Tai-Yoo Kim · Almas Heshmati

Economic Growth

The New Perspectives for Theory and Policy

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Preface

This book has been written for readers who desire to witness a significant economic growth, one that will bring about an enhancement of the national economy and welfare. Important target readers that we have kept in mind include college and graduate students, economic policymakers, politicians, the experts and leaders of economic policy. Anyone with a basic knowledge of economic theory who wishes to learn more about economic growth, however, will benefit from perusing the contents of this book. The new perspectives of economic growth theory that we introduce here will prove especially useful to those who question, and to those who have been disappointed with the limited efficacy with which traditional economics and economic growth theories have applied to the real world.

Constructing a theoretically correct perception of the nature of economic growth, and crafting practical government policies to stimulate actual economic growth, require a firm grip on three fundamental characteristics of economic growth.

First of all, the nature of economic growth is not defined by the speed at which the economy grows, but by whether or not it accelerates in its growth. In other words, the current speed of economic growth is far less important than the rate of its acceleration (or deceleration). This is because the rate of acceleration is the factor that indicates the technological nature, or industrial organization, of an economy. Technological nature and industrial organization are ultimately what determine the rate of a country's future economic growth. In any given historical period, the rate of acceleration was in fact not only linked to the economic characteristics of a country, but also to the social, political, and cultural factors stemming from economics.

The second point to remember is that economic growth is a fruit of the expansive reproduction system. The economic growth of a country or society accelerates when the virtuous cycle of an expansive reproduction system is created and maintained. When the country or society falls out of this virtuous cycle, its economic growth stalls; if a malicious cycle is formed, its economy begins to regress. A virtuous cycle is formed when accumulated capital is invested in technological innovation, generating new demand for the new products created by newly developed technology. This spurs a qualitative development of the economy and the sophistication of industrial organization, which become the backbones of the expansive reproduction system. Qualitative development of the economy allows for mass production and mass supply, gratifying the newly generated demand and keeping up an expansive equilibrium. In a society where the expansive reproduction system is the engine of economic growth, then, technological innovation is its powerful fuel.

Finally, the role of value creation in economic growth is crucial. An expanding economy is indicative of generation of new values, which had not previously existed. Traditional industrial classifications, such as primary, secondary, and tertiary, or manufacturing versus service, however, are woefully inadequate for a proper understanding of the role of value creation in economic growth. Economic policies based on the traditional classifications and theories have thus often caved into skewed and unproductive controversies. Instead of trying to ascertain different categories of economy, it is more important to understand that an economy develops through the cycle of the processes of creation, expansion, and transmission of value. The rise and fall of every state in history, then, were inextricably linked to the processes of value creation in various societies in different time periods, be they large and powerful, or tiny and insignificant.

We hope that our new economic growth theory will offer useful and applicable suggestions for countries seeking to stimulate new economic growth, for both developing countries trapped in a malicious cycle of chronically low growth rates and poverty and advanced industrial states struggling with economic crises and recession. We believe that our theory will not only offer exciting new solutions for the economies of individual countries, but for the common growth and prosperity of the global economy at large.

We are deeply grateful for the support of the National Research Foundation of Korea (NRF), Grant No.2010-0026178, near the time of the publication of our research. Without Editor Toby Chai, the staff, and the Springer publishing company, this book would never have seen the light of day. Although we cannot reiterate all the names of our co-authors here, their dedicated and creative efforts were what enabled the completion of our theory and book. Their names can be found in the individual chapters to which they contributed. If any mