Hall et al. (2007) provides a good theoretical basis. The paper attempts to apply this theory to identify decision variables of tax revenue. Compared to linear regression and stepwise regression, the kernel estimation of nonparameters gives good effect of model fitting, and more importantly, the method can automatically remove these irrelevant regressors in the model under data driven to explain the above problems which cannot be explained by the parameters methods. Here we will identify the decision variables of tax revenues with the nonparametric method to provide the basis on decision support system of tax revenue.

4 Empirical Results of the Nonparametric Selection

We use gauss kernel function for continuous variables:

$$K(x,X_i,h) = \frac{1}{\sqrt{2\pi}}\exp\left\{-1/2\left(\frac{X_i - x}{h}\right)^2\right\}. \tag{8}$$

Let $l(X_{is}^d, x_s^d, \lambda_s)$ and $K(x,X_i,h)$ instead by specific expression; the changed model (3.1) can be given by

$$Y = \frac{\sum_{i=1}^{110} Y_i \prod_{s=1}^{9}\exp\{-1/2\left(\frac{X_is - x_s}{h_s}\right)^2\}\lambda_{10}}{\sum_{i=1}^{110}\prod_{s=1}^{9}\exp\{-1/2\left(\frac{X_is - x_s}{h_s}\right)^2\}\lambda_{10}}. \tag{9}$$

Table 1 The bandwidth of different variables

Variables	Bandwidth	Variables	Bandwidth
Area	0.3891996	Third industry	123679652
Amount of exports	5.19e+12	Amount of imports	5.25616e+11
Industrial gross index	10.68282	Total profit	41167.35
Second industry	2.546804	Current assets	3.32e+13
Long-term investments	1.33e+12	Real estate investment	205902.6
Agriculture	10896052	Per capita GDP	5476.759
Population density	66.58953	Retail sales of goods	1.47e+12
Financial expenditure	1.26748e+11	Fixed assets investment	3.07491e+11
Foreign direct investment	74788830712		

The selection of $(h, \lambda) = (h_1, \ldots, h_9, \lambda_{10})$ uses the method of CV minimization. Let $(h, \lambda) = (h_1, \ldots, h_9, \lambda_{10})$ denote the smoothing parameters that minimize $CV(H, \lambda)$ where

$$CV(h,\lambda) = \sum_{i=1}^{100} \left[Y_i - \frac{\sum_{i=1}^{110} Y_i \prod_{s=1}^{9} K(\frac{X_{is}^c - x_s^c}{h_s}) l(X_{i10}, x_{10}, \lambda_{10})}{\sum_{i=1}^{110} \prod_{s=1}^{9} K(\frac{X_{is}^c - x_s^c}{h_s}) l(X_{i10}, x_{10}, \lambda_{10})} \right] /110.$$

By using nonparametric kernel estimation method to estimate the model, we get the bandwidth of different variables summarized in Table 1 through minimizing CV method. A computer software is offered by Hayfield and Racine (2008).

From the Table 1 we may see, the continuous regressors of third industry, amount of imports, amount of exports, current assets, long-term investments, real-estate investment, agriculture, retail sales of goods, financial expenditure, fixed assets investment, and foreign direct investment are effectively smoothed out of the resulting nonparametric estimate, having bandwidths that are orders of magnitude larger than the respective regressors' standard deviation. It shows that these variables are little related to tax revenues in a sense of large sample. So, using non-parameter kernel method, we get six decision variables of tax revenue, including area, treated as a discrete regressor, which has a small bandwidth again suggesting that this regressor is relevant:

Industrial gross output index x_{13}, the proportion of the second industry to GDP x_3 per capita GDP x_1, population density x_2, total profit x_{17}, and area x_{10}.

Before eliminating the variables the mean square error of nonparametric method reduced by 80.7 % than that of parametric methods. Note that after eliminating eleven variables, the mean square error of nonparametric method is reduced instead of increased, while the mean square error of parametric method including stepwise regression and linear regression increases (Table 2). It implies that nonparametric kernel estimation method is much better than parameters approach in the model fitting effect; also the estimation of nonparametric kernel is more robust than the estimation of parameter.

Table 2 Comparison of parameter models with nonparametric methods

MSE	Nonparametric method	Stepwise regression	Linear regression
Before eliminating variables	0.06535574	0.1181059	0.1181059
After eliminating variables	0.05892305	0.1181143	0.2854998

5 Conclusion

The paper has explored the decision variables of tax revenues. The main contribution of nonlinear method of the nonparameters compared to the more classical linear method of the parameters is presented as follows:

1. **Robust estimation.** The nonparametric method not only can apply to the variable selection of nonlinear model but also suit for that of the linear model the mean square error of the model after the variable selection without any increase in error, but a slight decrease. It shows that the nonparametric kernel estimation is more robust than linear parameters.
2. **The precision of fitting model improved.** The result shows after the variable selection, the MSE of nonparametric method has reduced.
3. **Automatic dimensionality reduction.** It is the nonparametric method that selected out six decision variables of tax revenue from seventeen variables based on data driven.
4. **Identify linear and nonlinear relation.** The nonparametric kernel method not only obtained a relatively robust estimation but also made sure of the less decision variables of tax revenue. The decision variables selected respectively by three approaches were not completely consistent. The industrial gross output index, per capita GDP, the proportion of the second industry to GDP, and area are the common decision variables in three approaches. The results may indicate that tax revenue mainly depends on the development of the second industry and different regional economic structures have different decision variables. The variable of Real estate investment is only one not the decision variables in three approaches, it provides negative empirical evidence whether to control real-estate investment decisive influence to the tax revenue.

Acknowledgements The study was carried out with the financial support of the Most Important Soft Science Subjects of Zhejiang (2011C25075).

References

S.J. Cao, X. Liu, W.J. Zhang, Fiscal decentralization, local government competition And actual tax burden of listed companies. J. World Econ. **4**, 69–83 (2009)

H.R. Davoodi, D.A. Grigorian, Tax potential vs. tax effort: a cross-country analysis of Armenia's stubbornly low tax collection. International Monetary Fund 38–41 (2007)

A.S. Gupta, Determinants of tax revenue efforts in developing countries. IMF Working Paper No. 07/184 (2007)

P. Hall, Q. Li, J. Racine, Nonparametric estimation of regression functions in the presence of irrelevant regressors. Rev. Econ. Stat. **89**, 784–789 (2007)

T. Hayfield, J. Racine, Nonparametric econometrics: the np package. J. Stat. Softw. **27**, 1–32 (2008)

B.Y. Lv, Q.W. Guo, The tax growth source: to explain under the framework of tax ability and tax efforts. J. Soc. Sci. China **2**, 76–90 (2011)

J.F. Wang, The central centralized tax high-growth path: theory and empirical analysis. J. Manage. World **7**, 45–52 (2008)

Structure Correlation Between Knowledge-Oriented Culture, Knowledge Sharing, and Innovative Management at Junior High Schools

Hsin-Chih Lin

Abstract The purpose of this research is to explore the relationship between knowledge-oriented culture (KOC), knowledge sharing (KS), and innovative management (IM) at junior high schools in Taiwan. The main findings are as follows: First, KOC significantly affects KS, and trust and autonomy (TA) of KOC is proved the most influential. Second, KOC significantly affects IM, and emphasis on innovation (EI) of KOC is proved the most influential. Third, KS significantly affects IM, and sharing behavior (SB) of KS is more influential than sharing willingness (SW). Fourth, structure equation modeling (SEM) of KOC, KS, and IM is proved to have a good model data-fit. Finally, KS, though with a weak mediation effect, is proved a mediator variable between KOC and IM.

Keywords Organizational culture • Knowledge sharing • Innovative management

1 Introduction

The future belongs to knowledge-creative organizations, which means if organizations aim to usher the future, they must keep creating innovative knowledge and reforming themselves, and so must the future schools. During the past 20 years in Taiwan, the educational reform has been proceeding like a raging fire. The major goal of the reform is to untie the stereotyped educational system, which means to break improper regulations and improve diversity of schools. Therefore, how to apply knowledge management to innovative management (IM) at schools is as emphasized as other relevant issues.

H.-C. Lin (✉)
National Academy for Educational Research, Research Center for Educational System and Policy, No. 2, Sanshu Rd., Sanxia Dist., New Taipei City 237, Taiwan (R.O.C.)
e-mail: hsinchih@mail.naer.edu.tw

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_36,

Briefly, the purpose of this research is to explore the relationship between knowledge-oriented culture (KOC), knowledge sharing (KS), and IM at junior high schools in Taiwan. Specifically, there are five relevant research questions below:

1. Does KOC significantly affect KS? And what dimension of KOC affects KS the most?
2. Does KOC significantly affect SI? And what dimension of KOC affects IM the most?
3. Does KS significantly affect IM? And what dimension of KS affects IM the most?
4. Does structure equation modeling (SEM) of the three latent variables (KOC, KS, SI) have a good model data-fit?
5. Is KS a mediator variable between KOC and IM?

2 Assumed Relation of KOC, KS, and IM

Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knower. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms (Davenport and Prusak 1998). Activities in knowledge creation are carried out between people, and knowledge is coming possibly from individuals or a wise man, possibly from organizations or the routine of an organization. Arthur Anderson Business Consultant Company further defines the creation of organizational knowledge as the following formula: $K = (P + I)^s$, where "K" represents knowledge, "P" represents people, "+" represents technology, "I" represents information, and "S" represents share. That means the organizational knowledge will be accumulated to multiplier effects through technology which integrates people and information closely and in the network of share (Arthur Anderson Business Consultant Company 2000). Furthermore, if organizations/schools want to maintain continuous innovation and great competitiveness, they need to keep creating new knowledge by means of technology and in the network of share. The chart below shows the causal relationship model assumed between KOC, KS, and IM (see Fig. 1).

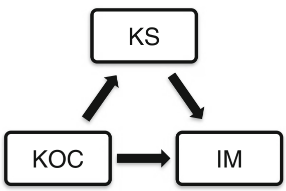


Fig. 1 Assumed causal relationship model between KOC, KS, and IM

3 Definition of KOC

Davenport et al. (1998) pointed out that "the organizational culture accessible to knowledge" is one of the key success factors for knowledge management and stressed that without this kind of culture above, knowledge management will be difficult to achieve. Besides, the researches on knowledge management application also show that the success of sharing knowledge and management is closely related to the organizational culture (Alaviv and Leidner 1999). KOC in this study is defined as "the organizational culture characteristics that promote organizations to create knowledge and improve their management."

Based on related theories and former researches (Schein 1996; Allee 1997; Kimball 1998; Martinez 1998; Greengard 1998; Ganesh 1998; Pfeffer 1998; Pfeffer and Robert 1999; Stauffer 1999; Martin 2000), the researcher summarizes that profession, open, innovation, learning, share, teamwork, harmony, trust and autonomy (TA) are the common KOC characteristics or factors. From the pretest of questionnaire survey (176 subjects) and statistical factor analysis (SPSS 19.0), there are eight characteristics which are proved to be the significant factors:

(1) professional approach (PA): the extent that school major decisions, solutions, and opinions are all based on professional knowledge instead of authority.
(2) open approach (OA): the extent that staffs can exchange their opinions unimpededly and freely and sometimes solve their problems by informal ways.
(3) emphasis on innovation (EI): the extent that school staffs think highly of creating new things.
(4) activeness in learning (AL): the extent that school staffs love learning and are active in new things.
(5) experience sharing (ES): the extent that school staffs are active in sharing their experience with each other.
(6) team work (TW): the extent that school staffs value collaborative work instead of being a hero.
(7) harmony of relationship (HR): the extent that school staffs love and help each other like a big family.
(8) trust and autonomy (TA): the extent that school staffs trust each other's ability and each staff can solve the problems independently with empowerment. The alpha coefficient for the eight factors (38 items) is 0.879, suggesting that the items have relatively high internal consistency.

4 Definition of KS

KS, knowledge sharing, means the extent of personal willingness and actual behavior that knowledge owners share their knowledge with knowledge demanders. It should be divided into two parts as follows: (1) sharing willingness (SW), the extent that each school staff wants to share their knowledge with each other and (2) sharing behavior (SB), the extent that each school staff actually shares their knowledge with each other. The alpha coefficient for the two factors (10 items) is 0.857, suggesting that the items have relatively high internal consistency.

5 Definition of IM

IM, innovative management, means organizations and staffs put new ideas into management. Practically, there are four dimensions as follows: (1) innovation on teaching (IT), the extent that school teachers deal with teaching by new ideas or new information; (2) innovation on leadership (IL), the extent that leaders or authorities use new strategies to manage the school; (3) innovation on public relation (IPR), the extent that schools put emphasis on relations outer the school, such as communities, scholastic activities, and parental participation; (4) innovation on information and technology (ITI), the extent that schools put emphasis on information and technology facilities, such as renewing them constantly, staffs' capability to use them, and staffs' satisfaction about them. The alpha coefficient for the four factors (20 items) is 0.885, suggesting that the items have relatively high internal consistency.

6 Results

Based on related theories and former researches, the questionnaire is charily developed to investigate 967 teachers from 85 junior high schools in Taiwan. Through SPSS 19.0 and LISREL 8.7, the data is processed. The main findings are as follows:

1. KOC significantly affects KS, and TA of KOC is proved the most influential.

Taking KOC as an independent variable and KS as a dependent variable by means of simple regression analysis, KOC is proved to affect KS significantly (see Table 1). Furthermore simultaneous multiple regression analysis is used for eight factors of KOC predicting KS. The outcome shows that eight factors of KOC are all proved to have significant influences, which in turn are TA, ES, OA, AL, EI, PA, HR, and TW (see Table 2). Apparently, TA of KOC is proved to affect KS the most.

2. KOC significantly affects IM, and EI of KOC is proved the most influential.

Taking KOC as an independent variable and IM as a dependent variable by means of simple regression model analysis, it is proved that KOC significantly affects IM

Table 1 Summary of simple regression analyses for KOC predicting KS ($N = 967$)

Model	B	SE	β	t	R^2
Constant	1.827	0.124		14.737***	
KOC	0.640	0.027	0.604	23.566***	0.365

***$p < 0.001$

Table 2 Summary of simultaneous multiple regression analyses for eight factors of KOC predicting KS ($N = 967$)

Variable	B	SE	β	t	R^2 change
Constant	1.695	0.127		13.385***	
TA	0.221	0.035	0.241	6.320***	0.304
ES	0.176	0.034	0.190	5.135***	0.042
OA	0.104	0.028	0.129	3.740***	0.017
AL	0.099	0.034	0.105	2.904**	0.005
EI	0.066	0.033	0.078	2.022*	0.003
PA	0.052	0.024	0.067	2.003*	0.002
HR	0.047	0.028	0.053	1.966*	0.002
TW	0.043	0.029	0.051	1.875*	0.002

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3 Summary of simple regression analyses for KOC predicting IM ($N = 967$)

Variable	B	SE	β	t	R^2
Constant	0.972	0.100		9.749***	
KOC	0.757	0.022	0.744	34.635***	0.554

***$p < 0.001$

Table 4 Summary of simultaneous multiple regression analyses for eight factors of KOC predicting IM ($N = 967$)

Variable	B	SE	β	t	R^2 change
Constant	0.982	0.105		9.324***	
EI	0.138	0.032	0.171	4.902***	0.414
TA	0.112	0.029	0.147	4.439***	0.078
HR	0.104	0.028	0.126	3.828***	0.031
AL	0.102	0.028	0.113	3.609***	0.014
PA	0.098	0.027	0.112	3.100**	0.010
ES	0.082	0.025	0.093	2.862**	0.006
TW	0.068	0.025	0.088	2.439*	0.003
OA	0.052	0.024	0.067	2.215*	0.002

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 5 Summary of simple regression snalyses for KS predicting IM ($N = 967$)

Variable	B	SE	β	t	R^2
Constant	1.498	0.113		13.210***	
KS	0.613	0.024	0.639	25.773***	0.407

***$p < 0.001$

(see Table 3). Furthermore simultaneous multiple regression analysis is used for eight factors of KOC predicting IM. The result shows that all the eight factors of KOC are proved to have significant influences, which in turn are EI, TA, HR, AL, PA, ES, TW, and OA (see Table 4). Apparently, EI of KOC is proved to affect IM the most.

3. KS significantly affects IM, and SB of KS is more influential than SW.

Taking KS as an independent variable and IM as a dependent variable by means of simple regression analysis, it is found that KS significantly affects IM (see Table 5). Furthermore simultaneous multiple regression analysis is used for two

Table 6 Summary of simultaneous multiple regression analyses for two factors of KS predicting IM ($N = 967$)

Variable	B	SE	β	t	R^2 change
Constant	1.532	0.116		13.156***	
SB	0.340	0.029	0.407	11.775***	0.367
SW	0.268	0.033	0.285	8.241***	0.042

***$p < 0.001$

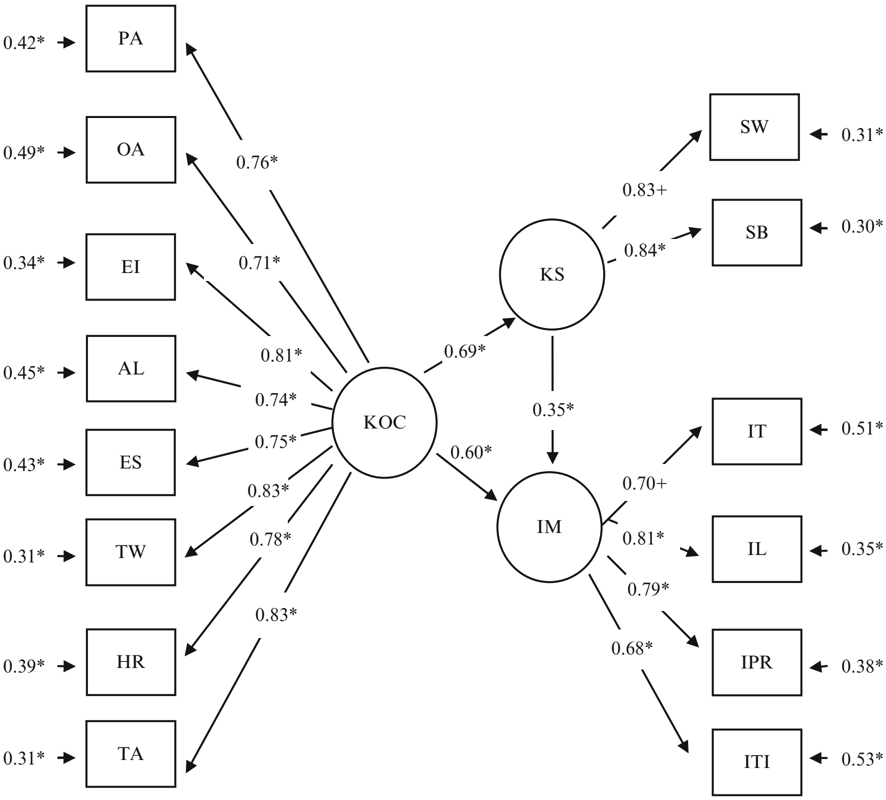


Fig. 2 The path diagram and relationship of KOC, KS, and IM

factors of KS predicting IM. The outcome shows that both SW and SB are proved to have significant influences. And SB of KS affects IM more than SW (see Table 6).

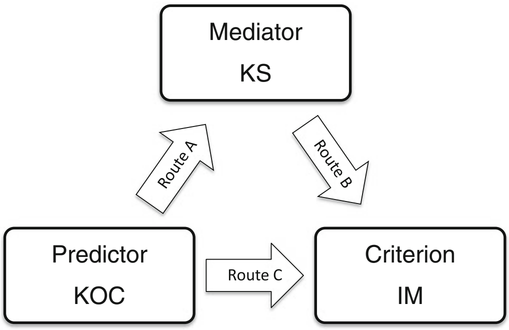
4. SEM of KOC, KS, and IM is proved to have a good model data-fit.

Figure 2 shows the path diagram of KOC, KS, and IM. All the factor loading of 14 measurement indicators are larger than 0.68, which shows they can explain the three latent variables adequately. The next question is whether the model fits the data or not. We found that all the data-fit criterions except for chi-square(χ^2) were satisfied (see Table 7). However chi-square(χ^2) criterion for model data-fit itself has a few flaws and limitations, one of which is that the more the samples are, the

Table 7 Summary of goodness of fit statistics for SEM of KOC, KS and IM

Goodness of fit statistics		Data-fit criterion	Results	Fit or not
Model overall fit	(1) χ^2	The smaller the better($p > 0.05$)	407.41 ($p < 0.00$)	Not fit
	(2) GFI	> 0.90	0.94	Fit
	(3) AGFI	> 0.90	0.92	Fit
	(4) RMR	< 0.05	0.03	Fit
	(5) RMSEA	(a) < 0.05 (Perfect)		
		(b) $0.05 \sim 0.08$ (Good)	0.069	Fit
		(c) $0.09 \sim 0.10$ (Ok)	(Good)	
		(d) > 0.10 (Bad)		
	(6) ECVI	$0 \sim 1$, and the smaller the better	0.49	Fit
Model comparison fit	(1) NFI	> 0.90	0.98	Fit
	(2) NNFI	> 0.90	0.98	Fit
	(3) CFI	> 0.90	0.97	Fit
	(4) RFI	> 0.90	0.98	Fit
	(5) IFI	> 0.90	0.99	Fit
Model parsimony fit	(1) PNFI	> 0.50	0.80	Fit
	(2) PGFI	> 0.50	0.66	Fit
	(3) CAIC	The smaller the better	653.55	
		(a) $<$ Independent CAIC	< 826.79	Fit
		(b) $<$ Saturated CAIC	< 24931	
	(4) CN	> 200	250.44	Fit

Fig. 3 Assumed mediator variable model



more easily the model is unfit. The samples of the research are up to 967 so that chi-square(χ^2) result is acceptable. To sum up, it is concluded that SEM of KOC, KS, and IM is proved to have a good model data-fit.

5. KS, though with a weak mediation effect, is proved a mediator variable.

To judge whether KS is a mediator variable between KOC and IM, the mediator variable model (Bagozzi and Yi 1988) is used in this study (see Fig. 3). First, Route A coefficient should reach the significant level. Second, Route B coefficient should

Table 8 Summary of mediation effect for mediator variable (KS) between KOC and IM

Variable	Mediation effects of three routes: Route A	Route B	Route C	Direct effect between KOC and IM
η_1 KS	0.69*	0.35*	0.60*	0.84*

$^{*}p < .05$

also reach the significant level. Finally we control A and B and see if Route C coefficient is changed. If Route C coefficient becomes 0 or much smaller so that it can't reach the significant level, we believe that there is a strong mediation effect. If Route C coefficient becomes a little smaller and still reaches the significant level, we can only claim that there is a weak mediation effect (Barron and Kenny 1986). First, Route A coefficient, 0.69, is proved to reach the significant level. Second, Route B coefficient, 0.35, is also proved to reach the significant level. Finally, when Routes A and B are controlled, Route C's coefficient becomes a little smaller but still reached the significant level. Therefore it is proved that there is a weak mediation effect, and KS is proved a weak mediator variable (Table 8).

7 Implication

First, according to the findings above, KOC is proved to have a significant influence both on KS and IM at junior high schools in Taiwan. In other words, if the school's KOC is positive, it will promote its staffs' KS and innovation. On the other hand, the negative KOC will hinder KS and innovation at schools. Therefore, the researcher suggests school leaders or local superintendents devote themselves to shaping a positive KOC at schools, especially focus on "trust and autonomy" of KOC for promoting staffs' KS and "emphasis on innovation" of KOC for promoting IM.

Besides, KS is also proved to have a significant influence on IM at junior high schools in Taiwan. That means if the school staffs are willing to share knowledge with each other, the IM of the school will go well. However, the research found that staffs' willingness of KS performs better than their actual behavior. Therefore, we suggest schools, school leaders, and local superintendents provide more incentives to encourage their staffs to share in action.

Moreover, although SEM of KOC, KS, and IM is proved to have a good model data-fit, KS is merely proved to have a weak intermediary effect, which implies there are still other intermediary variables not included in the analysis. Therefore the researcher suggests other factors such as leadership of principal, organizational health, organizational commitment, and job satisfaction could be included for the further researches.

Finally, this research collected data only through questionnaire survey, and some of them are possibly not showing the true thoughts and feelings due to various factors. Hence qualitative research methods, such as interview, field observation, and long-term follow-up case study, are recommended in the future researches.

References

M. Alaviv, D.E. Leidner, Knowledge management system: Issues, challenges, and benefits. Commun. AIS **1**(7), 1–37 (1999)

V. Allee, *The knowledge Evolution: Expanding Organizational Intelligence* (Butterworth-Heinemann, Boston 1997)

Arthur Anderson Business Consultant Company, *The First Book of Knowledge Management* (Business Weekly, Taipei 2000)

R.P. Bagozzi, Y. Yi, On the evaluation of structural equation models. Acad. Market. Sci. **16**,76–94 (1988)

R.M. Barron, D.A. Kenny, The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. J. Pers. Soc. Psychol. **51**(6), 1173–1182 (1986)

T. Davenport, L. Prusak, *Working Knowledge: How Organizations Manage What They Know* (Harvard Business School Press, New York 1998)

T.H. Davenport, W. De Long, M.C. Beers, Successful knowledge management projects. Sloan Manag. Rev. **39**(2), 443–457 (1998)

D.B. Ganesh, Managing knowledge through people. Knowl. Process Manag. **5**(3), 165–171 (1998)

S. Greengard, How to make KM a reality. Workforce **77**(10), 90–92 (1998)

F. Kimball, Shedding light on knowledge work learning. J. Qual. Participation **21**(4), 8–16 (1998)

B. Martin, Knowledge management within the context of management: An evolving relationship. Singarpore Manag. Rev. **22**(2),17–36 (2000)

M. N. Martinez, The collective power of employee knowledge. HR Mag. **43**(2), 88–94 (1998)

J. Pfeffer, Seven practices of successful organization.California Manag. Rev. **42**(1), 83–10 (1998)

J. Pfeffer, I.S. Robert, Knowing “what” to do is not enough: Turning knowledge into action. California Manag. Rev. **42**(1), 83–108 (1999)

E.H. Schein, Three cultures of management: The key to organizational learning. Sloan Manag. Rev. **38**(1), 9–21 (1996)

D. Stauffer, Why people hoard knowledge. Across the Board **36**(8), 16–31 (1999)

What Determines the Medical Expenses in China?–Evidence from Outpatients Case

Juying Zeng

Abstract In order to explore the effective determinants of average medical expenses in China, the research establishes a semi-parametric regression approach with local-constant least-squares (LCLS) and local-linear least-squares (LLLS) techniques to first confirm effective determinants with relevance and further identify decisive and control variables with linearity that contribute to average medical expenses for outpatients. (1) The identification finds out similar effective determinants while diverse decisive and control variables of average medical expenses for outpatients among different regions. (2) Average treatment number of outpatients for each physician per day should be slightly controlled in region A, and the enrollment licensed physicians should be increased in region C in order to control average medical expenses for outpatients. (3) The impact effects of indirect control variables and direct decisive variables on medical expenses remain further explored for policy implementation.

Keywords Average medical expenses • Semi-parametric model • Determinants • Decisive variable • Control variable

1 Introduction

In order to control average medical expenses, The Task Schedule on Pilot Reform for Public Hospital pronounces the pilot hospitals in medical care reform can set additional pharmaceutical service fee and increase governmental fiscal compensation

J. Zeng (✉)
Research Institute of Quantitative and Technical Economics, Chinese Academy of Social Science, No. 5 Jianguomeinei Street, Beijing 100732, China

Mathematics and Statistics Department, Zhejiang University of Finance and Economics, No. 18 Xueyuan Street, Xiasha, Hangzhou 310018, China
e-mail: riverzjy@yahoo.com.cn

J. Watada et al. (eds.), *Innovative Management in Information and Production*, DOI 10.1007/978-1-4614-4857-0_37,

simultaneously with the drug addiction abolishment under the framework of returning to public welfare. Chinese Health Statistics Summary 2012, issued by Health Ministry of China, illustrates that average medical care expense and average drug expense for both inpatients and outpatients increase during period 2007–2011, which implies the health reform still needs to be further deepened. Therefore, to confirm effective determinants of average medical expenses is the prerequisite to realize the objective of controlling medical expenses for patients.

Since health expenditure is an issue closely related to economic growth (Wang 2011), existing researches on determinants of health expenditures are implemented from the perspective of both macroeconomic indicators and inside professional indicators for hospital. On the one hand, with different empirical data in different countries, Matteo (2005) examines the determinants of real per capita health expenditures with the impact of age distribution, income, and time; Hartwig (2008) empirically tests health expenditure is driven by wage increases in excess of productivity growth; and Murthy and Okunade (2009) find out real per capita GDP and real per capita foreign aid resources are two core determinants of real per capita health expenditure. On the other hand, Yin et al. (2010) validate the dominating factor in hospital expenditure is the pharmaceutical fee; Duarte (2012) presents that at least one third of the price elasticity across a variety of health-care services is explained by the number of visits; while the rest is explained by the intensity of each visit.

Concerning existing literatures on determinants of medical expenditures in China, Liu et al. (2009) illustrate the penetration of for-profit hospitals has lowered average medical expenditures for both inpatient and outpatient services in public general hospitals. Li (2012) analyzes average medical expenses of public hospitals with descriptive statistics in Chifeng City of Inner Mongolia during 2001–2010.

However, existing literatures on determinants of medical expenditures fail to synthesize all possible determinants from both macroeconomic indicators and interior professional indicators for hospital. The literatures on medical expenditures in Chinese health sector neither confirm the determinants nor put forward practicable measures to control medical expenditures only by some qualitative opinions for regulation. Furthermore, parametric linear model is mostly employed for searching determinants, while the potential relationships between average medical expenses and all indexes considered are unknown.

To confirm which variables are effective determinants, which are decisive variables and control variables that exert direct and indirect impacts on average medical expense, respectively, is of crucial importance in policy decision; the research establishes a semi-parametric regression approach with the bridge of local-constant least-squares (LCLS) and local-linear least-squares (LLLS) techniques (Henderson et al. 2011) to first confirm effective determinants with relevance and further identify decisive and control variables of average medical expenses for outpatients, which present significant policy implications for realistic reform pilot for public hospitals.

The rest of research is organized as follows. Section 2 establishes the semi-parametric regression approach to confirm determinants and presents data description. Section 3 identifies the decisive and control variables of average medical expenses for outpatients. Section 4 draws the conclusion.

2 Model And Data

2.1 Model Specification

The research employs time-varying semi-parametric coefficient model (Fan and Huang 2005) to explore the determinants of average medical expenses for both outpatients and inpatients in China. It is known to all that average drug expense and medical care expense are two major parts of average medical expense; the research established the initial semi-parametric model with all possible determinants as follows:

$$Y_i = a(t_i)x1_i + b(t_i)x2_i + g(z_{1i}, z_{2i}, \ldots, z_{qi}), \quad i = 1, 2, \ldots, n, \tag{1}$$

where Y is average medical expenses, $x1$ is average drug expense, $x2$ is medical care expense, $z_1, z_2 i, \ldots, z_q$ refer to all possible control variables, and ε is a random error series with zero mean.

The relationships between $z_1, z_2, \ldots, z_q$ and Y are unknown and remain to be confirmed as irrelevant variables and determinants of average medical expenses. According to difference in the impact mechanism, the determinants are divided into decisive variables and control variables. Decisive variables refer to the relevant variables that exert direct linear impacts on average medical expenses while control variables refer to the ones who exert indirect nonlinear impacts. Take the Taylor expansion of $a(t_i)$, $b(t_i)$ at constant t_0 and asymptotically obtain

$$a(t_i) = a_1 + a_2(t_i - t_0), \quad b(t_i) = b_1 + b_2(t_i - t_0). \tag{2}$$

Estimate $(\hat{a}_1, \hat{b}_1, \hat{a}_2, \hat{b}_2)$, then

$$\hat{y}_i = \hat{a}(t_i)x1_i + \hat{b}(t_i)x2_i + g(z_i). \tag{3}$$

Let $\hat{y}_i^* = \hat{y}_i - \hat{a}(t_i)x1_i + \hat{b}(t_i)x2_i$, then Eq. (3) comes to

$$\hat{y}_i^* = g(z_i). \tag{4}$$

The determinants of average medical expenses are searched by 6 steps.

Step 1. Apply LSCV approach to obtain the bandwidths of all possible determinants in nonparametric regression model (4).

Step 2. Obtain the bandwidths h_0^n of all possible determinants in semi-parametric regression model (1), taken as the initial benchmark bandwidths. Repeat above steps if necessary.

Step 3. Apply the LCLS (Hall et al. 2007) to identify the effective determinants among all possible determinants $z_1, z_2, \ldots, z_q$ through whether the variable is relevant to dependent variable Y. Specifically, if the LCLS bandwidth of a variable reaches twice of its standard deviation (upper bound) (Li and Racine 2003), the variable is deemed as irrelevant to Y; otherwise, the variable is relevant to Y, taken as the effective determinants of average medical expense. Estimate Eq. (4) again with all irrelevant variables smoothed out.

Step 4. Estimate the root mean square error to evaluate the model superiority between the model with all possible determinants and the one with effective determinants.

Step 5. Estimate Eqs. (3) and (4) again with irrelevant determinants smoothed out in model (1). Assume Eq. (4) comes to

$$\hat{y}_i^{**} = g(z'_i). \tag{5}$$

Step 6. Estimate Eq. (5) by LLLS and estimate the bandwidths of all determinants (relevant variables) by LSCV approach. If the bandwidth of a determinant reaches twice of its standard deviation (the upper bound), the determinant is linear relevant with Y, taken as the decisive variable; otherwise, the determinant enters the semi-parametric model (1) nonlinearly, taken as the control variable.

2.2 Data Description

With reference of existing literatures on both macroeconomic indicators and inside professional indicators of medical expense, the research collects all possible determinants for average medical expenses provincially as follows. All data of the indicators are collected in China Statistical Yearbook (2003–2011) and China Statistical Yearbook on Health Care (2003–2011), which are available at website http://www.bjinfobank.com/.

The collected indicators are t, time; $z1$, province (region information); $z2$, number of outpatients (ten million); $z3$, average treatment number of outpatients for each physician per day; $z4$, number of licensed physicians (ten thousand); $z5$, number of inpatients beds in general hospital; $z6$, price index of medical health (last year = 100,%); $z7$, governmental health expenditure (ten billion); $z8$, GDP per capita (Yuan); $z9$, Disposable income of urban households per capita (Yuan); $z10$, urbanization (%); $z11$, aging rate (%); $z12$, illiteracy rate (%).

3 Determinants of Average Medical Expenses

The research aims to identify the effective determinants of average medical expenses for outpatients, of which linear decisive variables and nonlinear control variables are further confirmed for specific policy guidance. This section focuses on provincial and regional difference in determinants of average medical expenses for outpatients.

The semi-parametric model of average medical expenses for outpatients with pooled provincial data during 2005–2010 is given by:

$$\hat{y}_t = (1.033 + 0.005t)x1_t + (1.386 - 0.00048)x2_t + g(z_{1t}, z_{2t}, \ldots, z_{12t}, t).$$

According to the bandwidth tests of LCLS, the bandwidths of z4, z6, z8, z10, and z12 exceed their upper bound, implying their irrelevance to average medical expenses for outpatients; the RMSE of semi-parametric model with all possible determinants is 0.766; however, the RMSE remains almost the same with the eliminating of irrelevant variables, validating the reasonability of rejecting irrelevant variables with the LCLS approach. With the effective determinants, the new semi-parametric model is given by:

$$\hat{y}_t = (1.164 - 0.00026t)x1_t + (1.197 - 2.05 \times 10^{-5}t)x2_t + g(z_{1t}, z_{2t}, \ldots, z_{12t}, t).$$

The RMSE of new semi-parametric model is 0.894. According to the bandwidths tests of LLLS approach, relevant determinants z2, z3, z7, and z9 are decisive variables. They enter the model linearly since their respective bandwidth is higher than twice of its standard deviation, while the determinants z1 and z11 enter the model nonlinearly, taken as control variables. The RMSE of the semi-parametric model with the linear control variables separated is reduced to 0.7822. The adjusted semi-parametric model with decisive variables separated is given by:

$$\begin{aligned}\hat{y}_t =\ & (1.025 + 0.0007t)x1_t + (1.281 - 0.0008t)x2_t - (0.0137 + 1.927 \times 10^{-5}t)z2_t \\ & -(0.357 + 0.0022t)z3_t + (0.00189 - 6.87 \times 10^{-6}t)z_7 - (0.058 - 0.0006t)z_9.\end{aligned}$$

The impact effects of z2, z3, and z9 on average medical expense are −0.0137, −0.0357, and −0.058, implying that the increase in number of outpatients, average treatment number of outpatients for each physician per day, and disposable income of urban households per capita will decrease the average medical expense. Finally, the impact effect of governmental health expenditure (z7) is 0.00189, implying its slight positive role. Besides, the control variables province (z1) and aging rate (z11) exert indirect impact on average medical expense for pooled provincial data (Table 1). The provincial identification results illustrate that control variable province exerts nonlinear indirect impact on average medical expense, implying possible regional difference in effective determinants of average medical expenses.

Table 1 Bandwidths using LCLS and LLLS regression for provincial data during 2005–2010

Index	2SD	LCLS	LLLS
z1	0.5000	7.8241×10^{-17}	0.1141
z2	87.3091	4.2713	$4.6815 \times 10^{7*}$
z3	4.3323	1.0334	$2.5051 \times 10^{6*}$
z4	3.8506	$3.9452 \times 10^{5*}$	
z6	5.0718	8.3236*	
z7	1.2729×10^{2}	61.5274	$1.9137 \times 10^{7*}$
z8	3.0605×10^{4}	$4.0144 \times 10^{10*}$	
z9	9.3904×10^{3}	2.7826×10^{3}	$1.5060 \times 10^{9*}$
z10	29.7000	$1.5544 \times 10^{7*}$	
z11	3.4614	0.6619	5.7677
z12	14.5002	$1.0760 \times 10^{7*}$	

Notes: A bandwidth with a * next to it indicates that this variable is smoothed out of the regression

Table 2 Bandwidths using LCLS and LLLS regression for region A during 2005–2010

Index	2SD	LCLS	LLLS
z2	72.431	3.3530	28.684
z3	4.9553	0.1720	$1.3102 \times 10^{6*}$
z4	3.7499	$8.3211 \times 10^{5*}$	
z6	3.9937	$6.3252 \times 10^{6*}$	
z7	118.97	20.195	29.859
z8	3.8994×10^{4}	$4.7598 \times 10^{9*}$	
z9	1.1550×10^{4}	$4.5845 \times 10^{9*}$	
z10	35.4796	3.5140	9.8070
z11	2.9384	0.2010	2.5860
z12	8.0960	4.5170	$6.5623 \times 10^{5*}$

Notes: A bandwidth with a * next to it indicates that this variable is smoothed out of the regression

Therefore, the research divides all provinces into three regions as follows for further exploration. Region A contains Beijing, Tianjin, Shanghai, Shandong, Jiangsu, Zhejiang, Liaoning, Hunan, Chongqing, Guizhou, and Heilongjiang, whose average medical expenses for outpatients are higher than 175 Yuan in 2010. Region B contains Hainan, Hebei, Jilin, Anhui, Hubei, Shanxi, Sanxi, Guangdong, Ningxia, and Xinjiang, whose average medical expenses for outpatients range from 150 Yuan to 175 Yuan in 2010. Region C contains Neimenggu, Jiangxi, Sichuan, Fujian, Henan, Guangxi, Yunnan, Gansu, Qinghai, and Xizang, whose average medical expenses for outpatients are lower than 150 Yuan in 2010. Similarly, Tables 2–4 present the bandwidth tests results for regions A, B and C.

Table 3 Bandwidths using LCLS and LLLS regression for region B during 2005–2010

Index	2SD	LCLS	LLLS
z2	1.1783×10^2	5.0414	14.9063
z3	4.3859	0.4821	0.9848
z4	3.9193	0.0421	1.5294
z6	5.8604	2.5685	1.6704
z7	1.3407×10^2	27.3238	47.8717
z8	1.5100×10^4	$3.8412 \times 10^{10*}$	
z9	6.6885×10^3	1.8810×10^3	2.6441×10^3
z10	14.6719	2.9917	4.6419
z11	2.5946	0.4757	1.0257
z12	8.4206	6.7895	3.0448

Notes: A bandwidth with a * next to it indicates that this variable is smoothed out of the regression

Table 4 Bandwidths using LCLS and LLLS regression for region C during 2005–2010

Index	2SD	LCLS	LLLS
z2	54.2806	$2.0978 \times 10^{7*}$	
z3	3.0987	0.4104	1.0937
z4	3.3885	0.3080	$7.7152 \times 10^{3*}$
z6	5.1086	5.1488	2.3050
z7	1.2713×10^2	$5.2941 \times 10^{7*}$	
z8	1.6882×10^4	$1.0096 \times 10^{10*}$	
z9	6.0790×10^3	$2.1734 \times 10^{9*}$	
z10	16.1393	5.8349	3.3952
z11	2.8887	0.4556	4.4160
z12	19.9572	3.6778	41.8698

Notes: A bandwidth with a * next to it indicates that this variable is smoothed out of the regression

4 Conclusion

Synthesizing all possible determinants of average medical expense from both macro-economic and interior professional perspectives, the research establishes a semi-parametric regression approach with LCLS and LLLS techniques to first confirm effective determinants with relevance and further identify decisive and control variables with linearity that contribute to average medical expense for outpatients. The identification results are provided as follows.

In region A, average treatment number of outpatients for each physician per day (z3) and illiteracy rate (z12) are decisive variables, with linear impact effects on average medical expenses 0.00125 and 0.035, respectively. While number of outpatients (z2), governmental health expenditure (z7), urbanization (z10), and aging rate (z11) are control variables, which exert indirect impact on average medical expense for outpatients.

In region B, all possible determinants except GDP per capita (z8) are effective determinants and impact nonlinearly as control variables. In region C, the number of licensed physicians (z4) is the only decisive variable with impact effect of -0.514. Second, average treatment number of outpatients for each physician per day (z3), price index of medical health (z6), urbanization (z10), aging rate (z11), and illiteracy rate(z12) are control variables and exert indirect impact on average medical expense in region C.

The identified regional difference in decisive and control variables provides different policy implication to control average medical expense for outpatients in different region. Specifically, average treatment number of outpatients for each physician per day and illiteracy rate should be slightly controlled in region A and the enrollment of licensed physicians should be increased in region C in order to control average medical expense for outpatients. Still, the impact effects of indirect control variables and direct decisive variables on medical expenses remain further explored for policy implementation.

Acknowledgements This work is supported by the Fifth Chinese National Postdoctoral Special Sustentation Fund Project (2012T50172), Chinese National Postdoctoral Sustentation Fund Project (No. 20100480408), Ministry of Education, Humanities and Social Sciences Research for Youth Scholars (No. 12YJC630279), and Major Project of Science Foundation of Zhejiang Province (No. Z6110519).

References

F. Duarte, Price elasticity of expenditure across health care services. J. Health Econ. **31**(6),824–841 (2012)

J. Fan, T. Huang, Profile likelihood inferences on semiparametric varying-coefficient partially linear models. Bernoulli **11**(6), 1031–1057 (2005)

P. Hall, Q. Li, J. Racine, Nonparametric estimation of regression functions in the presence of irrelevant regressors. Rev. Econ. Stat. **89**(4), 784–789 (2007)

J. Hartwig, What drives health care expenditure?-Baumols model of unbalanced growth revisited. J. Health Econ. **27**(3), 603–623 (2008)

D.J. Henderson, C. Papageorgiou, C.F. Parmeter, Growth empirics without parameters. The Econ. J. **122**(3), 125–154 (2011)

Y. Li, An analysis of medical expenses of public hospitals in Chifeng under medical reform. Mod. Hosp. Manage. China **10**(3), 82–86 (2012).

Q. Li, J.S. Racine, Nonparametric estimation of distributions with categorical and continuous data. J. Multivariate Anal. **86**(2), 266–292 (2003)

G. Liu, L. Li, X. Hou, J. Xu, D. Hyslop, The role of for-profit hospitals in medical expenditures: Evidence from aggregate data in China. China Econ. Rev. **20**(4), 625–633 (2009)

L. Matteo, The macro determinants of health expenditure in the United States and Canada: assessing the impact of income, age distribution and time. Health Policy **71**(1), 23–42 (2005)

V. Murthy, A. Okunade, The core determinants of health expenditure in the African context: Some econometric evidence for policy. Health Policy **91**(1), 57–62 (2009)

K. Wang, Health care expenditure and economic growth: quantile panel-type analysis. Econ. Model. **28**(4), 1536–1549 (2011)

S. Yin, X. Wang, J. Wu, G. Wang, Grey correlation analysis on the influential factors the hospital medical expenditure. Lect. Notes Comput. Sci. Inform. Comput. Appl. **6377**, 73–78 (2010)

Making Profit in Stock Investment Before XD Dates by Using Genetic Algorithm

Tatcha Sudtasan and Komsan Suriya

Abstract This study extends the work of Sudtasan (Int. J. Intell. Techn. Appl. Stat. **5**, 143–155, 2012) to apply genetic algorithm to detect regime switching of eight stock prices before XD dates in the stock exchange of Thailand during 2005–2011. It reveals that regime switching does exist before XD dates only in the first half of the year. The study successfully discovers that ADVANC and PTT are good for short-term investment. CPALL and SCC are appropriate for medium-term investment. CPF, IVL, KBANK, and TCAP are potential for the long-term investment. Average buying days for all stocks are around 31 days before the XD dates. Rates of return of the investment in the first half of the year are higher than in the second half. Average annual rate of return is around 76 %. Technically, genetic algorithm without mutation performs better than a model with mutation. For the performance of the best genetic algorithm, a model with zero mutation rate that is applied to the data in the first half of the year can extract around 62 % of the highest potential profit.

Keywords Genetic algorithm • Stock investment • XD dates • Regime switching • Stock Exchange of Thailand

1 Introduction

XD is an abbreviation of excluding dividend. Before XD dates, it is possible that a stock price will increase especially the stock which pays a good dividend rate. This is because the time to receive the dividend becomes shorter and shorter for everyday before XD dates. An investor will receive the higher and higher yield if the stock price stays at the same level.

T. Sudtasan • K. Suriya (✉)
Chiang Mai University, Chiang Mai, Thailand
e-mail: miracle.zaza@gmail.com; suriyakomsan@yahoo.co.th

J. Watada et al. (eds.), *Innovative Management in Information and Production*, 351
DOI 10.1007/978-1-4614-4857-0_38,

When some companies announce unexpected dividend rates, especially the higher rates than the expected ones, then their stock prices will shoot sharply before the XD dates. Therefore, investors who collect the stocks before the rise of their prices will make substantial profit. From observations of many stocks, this phenomenon is possible to happen. If an investor knows how many days before XD dates are on the lower regime, then he will make good profit in the speculation of the stock price by purchasing the securities on those days.

This study will use genetic algorithm to detect the regime switching and identify the lower and higher regimes of eight stock prices before XD dates in the stock exchange of Thailand. It will suggest buying strategies for those stocks. It will also evaluate the performance of the suggested buying strategies. The research results will empower investors to buy stocks at the right time and make them successful in speculation in the stock market.

2 Development of the Model

There are several reasons why this study chooses genetic algorithm over other econometric models. First, GA is a model-free method. It does not rely on the type of data distribution and the stationary of the data. Therefore, it is flexible to use for all time series. Second, GA ensures profit maximization. It is a tool for optimization. It finds a solution that maximizes the objective function. It can ensure that the regime switching is from a lower to higher regime. It avoids the solution which indicates the switching from higher to lower regime. Third, GA is good to apply to a specific part of time series. It does not need a longtime series data: 30–50 observations are enough. Last, GA does not aim at forecasting. Rather, it emphasizes on what should be done during the whole process to ensure the highest performance or output. Therefore, it is good for indicating when the appropriate time periods to buy the stock are.

This study extends the work of Sudtasan (2012) which is the pioneer in applying genetic algorithm to detect regime switching in stock prices before "window dressing" at the year end. Before the work of Jann (2000) used genetic algorithm to detect multiple change point. This is the first paper that identify clearly that he uses genetic algorithm for the detection of the change point of a time series. Li and Lund (2012) also used genetic algorithm to detect multiple change point of a time series of climate data.

Considering previous studies on detection of regime switching and change points using variety of quantitative methods, this study proposes to use genetic algorithm to directly detect the regime switching. It is quite similar to Sudtasan and Suriya (2012), but it improves many features such as a better crossing-over process and clearer criteria to detect the regime switching. It differs from Jann (2000); Li and Lund (2012) in that it uses a shorter time series to detect the regime switching in a particular part of the series. Moreover, it focuses on detection of a single change point rather than multiple change points.

3 Model Specification, Processing, and Data

By using genetic algorithm with the process of crossing over and mutation, this study makes each pair of parents to produce four different children. Each child will present the information of the buying signals. Number one indicates that an investor should buy the stock on that day. Number zero indicates that the investor should not buy the stock on that day. The first data from the left-hand side and the last data on the right-hand side indicate the lagged 30 days and 1 day before the selling day.

Each child will evaluate its performance against the objective function. In this study, the objective function is the profit function as follows:

$$Profit = (Sellingprice - Averageprice) \times 100 \div AveragePrice. \tag{1}$$

The selling price is determined by the close price on the last day before the XD dates. The average price is the summation of the price over days that the model suggests the investor to buy the stock divided by the numbers of buying days.

The child that yields the highest value of objective function is the child who maximizes the profit. In the next round, this child will replace the father. The child who yields the second highest profit will replace the mother. The process will repeat 1,000 rounds to find the final best child.

However, the model does not rely on the solution from only the final best child. In every round, the model collects the solution of the best child. This is to ensure that the model must not lose the best solution during the iterative process. Therefore, there are 1,000 solutions for a family. Moreover there are 4,000 solutions from four families. Each family will find the best solution out of those 1,000 solutions. Comparing among the four best solutions from four families, the solution that yields the highest profit will be the best solution (Fig. 1).

Finally, for the condition of the best buying strategy, the best solution must yield the highest profit not only in a particular XD round but also in other XD rounds. To find this, the model will produce the best solution of each XD round. A solution will evaluate its performance in the out-of-sample tests. The model with the highest average out-of-sample profit will represent best of the best solution (Fig. 2).

The criteria to detect the regime switching are as follows:

1. The buying signals must appear on at least four consecutive days. For example, the buying signals appear on day 40, 39, 38 and 37. Then the regime switching takes place on day 37. This rule ensures that the buying signal is strong enough and the days around this period lay on the lower regime.
2. In case that the data ends before criteria 1 can be found, the buying signals must appear on at least two consecutive days including the end of the data.
3. When two groups of buying signals with less than four consecutive days in each group are separated by only one day of nonbuying signal and when there are at least two buying signals in each group, the first day in the first group is the day of regime switching.

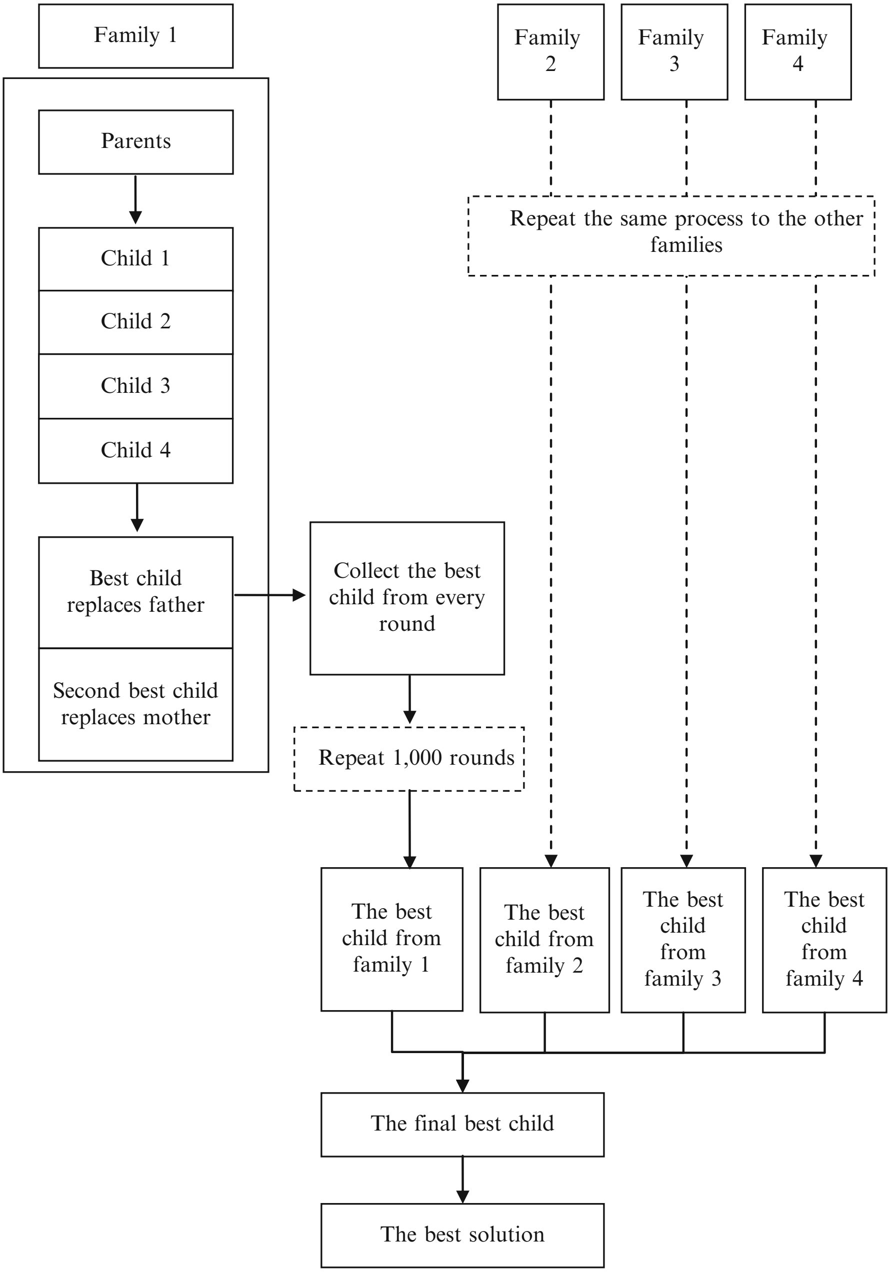


Fig. 1 The process of genetic algorithm in finding the best solution

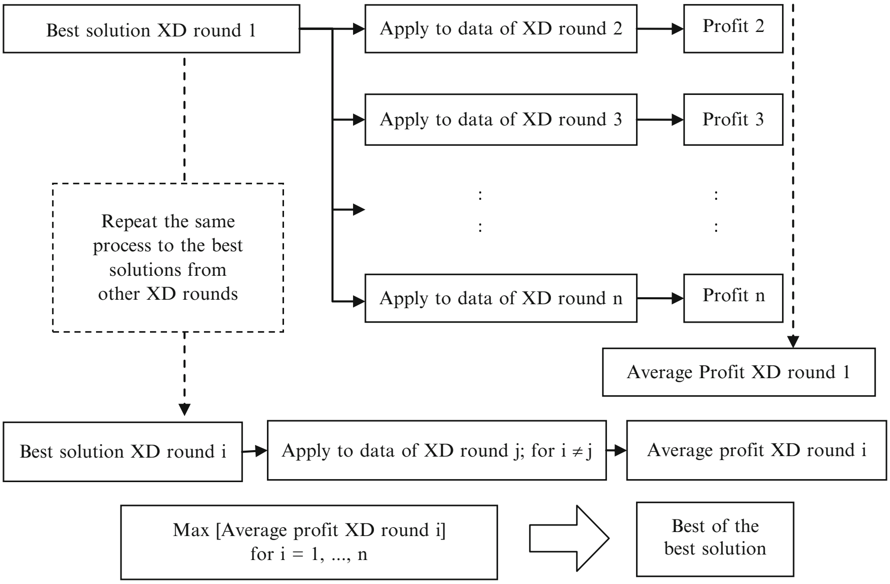


Fig. 2 The process to find best of the best solution (the out-of-sample test)

4. When there is more than one period that meets these criteria, the period that lies nearest to the XD dates is counted as the regime switching. This is to minimize the days of investment. With less days of investment, an investor bears less risk and may earn higher rate of return.
5. For the fragmented buying signals, it should be said that there is no signal.

   For the data, this study examines eight stocks during the period of 2005–2011. Seven stocks represent the biggest market capitalized stock of top seven biggest sectors in the stock exchange of Thailand. The eighth stock, TCAP, is a rapidly and strongly growing stock. The author retrieves the data from the finance and investment center (FIC), Chiang Mai University. Names of the stocks are listed in Table 1.

4 Results

This section presents the best result of the series of experiments. The genetic algorithm model uses zero mutation rate and calculates only for XD dates in the first half of the year. The results show that the regime switching takes place in 18 out of 24 investment plans (75 %). Therefore, it can be said that regime switching does exist in the first half of the year.

Table 1 List of stocks in the study

Abbreviation of stocks (alphabetical order)	Company's name	Sector	Market capitalization in October 2011 (USD million)
ADVANC	Advanced Info Service Public Co., Ltd.	Information and communication technology	12,197
CPALL	CP All Public Co., Ltd.	Commerce	7,067
CPF	Charoen Pokphand Foods Public Co., Ltd.	Food and beverage	7,133
IVL	Indorama Ventures Public Co., Ltd.	Petrochemicals and chemicals	5,308
KBANK	Kasikornbank Public Co., Ltd.	Banking	9,081
PTT	PTT Public Co., Ltd.	Energy and utilities	27,140
SCC	The Siam Cement Public Co., Ltd.	Construction materials	11,675
TCAP	Thanachart Capital Public Co., Ltd.	Banking	1,113

Note: Exchange rate THB30.8358/USD1.00, Bank of Thailand, October 2011 Source: The Stock Exchange of Thailand, October 2011

The out-of-sample test shows that the average profit rises to around 10 % compared to around 7.5 % in the whole year. The minimum profit reduces to −0.16 which is almost nonnegative profit. The maximum profit is, however, less than the case of the whole year; the number is around 23 % compared to around 28 %.

One of the highlights in this study is the performance of genetic algorithm in the first half of the year. The algorithm extracts up to 62 % of the highest profit (Table 2).

5 Discussions

5.1 Comparison Between Positive and Zero Mutation Rate

Good results from an algorithm without mutation are because the mutation usually changes number 0, which means "not buy" to be 1 which means "buy" randomly. If this happens at the wrong time, e.g., a day with high price, then the strategy cannot yield a lower cost than another strategy that is more careful to place number 1 in a day. It is apparent that good strategies are buying on only some days, not many days, to make good profit. Therefore, number 0 is preferable in the strategy than number 1. The less positions of mutation avoid the changing from number 0 to 1 unintentionally.

Table 2 Comparison of the profit from genetic algorithm and the real data (first half of the year) with zero mutation rate

Stocks and investment plans	Average profit from genetic algorithm in the out-of-sample tests (%)	Average potential profit from real data when buying at the lowest price (%)	Performance genetic of algorithm* (%)
ADVANC30	2.17	7.58	28.63
ADVANC40	1.43	8.11	17.63
ADVANC50	3.91	8.87	44.08
CPALL30	5.21	10.20	51.08
CPALL40	7.10	11.49	61.79
CPALL50	9.72	14.35	67.74
CPF30	5.02	10.85	46.27
CPF40	13.75	17.07	80.55
CPF50	17.02	20.35	83.64
IVL30	2.30	23.61	9.74
IVL40	25.35	30.88	82.09
IVL50	43.78	48.33	90.59
KBANK30	5.83	10.24	56.93
KBANK40	5.86	13.26	44.19
KBANK50	9.58	17.08	56.09
PTT30	2.96	7.98	37.09
PTT40	3.08	9.90	31.11
PTT50	3.09	11.64	26.55
SCC30	7.27	11.67	62.30
SCC40	7.60	13.08	58.10
SCC50	7.72	12.79	60.36
TCAP30	14.48	16.44	88.08
TCAP40	18.78	23.25	80.77
TCAP50	18.72	25.00	74.88
Average of all stocks	10.07	16.00	62.94

Note: Exchange rate THB30.8358/USD1.00, Bank of Thailand, October 2011
Source: The Stock Exchange of Thailand, October 2011

5.2 *Comparison Between XD Dates in the First and Second Half of the Year*

XD dates in the first half of the year are superior to the second half by at least two reasons. First, almost all companies pay dividend in the first half of the year even though many of them also pay in the second half too. This attracts more investors to speculate the stock prices in this period more than in the second half. Second, the announcement of dividend payment and XD dates is made longer than in the second half. In the first half, the announcement is around 40–50 days before XD dates compared to 10–15 days in the second half. This longer period makes investors well prepared for the investment or speculation. With more bidding volumes from more confident investors, then the price can rise sharper in the this period than in the second half.

5.3 Comparison Between 30, 40, and 50 days Before the Selling Point

It is hypothesized that if the genetic algorithm is robust, then the results from the 30, 40, and 50 days before XD dates should not be different. For example, if the regime switching is at 25 days before XD dates, then all the three models should point out similarly that regime switching takes place at day 25. The results do not confirm this hypothesis. Many solutions from data of 30, 40, and 50 days differ. However, it can be understood that the longer data allows an investor to find a better buying position that lies further from the XD dates, for example, when the model using data of 30 days found that day 25 is the regime switching but the model with data of 50 days may find another lower regime at day 46. This lower regime at day 46 can be lower than the lower regime found at day 25. Technically, it is the multiple regimes, containing more than one lower and one higher regime.

5.4 Best Buying Strategy of Each Stock

All the eight stocks are profitable for the investment before XD dates in the first half of the year. Good stocks for the short-term investment which an investor will buy and hold the stocks around 15 days until the selling day before XD dates, are ADVANC and PTT. For medium-term investment, 16–30 days are CPALL and SCC. The stocks for the long-run investment that an investor must buy more than 30 days prior to the XD dates are CPF, IVL, KBANK, and TCAP.

The rate of return is attractive with more than 100 % per year in two stocks, IVL and TCAP. CPF yields the return almost up to 100 %. SCC is also good for the investment with its 76 % of the return. Other stocks yield around 50 %. For all stocks, the annual rate of return is around 76 %. The average buying days are around 31 days before the selling day (Table 3).

5.5 Performance of Genetic Algorithm for Detection of Regime Switching

Sudtasan and Suriya (2012) found in the detection of regime switching before the year end that the performance of genetic algorithm is low, around 37 % of the highest potential profit. This study breaks this record when finding the performance of 62 % when applying the algorithm with zero mutation in the first half of the year.

Table 3 Summary of best strategies for buying stocks before XD dates in the first half of the year

Stocks	Average buying days before selling day[a]	Duration of holding the stocks until the selling day	Annual rate of return (% per year[b])
ADVANC	13.2	Short	42.74
CPALL	26	Medium	52.10
CPF	38	Long	94.08
IVL	48	Long	237.14
KBANK	49	Long	50.83
PTT	15.5	Short	49.65
SCC	24.6	Medium	76.84
TCAP	38.5	Long	126.83
All stocks	31.2		76.89[c]

Note: [a]The selling day is the last day before XD dates
[b]Calculation by (average out-of-sample profit/average buying days) × 260 days
[c]Geometric mean

The most influential reason why the study achieves such a higher performance is the zero mutation rate. When applying the rate of 0.30, the performance is around 37 % which is quite similar to the work of Sudtasan and Suriya; their work applied the mutation rate of 0.50. Then it can be seen that the performance is affected enormously by the different mutation rates.

6 Conclusions

This study applies genetic algorithm to detect regime switching of eight stock prices before XD dates both in the first half and second half of the year in the stock exchange of Thailand.

It reveals that regime switching does exist for stock prices before XD dates only in the first half of the year. For the second half of the year, the switching can be seen but not as clear as in the first half.

XD dates in the first half of the year are more attractive than those in the second half in terms of its highest potential profit, the clear buying signals for all eight stocks, and the yields that can be made by following the strategies suggested by genetic algorithm.

The study found that genetic algorithm without mutation performs better than one with mutation. Then it traces the model without mutation and found best strategies for stock investment before XD dates especially in the first half of the year. It discovers that ADVANC and PTT are good for short-term investment within 15 days before XD dates. It reveals that CPALL and SCC are appropriate for the medium-term investment, 16–30 days before XD dates. Moreover, CPF, IVL, KBANK, and TCAP are potential for longer than 31 days of the investment.

The rates of return of the investment strategies are impressive when calculated in the equivalence of the annual rate. More than half of the eight stocks yield more than 50 % of the return per year.

The performance of the genetic algorithm is quite good. The model with zero mutation rate that is applied to the data in the first half of the year can extract 62 % of the highest potential profit. Increasing the rate to be positive reduces the performance probably by half. However, even though the yield of the second half of the year is lower than in the first half, the performances of genetic algorithm with zero mutation rate are quite similar in both periods. The algorithm extracts around 62 % of the highest potential profit without the influence of how much profit is available in each period.

Acknowledgements The authors would like to thank Professor Berlin Wu, Prof. Hung T. Nguyen, and Prof. Songsak Sriboonchitta for the inspiration, stimulation, valuable comments, and technical supports to this study.

References

A. Jann, Multiple change-point detection with a genetic algorithm. Soft Comput. **4**, 68–75 (2000)

S. Li, R. Lund, Multiple changepoint detection via genetic algorithms. J. Climate **25**, 674–686 (2012)

T. Sudtasan, Detection of regime switching in stock prices before window dressing at the year end using genetic algorithm. Int. J. Intell. Techn. Appl. Stat. **5**, 143–155 (2012)

T. Sudtasan, K. Suriya, Detection of regime switching in stock prices before window dressing at the year end using genetic algorithm. Paper presented in the 5th international conference of the Thailand econometric society, Chiang Mai, January 2012

Construction of Networking Game for Addressing Social Isolation in a Super-Aging Society

Hisao Shiizuka

Abstract In this paper, we focus on social isolation among elderly people to better understand the reality of their lives and analyze the relationship between the factors behind changes in the family structures of the elderly and their social isolation and changes in modern communities. We also investigate new forms of communication aimed at improving the quality of life in a longevity society. Methodologically, we propose and examine a basic means to enhance local community networks, based on a scale-free network as a foundation for local community formation. From these considerations, we propose a new networking game for constructing the scale-free network in our daily life.

Keywords Networking game • Social isolation • Super-aging society • scale-free network

1 Introduction

Japan is faced with the problem of a super-aging society evolving at an unparalleled pace. The Japan Broadcasting Corporation (NHK) special program "Unconnected World? 'Solitary Death', Impact of 32,000 People," broadcast on January 31, 2010, brought home the reality of the solitary death of many elderly people, some of whom die unnoticed by anyone and with no one taking care of them, reminding the public of the seriousness of the issue. Meanwhile, a national survey conducted by the Ministry of Justice, in response to concerns about elderly people whose whereabouts are unknown, revealed that the number of elderly people in their 100's who are

H. Shiizuka (✉)
Department of Information Design, Kogakuin University, Nishishinjuku 1-24-2, Shinjuku, Tokyo 163-8677, Japan
e-mail: shiizuka@cc.kogakuin.ac.jp

J. Watada et al. (eds.), *Innovative Management in Information and Production*, DOI 10.1007/978-1-4614-4857-0_39,

"alive" according to the family register but whose whereabouts are unknown has reached 234,354. Of these, 77,118 people are, according to the register, over 120 years old, and 884 over 150 years old.

Such phenomena appear to be the result of weakening social bonds, owing to a lack of basic communication, eventually leading to social isolation [White Paper on the Aging Society (2011)]. We must generate practical and effective measures to respond to this issue, as soon as possible. A host of issues facing the aging society have been raised, centered on the aim of a healthy long life (Abe 2007). Initially, we must identify the causes of the problems surrounding the aged, which involve a complex variety of factors. It is thought that, by 2030, 10 % of the elderly may suffer from dementia and 40 % are expected to live alone. In addition, there is an urgent need to discuss, and implement on a national basis, specific measures to respond to issues that we are likely to face by 2025, when the baby boomers reach the age of 75. Recent studies suggest that the risk of typical elderly ailments such as dementia increases in response not merely to biological factors such as aging but also to social factors such as lack of communication (Barabasi 2006). The studies also suggest that the risk of dementia varies considerably depending on the existence of social networks (Watts and Strogatz 1998).

The causes of these problems likely include changes in family structures that may lead to an increased number of elderly people living alone and changes in communities in modern society that may lead to a weakening of social bonds.

In this paper, we focus on social isolation among the elderly to better understand the reality of their lives and analyze the relationship between the factors behind changes in the family structures of the elderly and their social isolation and changes in modern communities. We also investigate new forms of communication aimed at improving the quality of life in a longevity society. Methodologically, we propose and examine a basic means to enhance local community networks, based on a scale-free network as a foundation for local community formation.

From these considerations, we propose a new networking game for constructing the scale-free network in our daily life.

2 Community Design for Eliminating Social Isolation Among Elderly

2.1 Promoting Social Participation by Elderly

Promoting social participation by elderly people will be indispensable to addressing social isolation and building community bonds. The Cabinet Office survey on community participation by the elderly reveals that the number of elderly people wishing to join community activities in the future and/or interested in nonprofit organization (NPO) activities is increasing, indicating that an increasing number of elderly people are wishing to share common values or build bonds focused on common interests, despite weakening community bonds (Gallie et al. 2003).

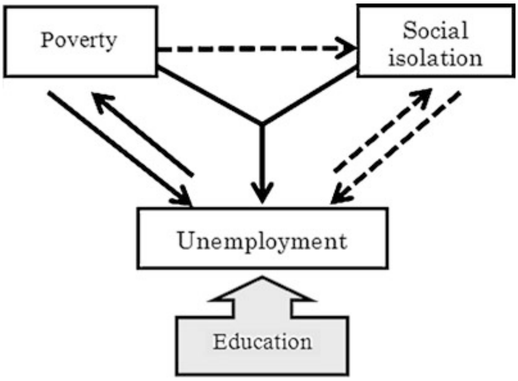


Fig. 1 Education and vicious cycle of social exclusion (Source: United Nations Development Programme in Croatia (UNDP) (2006) Poverty, Unemployment and social Exclusion, p. 12)

Some NPOs offer community and NPO activities to elderly people, to coordinate and translate into action their increasing wishes for social participation. However, some elderly people find it difficult to adapt to the manner in which such communities work, especially if they have long been accustomed to corporate society. As a result, few can find their place in such communities. Thus, it will be crucial, in promoting participation in community activities by elderly people, to develop (a) facilities ("hardware") as centers around which to build communities wherein a variety of people including the elderly can get together, (b) programs ("software") to promote multigenerational exchanges at these facilities, and (c) communicational ability ("human-ware") on the part of the elderly to facilitate the building of bonds with other people as well as with communities.

2.2 Major Causes of Social Isolation

What are the causes of "social isolation"? What are the major contributing factors? Studying these causes and factors is indispensable for generating policies to deal with isolation. In investigating these major factors, the social exclusion theory, with its deep affinities to the concept of social isolation, offers an important viewpoint. A United Nations Development Programme (UNDP) report states that social exclusion may be explained by a "vicious circle" involving three elements—unemployment, poverty, and social isolation—which influence each other to create a spiral of instability, as shown in Fig. 1.

Such social exclusion results in multiple deprivations, which typically begin with unemployment. Unemployment, in turn, naturally increases the risk of poverty. Poverty makes it yet harder for people to find jobs, increasing the chances of long-term unemployment (hence the straight line connecting them in the figure). People suffering from unemployment and poverty typically have difficulty participating in social activities because, for many, losing one's job is a social stigma that impedes exchanges with other people. Moreover, the economic difficulties caused by unemployment make it difficult for such people to sustain the reciprocity essential for maintaining social bonds and as a result increase the risk of social isolation, which, in turn, makes it difficult for them to obtain the support and information required for finding jobs, increasing further the chances of long-term unemployment.

This is the vicious circle of social exclusion. According to this theory, lack of education is a critical factor in unemployment, as it hinders the finding and retention of employment.

The major factors contributing to social isolation, according to this viewpoint, are unemployment and the resulting poverty. However, as the dotted lines connecting unemployment and poverty to social isolation suggest, their relationship to such isolation is not as simple as their own interrelation. A study by Shiizuka (2010) suggests that poverty is obviously caused by unemployment but that there is no convincing evidence to suggest that social isolation is caused by unemployment; instead, the study suggests that such isolation depends more on various cultural tendencies such as family structures and sociality. A study by Shiizuka (2010) on the nature of social exclusion also suggests at the social correlation, to some degree, between social isolation and unemployment/poverty (low income) but does not unconditionally support the model presented by the UNDP. In conclusion, unemployment/poverty may well be a major factor contributing to social isolation, but no simple or unequivocal influence can be identified, as the relationship is complex. To put it differently, social isolation is a compound product of these various factors. However, we should stress that many of the factors contributing to social isolation are social factors, and this suggests that prospective solutions must focus on the structure and influence of society. In light of this, the next section describes how social isolation affects the well-being of people and communities.

2.3 Building New Bonds

The building of social bonds is critical to ensuring that the aging society is a happy one while communities—and the whole notion of community—are being transformed by urbanization, IT (information technology), and increased emphasis on privacy. Communities in modern society are gradually losing their "regional characteristics" due to urbanization and advancing IT technologies. In the case of Japan, which faces both a super-aging society and an increasing number of families living alone, in order to eliminate the social isolation of elderly people by rebuilding community bonds, a new community design for the twenty-first century must seek to revive such regional characteristics, based on the subjective interactions of the people comprising the communities. This is the core issue of the so-called "local community."

A "local community" (one rooted in a specific region) refers to a group of people who share a sense of belonging to the same region, of making their lives in the same region, and of unity or mutual aid (mutual support). However, given the steady population shift to major cities, in parallel with the recent social structural changes caused by the aging society (including the low birth rate), the structure and role of such local communities are changing. The net inflow of population to the greater Tokyo area, commencing in 1996, is continually increasing and especially remarkable for the preponderance of members of the younger generation. Meanwhile, as the population concentration in the greater Tokyo area intensifies, regional cities are increasingly concerned about simply maintaining their municipal functions, especially in the case of small and middle-sized regional cities with populations of less than 50,000, where not merely the quality but the very existence of local communities is being threatened.

3 Scale-Free Network

It is necessary to build specific networks to address social isolation in a super-aging society. In this section, we argue that a system based on the concept of a scale-free network offers a viable structure to address social isolation by building and strengthening social bonds.

A network may be expressed in the form of a graph consisting of nodes (joints) and links (relationships between nodes). The Internet, which is used to be considered a random network of discretionary links based on loose rules, has in fact turned out to be a "power law-based" network (topology), otherwise known as a "scale-free network." Random networks such as the Internet were long considered to have a typical value for the number of links per node; therefore, the distribution of the network was considered to reflect a "normal" or "Poisson" distribution.

Fatiglioni et al. (2000), however, discovered that the Internet links are based on a "power law distribution," which does not have a typical specific value. The number of nodes with a small number of links and the number of nodes with a large number of links, tend to be as shown in Fig. 2b. Mathematically, the probability distribution

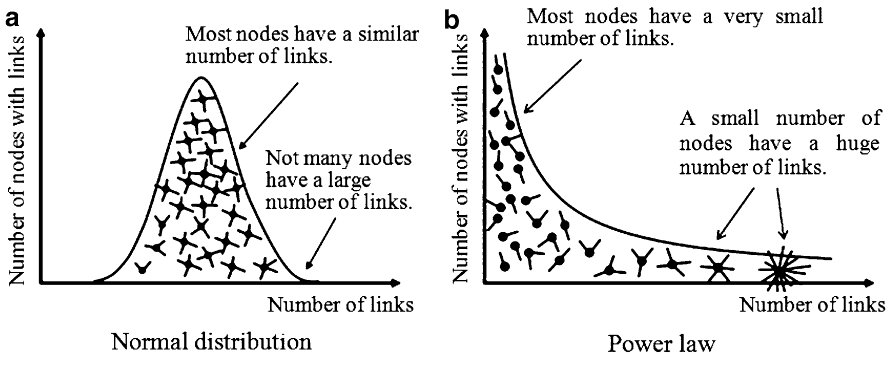


Fig. 2 Degree distribution of nodes with normal distribution and power law

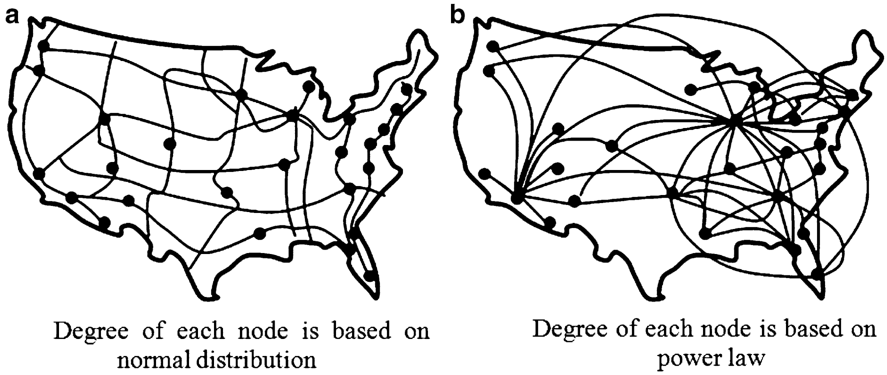


Fig. 3 Distribution image of links in "normal distribution" and "power law" in example of USA

of the probability $p(k)$ of a node possessing a degree k is expressed as $p(k) \approx k^{-\gamma}$, and the "scale-freeness" can be expressed by the so-called power law. Such degree distribution has no average scale which typically characterizes bias in a distribution. The distribution of such a probability has infinite variance (Fig. 3).

A power law-based scale-free network cannot intuitively distinguish between microscopic and macroscopic views. The clouds you see from an airplane look the same in shape at 50 m and at 5 km away. You cannot tell the distance. Such a structure is described as "fractal" and is based on the fact that a small number of nodes with many links typically account for most of the total number of links, as Pareto's law (or the "80–20 rule") stipulates. This is similar to the phenomenon where only a handful of rich people (2 %) possess an inordinate share of the global wealth (80 %). Various types of networks are available in modern society, including the Internet, human relations, corporate alliances, air routes, and power grids. An organism itself may be seen as a complex network, the brain a network of nerve cells connected by axons, and the nerve cells a molecular network governed by biochemical reactions.

Such complex systems may appear diverse and disorganized, but they actually share a single important characteristic: they are controlled by a relatively small number of "nodes" connected to a large number of sites. Only a fraction of the nodes, called "hubs," have a large number of links, while the rest connect to only a small number of nodes. Some of the hubs may have hundreds, thousands, or even millions of links, and in this sense, such networks may seem to have no scale (or be "scale-free").

A scale-free network has some important characteristics. One is its strong resilience against unexpected disruptions. A node in a random network, such as a highway network, may be communicationally isolated, like an island, if some nodes in the network break down. In a scale-free network, on the other hand, some routes will typically remain intact in such an event. Notably, the Internet suffers

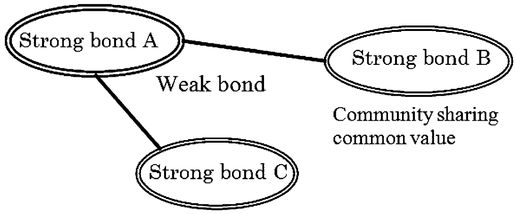


Fig. 4 Strong and weak bonds

no major disruptions, though hundreds of routers on the Internet are constantly failing. However, the Internet is extremely vulnerable to systematic attacks such as cyber attacks.

If properly understood, such characteristics may be exploited in various fields. For example, such knowledge aids in developing effective strategies to protect networks such as the Internet against computer viruses, or to develop medicines that attack only lesions. It may even be utilized in understanding consumer purchasing behavior from a scientific point of view.

In the following sections, we discuss applications of the scale-free network as a possible solution to the problem of social isolation, by considering, from a network point of view, various isolation-related phenomena in terms of social bonding in a super-aging society.

3.1 Six Degrees of Separation

In 1967, Granovetter (1973) asked a randomly selected group of 300 total strangers to forward letters he had written, addressed to his friends in Nebraska and Kansas, through the strangers' friends in Boston, and specifically requested that they hand over the letters to friends who were close enough to be called by their first names.

The purpose of this experiment was to understand the complex human relationships that connect people to (and within) communities, and the results showed that you can reach anyone in the world through a chain of only six friends. All Americans are connected through a chain of only six friends. This is called the "six degrees of separation."

Milgram's experiment actually triggered the ensuing "small-world problem." Milgram (1967) explained the small-world phenomenon in terms of network theory, noting that sparsely connected relationships between clusters, rather than closely connected mutual relationships (close friends and families) within a cluster, are the links of greatest significance.

As shown in Fig. 4, weak bonds between clusters, rather than strong bonds within clusters, will typically expand the network. In the context of human relationships, a group with only strong internal bonds will have difficulty expanding the community outward.

3.2 Strength of Weak Ties

The “strength of weak ties” is part of a social network theory that holds that weak networks (weak ties), such as nonintimate friends or “friends of friends,” are actually more important than strong networks (strong ties), such as families, intimate friends, or colleagues, in transferring valuable information or innovation. This hypothesis was proposed in 1973 by American sociologist Mark Granovetter in his paper “Strength of weak ties” (Research Report on Preventing Social Isolation of Elderly 2012), which reported on his empirical study seeking to identify a job-matching mechanism between companies and workers. The study, conducted in 1970, involving 282 male white-color workers in Newton City, a suburb of Boston, found that 56 % had found their jobs through human networks and that, of these, those who had found their jobs based on information obtained through weak human networks were more satisfied with their jobs. This is because much of the information obtained through strong networks that included the job seekers themselves was already known to them, while much of that obtained through weak networks was both unknown to them and important.

Granovetter claims that weak ties act as a “bridge” to connect strong networks, playing a critical role in transferring information to extensive areas. Networks consisting of strong ties have high levels of homogeneity and similarity and a tendency to concentrate only on strong ties, leading eventually to isolation of the network. Weak ties are required to promote mutual understanding and the transfer of information.

Much of the information and knowledge transferred through weak ties are valuable to the recipients. People are typically in frequent contact within strong networks but in many cases exchange only mediocre information. People in weak networks, on the other hand, tend to exchange more important information, precisely because their weak relationships make only that sort of information worth exchanging.

3.3 Network Invariants

We must be careful in inserting shortcuts to lessen the distance within a network, as special, arbitrarily added weak ties could shrink its world. All we require is a small number of long-distance links or hubs with an extremely large number of links.

Such a simple fact can build small-world networks in every context, including the varied human relationships that bond us with society, or languages used in conversation or thought.

Watts formulated two network invariants (Milgram 1967). One is the average length of the shortest path between all the pairs of joints L, as shown in Fig. 5a. The other is the cluster coefficient C, which may be defined as follows:

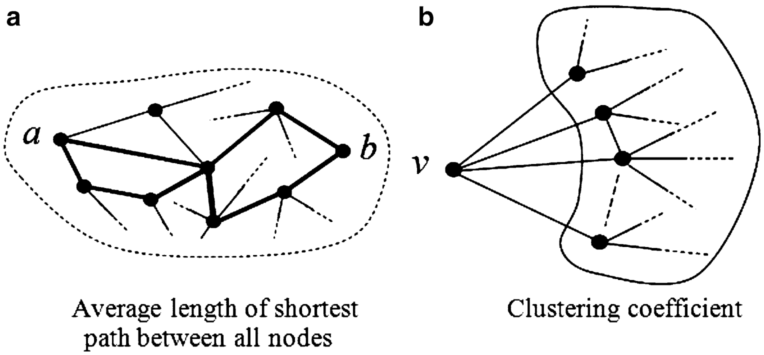


Fig. 5 Two network invariants presented by Watts

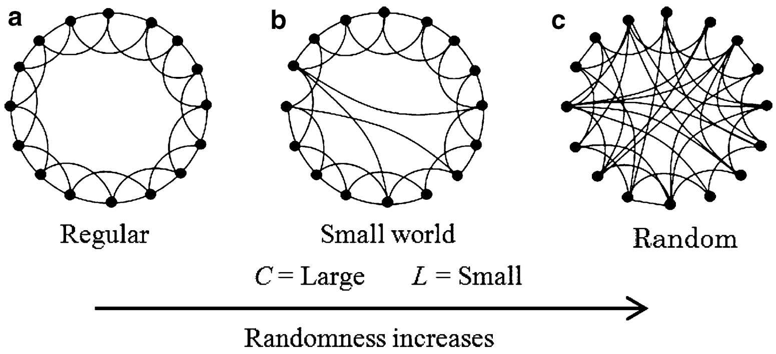


Fig. 6 Comparison of three networks

$$C = \frac{C_v}{{}_{k_v}C_2},$$

where C_v represents the actual number of branches in the network and ${}_{k_v}C_2$ represents the total number of branches of all the pairs of joints excluding the joints shown in Fig. 5b that can be provided by the following:

$${}_{k_v}C_2 = \frac{k_v}{2(k_v - 2)},$$

where k_v represents the total number of joints excluding the joint v.

We can express changes in complexity, as the randomness of the network increases, in terms of the magnitude of these two key quantities (L and C), as shown in Fig. 6.

The small world presented by Watts has the following characteristics:

1. The number of links is small in proportion to the total number of nodes (a distributed graph where all the nodes are not mutually connected directly).
2. The distance between any two nodes is short (similar to a random graph with the same number of nodes).
3. Many nodes are in a cluster form.

The first characteristic can generally be found in networks beyond a certain size (an employee of a company with 10,000 employees does not directly know all of his/her colleagues). On this presumption, (2), which is a feature of a random network, contradicts (3), which is a feature of a regular network. In the small world, however, they can coexist.

3.4 Creating Hubs by Growth and Preferential Attachment

A scale-free network can be built by means of what is termed growth and preferential attachment. Simply put, this is a characteristic of the network to prefer a node with more links to a node with less links, when adding new links for growth. For example, people tend to select large, popular Web sites when selecting portal sites (an example of network externality). Snow crystals grow larger as large-sized crystals absorb surrounding water molecules and smaller crystals. Space dust amalgamates to create new stars and asteroids. A cluster of small rivers creates a large river. These are all examples of preferential attachment. It may, in fact, be seen as a general law of the universe.

The same characteristic lies behind such phenomena as the rich get richer or increasing returns. It is not an equal world. The growth of links based on the power law is not limited to the Internet but has been noted in such diverse natural processes as cell coupling, AIDS infection, the size of earthquakes, the growth of crystals, and the formation of rivers and applied in economic theory, including the social scientific analysis of pricing and consumer behavior. The purpose of our study is to apply the scale-free network concept to communication involving the elderly and to address their social isolation. Here the concept implies that a given hub will typically expand as the number of people in the community increases. We may then investigate how to expand such a hub in terms of a scale-free network, aware of the fact that social isolation typically increases when a person is not connected with someone performing the role of a hub.

Figure 7 shows the process of creating such a scale-free network, where each node of the network corresponds to a person and a link between two nodes enables the two persons to communicate with each other. The figure shows the gradual process of nodes (hubs) being created, beginning with no hub at all. The structure of the scale-free network is designed in such a way that links emerging from nodes are

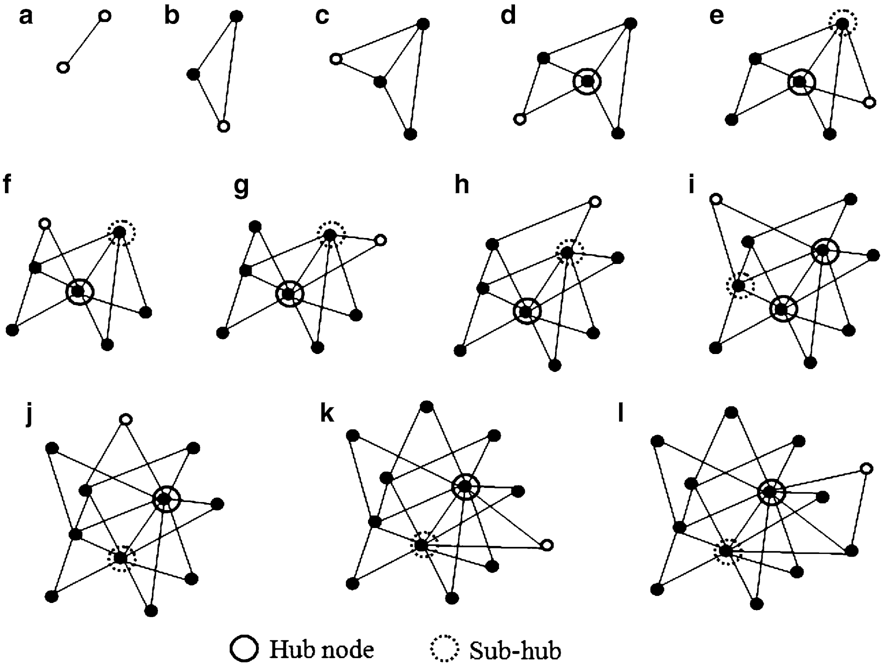


Fig. 7 Process of growing scale-free network

typically connected to hub nodes, the result of preferential attachment. The next section describes a methodology, based on graph theory, to create a system to address social isolation, by exploiting the process of network creation.

3.5 Network Robustness and Graph Trees

Building a network begins with one node. Linking this node to other nodes corresponds to the establishment of human relationships with others. However, we must somehow solve the challenging problem of who should help establish such relationships for isolated elderly people. The formulation of specific methodologies for designing local communities as described in 3.2 is closely related to this challenge.

A graph tree can be defined as a pattern of independent links which includes all the relevant nodes but does not include linked circuits. Simply put, by forming a tree, we can make contact with others simply by following the links of the tree.

Typically, multiple trees are incorporated into a single graph. We can select a specific tree in the following manner: include in the tree a link between two strongly bonded nodes and include in a co-tree a link between two weakly bonded nodes.

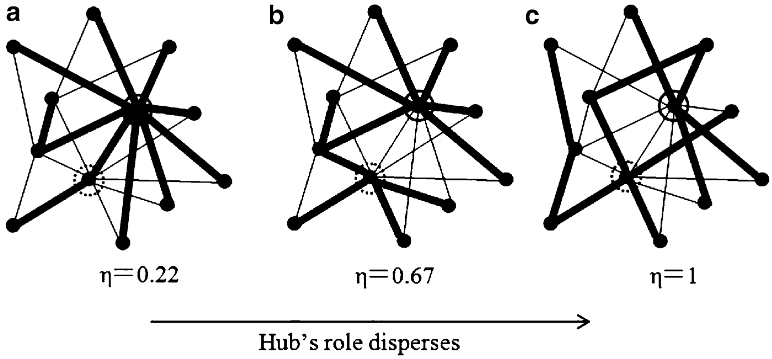


Fig. 8 Creating minimum community by links of trees

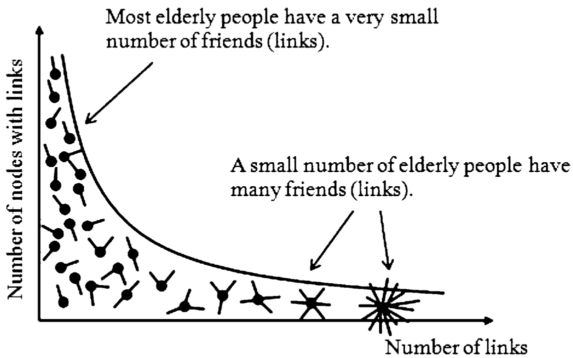


Fig. 9 Creating networks of elderly people by power law

The tree is considered to be changing constantly, since the level (strength) of the bonds is a function of time. We do not need to consider the possibility of links with strong bonds failing to form a tree. Figure 8 shows an example of three trees based on the network in Fig. 7k. The dispersity of the links of a given tree connected to hubs can be defined as follows:

$$\eta = \frac{deg(H_{ql})}{deg(H_{tl})}, \tag{1}$$

where $deg(H_{tl})$ represents the number of links of the tree connected to hubs, and $deg(H_{ql})$ represents the number of links of the tree connected to quasi-hubs. For example, η for the networks (a), (b), and (c) in Fig. 8 is 0.22, 0.67, and 1, respectively.

People cannot be friends with everyone, and many of the elderly have only a few friends. A very small number of them, however, have an extremely large number of friends. This phenomenon, as shown in Fig. 9, can be explained by the power law. For this reason, when designing local communities for elderly people, we can build a monitoring system which elderly people can access at any time, by incorporating a scale-free network. In building such a network, we must confront the following issues:

(a) Need for on-site experiments, on a trial basis, to create the scale-free network.
(b) Who will play the hub role?
(c) If administrative authorities assume the hub role, what should the existing comprehensive regional support centers do?
(d) Need for support of elderly people unable to use ICT.
(e) Participation in the network by elderly people who refuse to accept support.
(f) Understanding the distinctive quality of the scale-free network that people can feel connected even if the human relationship is weak.

4 Networking Game

Here, we propose the construction of a scale-free network game to avoid social isolation. Each node v_i in the network, you assign the initial gain g_i, respectively. The distance l_{ij} between two nodes is the value of the link weighted. Thus, the gain F_i of node reached takes the product of both as follow:

$$F_i = l_{ij} \cdot g_i. \tag{2}$$

Game Algorithm

The following is the algorithm for the game:

(a) The origin of the first to build a network is done from your home.
(b) Definition of nodes in the network:
    It can be the nodes in the network, you may decide, subject to the following elements of the default node: "friend," "acquaintance," "relatives," "unacquainted people," "particular building," "particular animal," and "other objects."
(c) In the above (b), if you are connected to a hub-node, your score (reward) will be doubled.
(d) Degree of each node, configure the network so that it has become such a power law distribution in accordance with the scale-free structure.
(e) If you want to run the above (e), to mediate people other than yourself to have a relationship with each other.
(f) If you have two that are mediated to a friend, your score (reward) is given.
(g) In order to approach the scale-free network, you can also cut off both the intermediary. In this case, your score, compensation, will be penalized.
(h) Repeat the above operation (reward) is obtained big score closer to scale-free network.

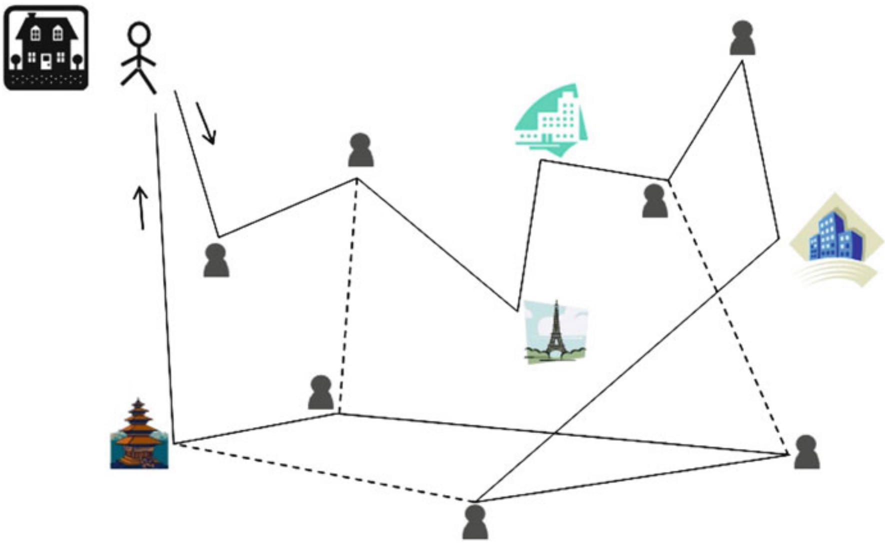


Fig. 10 One example of behavior to each node from leaving the home (*the dotted line* represents the relationship between the two could be the intermediary)

Figure 10 shows an image of the game network construction. The basic idea of the game network construction is that from the average distribution of network structure, we generated a structure of a network with a small number of hubs. In degree distribution in the average distribution network, each node has a shape close to a bell-shaped normal distribution. On the other hand, a network with a small number of hub nodes is a type hierarchy through (connector) hub. Each element is clustered around the (element with) a hub which is linked from a plurality of elements. If you count the number of links with other elements, the entire network can be seen in the power law pattern, and distribution of a few elements has very many links. That is, the structure of the scale-free networks is generated.

By the structure of the scale-free network, the following items can be considered as a factor in order to avoid the social isolation of an aging society:

1. The distance between you and other people will be shortened.
2. Your role in the community is remarkable.
3. Increased sense of belonging to your community.

5 Conclusion

In this paper, we first discussed the current status of and issues surrounding social isolation, with the aim of addressing the isolation of elderly people in Japan's super-aging society. The term social isolation is yet to be clearly defined. It is clear, however, that network building plays an important role in creating local communities. Thus, we here offered a methodology to address social isolation through community creation based on the concept of a scale-free network. Also we proposed a new networking game, based on the construction of the scale-free network in daily life. Its practical instrumentation remains as our most important interest in the future.

Many issues and tasks remain; among them is a detailed study on the relationship between the scale-freeness of such a network and social isolation, with a view to future practical applications.

References

A. Abe, Reality and cause of social exclusion in Japan. Seasonal Publication: Social Security in Japan **43**(1), 28–40 (2007)

A.-L. Barabasi, *Linked: The New Science of Networks* (NHK Publishing, 2006) (Translated by Kaoru Aoki), ww3.nd.edu/~networks/Linked

L. Fatiglioni, H.X. Wang, K. Ericsson et al., Influence of social network on occurrence of dementia: a community-based longitudinal study. Lancet **355**, 1315–1319 (2000)

D. Gallie, S. Paugam, S. Jacobs, Unemployment, poverty and social isolation: is there a vicious circle of social exclusion? Eur. Soc. **5**(1), 1–32 (2003)

M.S. Granovetter, The strength of weak ties. Am. J. Sociol. **78**(6), 1360–1380 (1973)

S. Milgram, The small world problem. Psychol. Today **1**, 60–67 (1967)

Research Report on Preventing Social Isolation of Elderly, Foundation Tokyo municipality Advisory Committee for autonomy (2012)

H. Shiizuka, Aging society and its related problems – toward extending healthy longevity. Kansei Eng. **9**(3), 131–139 (2010)

H. Shiizuka, A survey of dementia assessment scales. Kansei Eng. **9**(3), 167–171 (2010)

D. Watts, S. Strogatz, Collective dynamics of small-world networks. Nature **393**, 440–442 (2013)

White Paper on the Aging Society (2011), http://www8.cao.go.jp/kourei/whitepaper/w.2011/zenbun/23pdf_index.html

Game-Based Strategy Development for Hotel Yield Management

Koki Yoshimura and Junzo Watada

Abstract This paper deals with hotel yield management from a game perspective in a duopoly situation of two hotels. The hotel yield management decides strategies under consideration of the number of rooms in Bertrand game. Each hotel does not know the strategies taken by the counter hotel. We derive the strategy that realizes a maximum profit under the given conditions. Furthermore, we validate the game-based strategy developed for hotel yield management.

Keywords Game theory • Yield management • Hotel management • Bertrand situation

1 Introduction

Today, business circumstances are more competitive. We have to develop effective strategies to obtain an optimal profit in competitive environment. In this paper, we propose the game-based development of strategies in yield management, that is, model a competitive business circumstance to develop an optimal strategy using game theory under duopolistic state.

First, the duopoly state of two hotels is analyzed in a single year using game theory. Bertrand model is employed in this case. The Bertrand model works on the price to obtain the maximum profit considering the number of rooms (Waripan 2012).

Second, the optimal profits are derived theoretically based on mathematical game model.

K. Yoshimura (✉) • J. Watada
Graduate School of Information, Production and Systems, Waseda University, 2-7 Hibikino, Wakamatsu-ku, Kitakyushu-shi, Fukuoka, 808-0135, Japan
e-mail: yokokisoccer@ruri.waseda.jp; junzow@osb.att.ne.jp

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_40,

Third, the theoretical result is compared with the one obtained by Monte Carlo simulation.

The novelty of this model is found in the game perspective treatment of yield management (Neuman and Morgenstem 1947; Kobayashi et al. 2008).

2 Literature Review

Neumann and Morgenstern (1947) were the first who published the Theory of Games and Economic Behavior in 1944. It has experienced incessant growth in both the number of theoretical results and the scope and variety of applications. In 1950, John Nash (1950) introduced a Nash equilibrium point demonstrated that finite games have always had an equilibrium point, at which all players choose actions, which are best for them given their opponents' choices. Game theory concerned competitor's behavior in strategic situations, in which individuals make decisions when they are aware of the choices of others. Cooperative and noncooperative games are two main branches of game theory (Owen 1995; James 2006). Following the original work of Von Stackelberg (1934), the player who holds the powerful position in such a decision problem is called the leader, and the other players who react (rationally) to the leader's decision (strategy) are called the followers. In other game theory approaches, Leng and Parlar (2005) describe the advantage in the supply chain management that evaluates the need for enhancement corporate actions, risk sharing, strategic flexibility, and interdependence with other competitive parties. Yanga and Zhou (2006) consider the pricing and quantity decisions of a two-echelon system with a manufacturer who supplies a single product to two competitive retailers. This paper analyzes the effects of the duopolistic retailers' different competitive behaviors—Cournot, Collusion, and Stackelberg—on the optimal decisions of the manufacturer and the duopolistic retailers themselves. From the view of marketing, Lau and Lau (2002) studied effects of different demand curves on the optimal solution of a two-echelon system with the manufacturer-Stg process. Their studies focus on discussion of Cournot, Collusion, and Stackelberg process under various demand curves. They found out that under a downward-sloping, price-versus-demand relationship, the manufacturer's profit is the double of the retailer's. In the two-echelon system, another gaming structure opposite to the manufacturer-Stg process is the "retailer-Stg" process: the retailer acts as the Stackelberg leader and the manufacturer is the Stackelberg follower. Although this process is encountered less frequently in the literature, there is practical motivation for studying it. For example, Lau and Lau (2005) solved a retailer-Stg system with two manufacturers and a linear demand curve. Messinger and Narasimhan (1995) provided an interesting discussion of how the Stackelberg power leader had shifted to the retailer (buyer) in the grocery channel. Ertek and Griffin (2002) developed a two-echelon supply chain model, in which they considered both the manufacturer-Stg process and the retailer-Stg process. For the retailer-Stg process, they considered a pricing scheme for the buyer that involves both a multiplier and a constant markup. They showed that it was optimal for the buyer to set the markup to zero and use only a multiplier. Choi (1991) also considered the retailer-Stg system with a single manufacturer and a single retailer and investigated the effect of the demand curve's shape on the optimal solution. Other related two-echelon price-sensitive-demand Stackelberg models mainly focus on incorporating stochastic demand, information asymmetry, and other factors. For instance, Cachon (2001) developed game-theoretic models for the competitive cases of continuous review and periodic review of the models. Parlar and Weng (2006) study the effects of coordinating pricing and production decisions on the improvement of a firm's position in a price-competitive environment.

3 Bertrand Model

In this research, two hotels employ yield management. The two hotels are in duopolistic situation. Strategy employed is analyzed in a single year.

First, the optimal profits are derived theoretically based on mathematical model under the game environment. Second, the theoretical result is compared with the one obtained by Monte Carlo simulation. In the same area, two hotels X and Y are supposed to be duopolistic. The two hotels have the same number of rooms, that is, 100 rooms each. Both the room price systems are also the same. In addition, each room price is treated by yield management as follows (Fig. 1). Let Z denote the number of customers. Hotel sales and room price vary depending on the number of room:

Sales volume = one-room price × the number of sold rooms

Price rate: P—0.25 $\sim$ 1

A: Selling price rate 0.25 results in room price as 25 % $\rightarrow$ 0.25

B: Selling price rate 0.5 results in room price as 50 % $\rightarrow$ 0.50

C: Selling price rate 1.0 results in room price as 100 % $\rightarrow$ 1.00

The general demand curve of Fig. 2 is representing two things. First, demand is increased when price becomes cheaper. Second, demand is decreased when price becomes higher. This theory can prove same schematic in price decision model of hotel in the case of duopoly situation.

Therefore, when room price becomes cheaper compared to the competition hotel, the number of customers increases. On the other hand, when room price becomes higher, the number of customers decreases (Fig. 3). Let me assume that demand

A	B	C
Very early	Early	Normal
25%	50%	Normal price : 100%

One month ago — One week ago — Staying date

Fig. 1 Room price system in yield management

Fig. 2 Demand curve

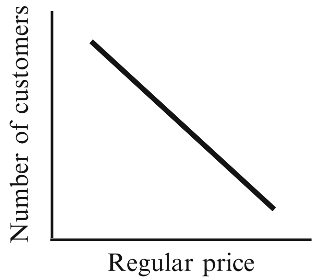


Fig. 3 The relation between room price and demand

Table 1 Room allocation

Type of strategy				Type of strategy			
X	a_1	b_1	c_1	Y	a_2	b_2	c_2
A_1	10	10	10	A_2	10	5	30
B_1	30	20	40	B_2	40	10	50
C_1	60	70	50	C_2	50	85	20

becomes 100 % when regular price is 10,000 JPY. If demand decreases, the more the regular price is higher than 10,000 JPY. Even if regular price is cheaper than 10,000 JPY, lose profit. So assume that regular price never becomes cheaper than 10,000 JPY.

Number of customers = number of rooms $(X+Y)$ − regular price

$Z_x = 80 - (P_x - P_y), Z_y = 80 - (P_y - P_x)$

Z_x The numbers of people staying in hotel X

Z_y The numbers of people staying in hotel Y

P_x The regular price of hotel X

P_y The regular price of hotel Y

80 % Let me assume that hotel demand becomes average 80 %.

Each hotel develops a strategy consisting of three patterns a, b, and c as shown in Table 1.

From the past data of experiences, we can classify customers into type (1) and type (2). A customer of type (1) focuses on room price as low as possible; on the other hand, a customer of type (2) emphasizes a hotel brand. In the type (2) case, customers decide a hotel encountered first. For example, in the case of type (1), people want to choose a low-price room as possible. However, when rooms of period

A_1 have already been fully booked in the hotel X a month previously, then this customer will book a room of period A_2 of hotel Y from hotel X, if the period A_2 of the hotel Y is available.

On the other hand, in the case of type (2), people regard the hotel brand important. When rooms of period A_1 have already been fully booked in the hotel X a month previously at this time, even if there are some vacant rooms of another type, the person will make a reservation in the same hotel X.

From the above, hotel profits will change depending on the number of rooms. Therefore, this research verifies which strategy is the best in yield management. In addition, they do not know the room allocation of the other hotel each other.

Then, the strategy c_1 of hotel X and the strategy a_2 of hotel Y are the same. These strategies for hotels X and Y have no difference other than the number of reserved able rooms. Actually when both hotels selected these strategies, the profit is the same in the simulation and evaluation function (see below). Even if it is impossible in real situation, it is important that this research is focused on the changes of the profits by using Bertrand model strategy for setting the room proportion strategy.

4 Monte Carlo Simulation of the Model

In the hotel management, the yield management is widely used as a hotel strategy. In this paper, the game theory of Bertrand model is applied to validate the yield management of hotel.

4.1 Prerequisite

In this model, one of the purposes is to simulate the current situation by Monte Carlo method. So the following items are generated randomly by Monte Carlo simulation:

Gathering ratio of customers
Reservation date by a customer
Feature of a customer: price oriented or bland oriented

Both room costs required per one room are the same as $d \times Z$
where d denotes a cost per room.

4.2 Evaluation Function

We create and verify the evaluation function decided for Bertrand model that selects the best for both hotels in game situation. The profit of both hotels depends on how to secure the number of the sold rooms. In other words, the selected strategies of room combination influence the total profit. Therefore the method calculates an allocation of room assignments and selects the largest total profit for both hotels X and Y. With the aim to maximize the total profit of each of the hotels, both strategies are compared under consideration of the results of the Monte Carlo simulation. The evaluation function is written as follows:

The one-room price $\times$ the number of sold rooms $-$ cost (1)

Notations

♣ Hotel type

X Target hotel
Y Competitor hotel

♣ Quantity of staying

Z The total number of people who visit the place and stay in hotels $(Z_x + Z_y)$
Z_x The number of people staying in hotel X
Z_y The number of people staying in hotel Y

♣ Rate of allocated number of room on appointment timing against total number of room

Z_A The rate when the appointment is made during the period A
Z_B The rate when the appointment is made during the period B
Z_C The rate when the appointment is made during the period C

♣ Price rates

P_A Price rate when appointment is made during the period A
P_B Price rate when appointment is made during the period B
P_C Price rate when appointment is made during the period C

♣ Profit : Pi

π_x The profit of hotel X
π_y The profit of hotel Y

♣ The unit price of room

R_A The unit room price in period A
R_B The unit room price in the period B
R_C The unit room price in the period C

♣ Calculation of one-room price in three types as $n = x, y$

In case of Cournot situation, one-room price varies depending on Z. In period A, one -room price is in the following:

$$R_{An} = P_A \cdot (100 \cdot Z) \tag{1}$$

In period B, one-room price is written as:

$$R_{Bn} = P_B \cdot (100 \cdot Z) \tag{2}$$

In period C, one-room price is written as follows:

$$R_{Cn} = P_C \cdot (100 \cdot Z) \tag{3}$$

♣ Total room cost ($n = x$, y)

$$D = d \cdot Z_n \tag{4}$$

where d denotes a cost for one room.

♣ Therefore, the total profit is derived using Eqs. (1)–(4) as follows:

$$\Pi = P_A \cdot P_n \times Z_A \cdot Z_n + P_B \cdot P_n \times Z_B \cdot Z_n + P_C \cdot P_n \times Z_C \cdot Z_n - d \cdot Z_n \ (6) \tag{5}$$

$$Z = Z_x + Z_y, \ \ Z_n = Z_x \ \text{ or } \ Z_y \tag{6}$$

Next, let us compute the theoretical values of the evaluation function.

♣ Price rate:

$$P_A = 0.25, P_B = 0.5, P_C = 1$$

♣ Room cost is denoted as $d = 3{,}000$.

In this case, the hotel X's strategy c_1 is same to the hotel Y's strategy a_2. Therefore, this simulation focuses on combination of c_1 and a_2. The evaluation function is calculated under c_1 and a_2. After that, these results are compared.

As a result, π_x and π_y result in the following:

$$\pi_x(P_x, P_y) = (-0.725 \cdot P_x^2 + 58 \cdot P_x \cdot P_y) - 3{,}000 \cdot P_x \tag{7}$$

$$\pi_Y(P_x, P_y) = (-0.725 \cdot P_y^2 + 58 \cdot P_x \cdot P_y) - 3{,}000 \cdot P_y \tag{8}$$

From the above computation, when hotel X's strategy is c and hotel Y's strategy is a, the hotel total profit of the evaluation function is

$$\pi_x^*(Z_x, Z_y) = \pi_y^*(Z_x, Z_y) = 0.270 \times 10^6 \tag{9}$$

This evaluation function becomes maximizing the total profit of both hotels.

5 Monte Carlo Simulation

Performing a Monte Carlo simulation to obtain the optimal strategy, we calculated the following:

[Result of the Simulation]

Table 2 Simulation "single year"

		Profit		Price		
		Hotel X ($\times 10^6$)	Hotel Y ($\times 10^6$)	A ($\times 10^4$)	B ($\times 10^4$)	C ($\times 10^4$)
1	a_1,a_2	0.243	0.253	0.234	0.468	0.935
2	a_1,b_2	0.282	0.363	0.220	0.441	0.881
3	a_1,c_2	0.369	0.127	0.221	0.441	0.882
4	b_1,a_2	0.269	0.290	0.224	0.447	0.895
5	b_1,b_2	0.315	0.387	0.214	0.428	0.856
6	b_1,c_2	0.424	0.160	0.207	0.414	0.827
7	c_1,a_2	0.261	0.261	0.213	0.426	0.852
8	c_1,b_2	0.274	0.340	0.223	0.447	0.893
9	c_1,c_2	0.321	0.147	0.210	0.420	0.840

Table 3 Results of simulation and evaluation function

Profit	$X : c_1(\times 10^6)$	$Y : a_2(\times 10^6)$
Evaluation function	0.270	0.270
Simulation	0.261	0.261

The simulation was pursued 30 times for all the combination of strategies as shown in Table 2. Comparing the highest average value in it, different values were obtained every time because of the random Monte Carlo simulations.

When comparing the results between the Monte Carlo simulation and the theoretically evaluation function, hotel X with strategy c_1 and hotel Y with strategy a_2, both hotels obtained the highest profits using the evaluation function as shown in Table 3.

In the simulation, the total number of customer is determined using random variables; the evaluation function derives the Bertrand model-Nash equilibrium for both hotels. And the number of sold rooms in hotels X and Y is derived by the same result of Bertrand model-Nash equilibrium in evaluation function. In the simulation the same Bertrand model-Nash equilibrium is used $Z_x = Z_y = 80$ and the value is calculated as shown in Table 4. From this, this simulation has proved to be the correct. And when these two hotels execute strategy b_1 & b_2, become the optimal strategy.

6 Conclusion

The optimum strategy has been developed for hotel yield management in Bertrand situation. In this study, the number of customers varies randomly by using the exponential distribution. If we can know the number of guests who stay in the hotel, we obtain the optimal decision-making strategies by means of using Bertrand

Table 4 Simulation in a single year

			Profit		Price		
			Hotel X ($\times 10^6$)	Hotel Y ($\times 10^6$)	A ($\times 10^4$)	B ($\times 10^4$)	C ($\times 10^4$)
	1	a_1, a_2	0.243	0.253	0.234	0.468	0.935
	2	a_1, b_2	0.282	0.363	0.220	0.441	0.881
	3	a_1, c_2	0.369	0.127	0.221	0.441	0.882
	4	b_1, a_2	0.269	0.290	0.224	0.447	0.895
$\Rightarrow$	5	b_1, b_2	0.315	0.387	0.214	0.428	0.856
	6	b_1, c_2	0.424	0.160	0.207	0.414	0.827
$\Rightarrow$	7	c_1, a_2	0.270	0.270	0.223	0.447	0.893
	8	c_1, b_2	0.274	0.340	0.223	0.447	0.893
	9	c_1, c_2	0.321	0.147	0.210	0.420	0.840

simulation. In the case of Bertrand model, hotel managers have to accurately select strategies as well as to estimate the number of customers.

In this paper we discussed only one-year hotel strategy. Multiple-year strategy should be discussed by means of the perspective of real option model. We will consider a calculation for discount using net present value method that is repeated for 5 years.

References

G.P. Cachon, Stock wars: inventory competition in a two-echelon supply chain with multiple retailers. Oper. Res. **49**(5), 658–674 (2001)

S.C. Choi, Price competition in a channel structure with a common retailer. Market. Sci. **10**(4), 271–296 (1991)

G. Ertek, P.M. Griffin, Supplier- and buyer-driven channels in a two-stage supply chain. IIE Trans. **34**(8), 691–700 (2002)

W.N. James, *Game Theory Decisions, Interaction and Evolution* (Springer, New York, 2006), pp. 148–160

K. Kobayashi, K. Matsushima, K. Hishida, Economic benefit evaluation of reservation system. Japan Soc. Civil Eng. Trans. D **64**(2), 299–318 (2008) (in Japanese)

A. Lau, H.-S. Lau, Effects of a demand-curve's shape on the optimal solutions of a multi-echelon inventory/pricingmodel. Eur. J. Oper. Res. **147**(3), 530–548 (2002)

A. Lau, H.-S. Lau, Some two-echelon supply-chain games: improving from deterministic-symmetric-information to stochastic asymmetric-formation models. Eur. J. Oper. Res. **161**(1), 203–223 (2005)

M. Leng, M. Parlar, Game theoretic applications in supply chain management. A rev. Infor. **43**(3), 187–220 (2005)

P.R. Messinger, C. Narasimhan, Has power shifted in the grocery channel? Market. Sci. **14**(2), 189–223 (1995)

J.F. Nash Jr., Equilibrium points in n-person games. Procs. Natl. Acad. Sci. **36**(1), 48–49 (1950)

J.V Neuman, O. Morgenstem, *Theory of Games and Economic Behavior* (Princeton University press, Princeton, 1947)

J.V Neumann, O. Morgenstern, *Theory of Games and Economic Behavior*, 2nd edn. (Princeton University Press, Princeton, NJ, 1947) (1st edn.: 1944)
G. Owen, *Game Theory*, 3rd edn. (Academic Press, New York, 1995)
M. Parlar, Z.K. Weng, Coordinating pricing and production decisions in the presence of price competition. Eur. J. Oper. Res. **170**(1), 211–227 (2006)
H.V. Stackelberg, *Marktform und Gleichgewicht* Springer, Vienna, 1934 (An English translation appeared in 1952 entitled) *The Theory of the Market Economy* (Oxford University Press, Oxford, 1952)
T. Waripan, Game theory-based two? echelon logistic models for competitive behaviors in logistic. Master Thesis, Waseda University, 2012
S.L. Yanga, Yong-Wu Zhou, Two-echelon supply chain models: Considering duopolistic retailers' different competitive behaviors. Int. J. Prod. Econ. **103**(1), 104–116 (2006)

Approximations of Fuzzy Numbers by General Trapezoidal Fuzzy Numbers

Chi-Tsuen Yeh and Pei-Hau Lin

Abstract Recently, many scholars investigated interval, triangular, trapezoidal, and semi-trapezoidal approximations of fuzzy numbers. These researches can be grouped into two classes: one is to study approximations of fuzzy numbers without any constraint; the other one is to study approximations preserving some attributes. In this paper, we propose two general approximations of fuzzy numbers named general f-trapezoidal approximation and general f-triangular approximation. The two approximations will generalize those approximations of the first class under the Euclidean distance. Finally, we propose an efficient algorithm for computing the proposed approximations and illustrate by an example.

Keywords Trapezoidal fuzzy numbers • Triangular approximation • Semi-trapezoidal approximation • Hilbert space

1 Introduction

Fuzzy intervals play important roles in many applications, such as fuzzy control systems, discrete dynamic systems, or intelligence technology. In practice, we often used fuzzy intervals to represent uncertain or incomplete information. For shortening computation time, we usually approximate general fuzzy intervals by interval, triangular, trapezoidal, and/or semi-trapezoidal fuzzy numbers, so as to simplify calculations. In addition, ranking or ordering fuzzy numbers is a fundamental problem of fuzzy optimization or fuzzy decision making. Another application is to make the comparison of fuzzy numbers by using the order relations defined on the approximations of fuzzy numbers. Therefore, how to approximate a fuzzy

C.-T. Yeh • P.-H. Lin (✉)
Department of Applied Mathematics, National University of Tainan, 33, Sec. 2, Shu-Lin St., Tainan city 70005, Taiwan
e-mail: ctyeh@mail.nutn.edu.tw; peggy1229@kimo.com

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0_41,

number is immensely important. In Ma et al. (2000) first studied symmetric triangular approximations of fuzzy numbers. Consequently, in Grzegorzewski (2002) proposed interval approximations, in Abbasbandy and Asady (2004) proposed trapezoidal approximations, in Zeng and Li (2007) proposed weighted triangular approximations which were improved by Yeh (2008, 2009), and in Nasibov and Peker (2008) proposed the nearest parametric approximations which were improved by Ban (2008, 2009) and Yeh (2011), independently. In addition, during the last years, approximations of fuzzy numbers preserving some attributes were studied too. For example, trapezoidal approximations preserving the expected interval were proposed by Grzegorzewski and Mrowka (2005, 2008) and improved by Ban (2008) and Yeh (2007, 2008) independently, trapezoidal approximations preserving cores of fuzzy numbers were proposed by Grzegorzewski and Stefanini in 2009 and further studied by Abbasbandy and Hajjari (2010), and trapezoidal approximations preserving the value and ambiguity were proposed by Ban et al. (2011). In this paper, we study more general approximations without preserving any attribute, named general f-trapezoidal approximations and general f-triangular approximations. In Sect. 2, we present several preliminaries and state our main problem. In Sect. 3, the formulas for computing general f-trapezoidal approximations and general f-triangular approximations are provided. In Sect. 4, we study an efficient algorithm and illustrated by an example. The conclusions are drawn in Sect. 5.

2 Problem Statement

A fuzzy number $\tilde{A}$ is a subset of the real line R with membership function $\mu_{\tilde{A}} :\to [0,1]$ such that (Dubois and Prade 1978):

1. $\tilde{A}$ is normal, i.e., there is an $x_0 \in R$ with $\mu_{\tilde{A}}(x_0) = 1$.
2. $\tilde{A}$ is fuzzy convex, i.e., $\mu_{\tilde{A}}(rx+(1-r)y) \leq min\{\mu_{\tilde{A}}(x), \mu_{\tilde{A}}(y)\}$ for all $x, y \in [0,1]$.
3. $\tilde{A}$ is upper semicontinuous, i.e., $\mu_{\tilde{A}}^{-1}([\alpha,1])$ is closed for all $\alpha \in [0,1]$.
4. The support of $\mu_{\tilde{A}}$ is bounded, i.e., the closure of $\{x \in R : \mu_{\tilde{A}} > 0\}$ is bounded. Recall that $\tilde{A}$ can be also represented by using its $\alpha - cuts$ $[A_L(\alpha), A_U(\alpha)], \alpha \in [0,1]$ (an ordered pair of left continuous functions)

which satisfy the following conditions:

1. $\tilde{A}_L$ is increasing on [0,1].
2. $\tilde{A}_U$ is decreasing on [0,1].
3. $\tilde{A}_L(\alpha) \leq \tilde{A}_U(\alpha)$, for all $\alpha \in [0,1]$.

Let $f : [0,1] \to [0,1]$ be a left continuous and decreasing function such that $f(0) = 1, and f(1) = 0$. A fuzzy number $\tilde{A}$ is called general f-trapezoidal if its α-*cuts* are of the form

$$[x_2 - (x_2 - x_1)f(\alpha), x_3 + (x_4 - x_3)f(\alpha)], \alpha \in [0,1]$$

where $x_1 \leq x_2 \leq x_3 \leq x_4$. And, when $x_2 = x_3$ additionally, it is called general f-triangular. Recently, the following f-trapezoidal fuzzy numbers had been studied:

1. If $f(\alpha) = 1-\alpha$, they are usually trapezoidal fuzzy numbers.
2. Let $s > 0$ and $f(\alpha) = (1-\alpha)^s$ Nasibov and Peker (2008) first studied fuzzy approximations of this type.
3. Let $n > 0$ and $f(\alpha) = 1-\alpha^n$. Bodjanova (2005) first studied trapezoidal fuzzy numbers of this class.

Let $F(R), F_T(R)$, and $F_\Delta(R)$ denote the sets of fuzzy numbers, f-trapezoidal fuzzy numbers, and f-triangular fuzzy numbers, respectively, and let $\lambda = \lambda(t) : [0,1] \to R$ be a weighted function on [0,1] (i.e., nonnegative function with $\int_0^1 \lambda(t)\mathrm{d}t > 0$). Now, we define a distance on $F(R)$ as follows:

$$d(\tilde{A},\tilde{B}) = [\int_0^1 (|A_L(\alpha)-B_L(\alpha)|^2 + |A_U(\alpha)-B_U(\alpha)|^2)\lambda(\alpha)\mathrm{d}\alpha]^{1/2}$$

for any fuzzy numbers $\tilde{A} = [A_L(\alpha), A_U(\alpha)]$ and $\tilde{B} = [B_L(\alpha), B_U(\alpha)]$. For any $\tilde{A} \in F(R)$, a general f-trapezoidal fuzzy number $T_f(\tilde{A}) \in F_T(R)$ is called the f-trapezoidal approximation of $\tilde{A}$ if it satisfies

$$d(\tilde{A}, T_f(\tilde{A})) \leq d(\tilde{A},\tilde{X}), \forall \tilde{X} \in F_T(R).$$

While $f(\alpha) = 1-\alpha$, it is the trapezoidal approximation of $\tilde{A}$ which had been studied by Abbasbandy and Asady, and while $f(\alpha) = (1-\alpha)^s$, it is called the semi-trapezoidal approximation which was first studied by Nasibov and Peker and improved by Ban and Yeh, independently. Similarly, for any $\tilde{A} \in F(R)$, a general f-triangular fuzzy number $\Delta_f(\tilde{A}) \in F_\Delta(R)$ is called the f-triangular approximation of $\tilde{A}$ if it satisfies

$$d(\tilde{A}, \Delta_f(\tilde{A})) \leq d(\tilde{A},\tilde{X}), \forall \tilde{X} \in F_\Delta(R).$$

In this paper, we study the f-trapezoidal approximation and the f-triangular approximation of any fuzzy number which will both generalize and make a survey of the recent approximations.

3 Main Results

Let $\tilde{A} \in F(R)$. For convention, let's fix the following real numbers:

$$a = \int_0^1 \lambda(t)\mathrm{d}t, \quad b = \int_0^1 f(t)\lambda(t)\mathrm{d}t \quad b = \int_0^1 f(t)^2\lambda(t)\mathrm{d}t$$

and

$$l=\int_0^1 A_L(t)\lambda(t)\mathrm{d}t, \quad l_f=\int_0^1 A_L(t)f(t)\lambda(t)\mathrm{d}t$$
$$u=\int_0^1 A_U(t)\lambda(t)\mathrm{d}t, \quad u_f=\int_0^1 A_U(t)f(t)\lambda(t)\mathrm{d}t$$

Note that $a,b,c\geq 0$ and that by applying Cauchy inequality we have $ac-b^2\geq 0$. Since $f=f(x)$ is not constant, we have $ac-b^2>0$, which implies the matrixes

$$\phi:=\begin{bmatrix} a & b & 0 & 0\\ b & c & 0 & 0\\ 0 & 0 & a & b\\ 0 & 0 & b & c\end{bmatrix}, \quad \psi:=4\begin{bmatrix} 2a & b & b\\ b & c & 0\\ b & 0 & c\end{bmatrix}$$

are invertible. It is easy to verify that

$$\phi^{-1}=\frac{1}{(ac-b^2)^2}\begin{bmatrix} c & -b & 0 & 0\\ -b & a & 0 & 0\\ 0 & 0 & c & -b\\ 0 & 0 & -b & c\end{bmatrix}, \quad \psi^{-1}=\frac{1}{2c(ac-b^2)}\begin{bmatrix} c^2 & -bc & -bc\\ -bc & 2ac-b^2 & b^2\\ -bc & b^2 & 2ac-b^2\end{bmatrix}$$

Also, we define real functions $s_i=s_i(\tilde{A})$ and $t_i=t_i(\tilde{A})$ by $(s_1,s_2,s_3,s_4):=(l,l_f,u,u_f)\phi^{-1}$
and $(t_1,t_2,t_3):=(l+u,l_f,u_f)\psi^{-1}$.
Now, let's define four subsets of fuzzy numbers as follows:

$$\Gamma_1=\{\tilde{A}\in F(R): s_1(\tilde{A})\leq s_3(\tilde{A})\},$$
$$\Gamma_2=\{\tilde{A}\in F(R): t_2(\tilde{A})\leq 0, t_3(\tilde{A})\geq 0, s_1(\tilde{A})>s_3(\tilde{A})\},$$
$$\Gamma_3=\{\tilde{A}\in F(R): t_2(\tilde{A})>0\},$$
$$\Gamma_4=\{\tilde{A}\in F(R): t_3(\tilde{A})<0\}.$$

Lemma 1. *The four subsets $\Gamma_i, 1\leq i\leq 4$, are disjoint and form a partition of fuzzy numbers.*

Theorem 2. *Let $T(\tilde{A})\in F(R)$ and let $T(\tilde{A})$ be its general f-trapezoidal approximation. Then, $T(\tilde{A})$ can be computed in the following cases: If, then*

If $\tilde{A}\in\Gamma_1$, then $T(\tilde{A})=[s_1+s_2f(a), s_3+s_4f(a)]$.
If $\tilde{A}\in\Gamma_2$, then $T(\tilde{A})=[t_1+t_2f(a), t_1+t_3f(a)]$.
If $\tilde{A}\in\Gamma_3$, then $T(\tilde{A})=[x, x+yf(a)]$, where $(x,y)=(l+u,u_f)\begin{bmatrix} 2a & b\\ b & c\end{bmatrix}^{-1}$.

If $\tilde{A} \in \Gamma_4$, *then* $T(\tilde{A}) = [x + yf(a), x]$, *where* $(x,y) = (l+u, l_f)\begin{bmatrix} 2a & b \\ b & c \end{bmatrix}^{-1}$.

Theorem 3. *Let* $T(\tilde{A}) \in F(R)$ *and let* $\Delta(\tilde{A})$ *be its general f-triangular approximation. Then,* $\Delta(\tilde{A})$ *can be computed in the following cases: If* $\tilde{A} \in \Gamma_1 \bigcup \Gamma_2$, *then* $T(\tilde{A}) = [t_1 + t_2 f(a), t_1 + t_3 f(a)]$

If $\tilde{A} \in \Gamma_3$, *then* $T(\tilde{A}) = [x, x + yf(a)]$, *where* $(x,y) = (l+u, u_f)\begin{bmatrix} 2a & b \\ b & c \end{bmatrix}^{-1}$.

If $\tilde{A} \in \Gamma_4$, *then* $T(\tilde{A}) = [x + yf(a), x]$, *where* $(x,y) = (l+u, l_f)\begin{bmatrix} 2a & b \\ b & c \end{bmatrix}^{-1}$.

4 Algorithm and Examples

In the previous section, we have presented formulas for computing the general f-trapezoidal approximation $T(\tilde{A})$ and the general f-triangular approximation $\Delta(\tilde{A})$ of any fuzzy number $\tilde{A}$. In the process of applying Theorems 2 and 3, we need to determine which one subset $\Gamma(i), 1 \leq i \leq 4$, the given fuzzy number $\tilde{A}$ belongs to. In the following algorithm, we straightforwardly compute $T(\tilde{A})$. It is really more efficient.

4.1 Algorithm 4

Let $\tilde{A} = [A_L(\alpha), A_U(\alpha)]$ be a fuzzy number and $T(\tilde{A})$ be general f-trapezoidal approximation of $\tilde{A}$.

Step 1. Compute the following objectives: a,b,c and l, l_f, u, u_f.
Step 2. Compute ϕ, ϕ^{-1}, and $(s_1, s_2, s_3, s_4) = (l, l_f, u, u_f)\phi^{-1}$. If $s_1 \leq s_3$, then $T(\tilde{A}) = [s_1 + s_2 f(a), s_3 + s_4 f(a)]$.
Step 3. Otherwise, compute ψ, ψ^{-1}, and $(t_1, t_2, t_3) = (l+u, l_f, u_f)\psi^{-1}$.
Step 4. If $t_2 \leq 0$ and $t_3 \geq 0$, then $T(\tilde{A}) = [t_1 + t_2 f(a), t_1 + t_3 f(a)]$.
Step 5. If $t_2 > 0$, then $T(\tilde{A}) = [x, x + yf(a)]$, where $(x,y) = (l+u, u_f)\begin{bmatrix} 2a & b \\ b & c \end{bmatrix}^{-1}$.
Step 6. If $t_3 < 0$, then $T(\tilde{A}) = [x + yf(a), x]$, where $(x,y) = (l+u, l_f)\begin{bmatrix} 2a & b \\ b & c \end{bmatrix}^{-1}$.

Note that, to obtain an algorithm for computing the general f-triangular approximation $\Delta(\tilde{A})$ of $\tilde{A}$, it only drops Step 2 from the above Algorithm 4.

4.2 Example 5

Let $f(t) = 1 - t^2$, $\lambda(t) = t$, and $\tilde{A} = [\alpha^4, 3 - \sqrt{\alpha}], 0 \le \alpha \le 1$. Find the general f-trapezoidal approximation $T(\tilde{A})$ and the general f-triangular approximation $\Delta(\tilde{A})$ of $\tilde{A}$. First, we apply Algorithm 4 to compute the general f-trapezoidal approximation of $\tilde{A}$, as follows. By Step 1, it is easy to verify that

$$a = \frac{1}{2}, \quad b = \frac{1}{4}, \quad c = \frac{1}{6}, \quad l = \frac{1}{6}, \quad l_f = \frac{1}{24}, \quad u = \frac{11}{10}, \quad u_f = \frac{103}{180}.$$

Therefore, by Step 2 we compute

$$\phi = \begin{bmatrix} \frac{1}{2} & \frac{1}{4} & 0 & 0 \\ \frac{1}{4} & \frac{1}{6} & 0 & 0 \\ 0 & 0 & \frac{1}{2} & \frac{1}{4} \\ 0 & 0 & \frac{1}{4} & \frac{1}{6} \end{bmatrix} \quad \text{and} \quad \phi^{-1} = 4 \begin{bmatrix} 2 & 3 & 0 & 0 \\ -3 & 6 & 0 & 0 \\ 0 & 0 & 2 & -3 \\ 0 & 0 & -3 & 6 \end{bmatrix}.$$

Hence, we obtain

$$(s_1, s_2, s_3, s_4) = (l, l_f, u, u_f)\phi^{-1} = (\frac{5}{6}, -1, \frac{29}{15}, \frac{8}{15})$$

Since $s_1 \le s_3$, the general f-trapezoidal approximation of $\tilde{A}$ is

$$T(\tilde{A}) = [\frac{5}{6} - (1 - \alpha^2), \frac{29}{15} + \frac{8}{15}(1 - a^2)]$$

Now, we compute the general f-triangular approximation of $\tilde{A}$. By Step 3, we compute

$$\psi = \begin{bmatrix} 1 & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{1}{6} & 0 \\ \frac{1}{4} & 0 & \frac{1}{6} \end{bmatrix} \quad \text{and} \quad \psi^{-1} = 4 \begin{bmatrix} 4 & 6 & -6 \\ -6 & 15 & 9 \\ -6 & 9 & 15 \end{bmatrix}.$$

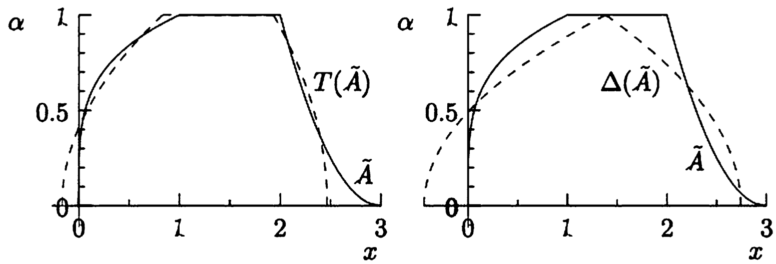
Hence, we obtain

$$(t_1, t_2, t_3 = (l + u, l_f, u_f)\psi^{-1} = (\frac{83}{60}, -\frac{73}{40}, \frac{163}{120})$$

and the general f-triangular approximation of $\tilde{A}$ is

$$\Delta(\tilde{A}) = [\frac{83}{60} - \frac{73}{40}(1 - \alpha^2), \frac{83}{60} + \frac{163}{120}(1 - \alpha^2)]$$

as shown in the following figures:



5 Conclusions

In this paper, we propose two more general approximations of fuzzy numbers, named general f-trapezoidal approximation and general f-triangular approximation. In practices, you can see situation of shape of the given fuzzy number. Then, pick out a suitable function $f = f(x)$, which must be decreasing and left continuous such that $f(0) = 1$ and $f(1) = 0$, and pick out a weighted function $\lambda = \lambda(t)$ (in general, you can simply choose $\lambda(t) = 1$). Consequently, apply the proposed Algorithm 4 to compute its general f-trapezoidal approximation and/or f-triangular approximation.

References

S. Abbasbandy, B. Asady, The nearest trapezoidal fuzzy number to a fuzzy quantity. Appl. Math. Comput. **156**, 381–386 (2004)

S. Abbasbandy, T. Hajjari, Weighted trapezoidal approximation preserving cores of a fuzzy number, Comput. Math. Appl. **59**, 3066–3077 (2010)

A.I. Ban, Approximation of fuzzy numbers by trapezoidal fuzzy numbers preserving the expected interval. Fuzzy Set. Syst. **159**, 1327–1344 (2008)

A.I. Ban, On the nearest parametric approximation of a fuzzy number-revisited. Fuzzy Set. Syst. **160**, 3027–3047 (2009)

A.I. Ban, A. Brandas, L. Coroianu, C. Negrutiu, O. Nica, Approximations of fuzzy numbers by trapezoidal fuzzy numbers preserving the value and ambiguity. Comput. Math. Appl. **61**, 1379–1401 (2011)

S. Bodjanova, Median value and median interval of a fuzzy number. Inform. Sci. **172**, 73–89 (2005)

D. Dubois, H. Prade, Operations on fuzzy number. Int. J. Syst. Sci. **9**, 613–626 (1978)

P. Grzegorzewski, Nearest interval approximation of a fuzzy number. Fuzzy Set. Syst. **130**, 321–330 (2002)

P. Grzegorzewski, E. Mrowka, Trapezoidal approximations of fuzzy numbers. Fuzzy Set. Syst. **153**, 115–135 (2005)

P. Grzegorzewski, Trapezoidal approximations of fuzzy numbers preserving the expected interval - algorithms and properties. Fuzzy Set. Syst. **159**, 1354–1364 (2008)

M. Ma, A. Kandel, M. Friedman, A new approach for defuzzification. Fuzzy Set. Syst. **111**, 351–356 (2000)

E.N. Nasibov, S. Peker, On the nearest parametric approximation of a fuzzy number. Fuzzy Set. Syst. **159**, 1365–1375 (2008)

C.-T. Yeh, A note on trapezoidal approximations of fuzzy numbers. Fuzzy Set. Syst. **6158**, 747–754 (2007)
C.-T. Yeh, On improving trapezoidal and triangular approximations of fuzzy numbers. Int. J. Approx. Reasoning **48**, 297–313 (2008)
C.-T. Yeh, Trapezoidal and triangular approximations preserving the expected interval. Fuzzy Set. Syst. **159**, 1345–1353 (2008)
C.-T. Yeh, Weighted trapezoidal and triangular approximations of fuzzy numbers. Fuzzy Set. Syst. **160**, 3059–3079 (2009)
C.-T. Yeh, Weighted semi-trapezoidal approximations of fuzzy numbers. Fuzzy Set. Syst. **165**, 61–80 (2011)
W. Zeng, H. Li, Weighted triangular approximation of fuzzy numbers. Int. J. Approx. Reasoning **46**, 137–150 (2007)

Author Index

J. Watada et al. (eds.), *Innovative Management in Information and Production*,
DOI 10.1007/978-1-4614-4857-0, © Springer Science+Business Media New York 2014

Subject Index

DOI 10.1007/978-1-4614-4857-0,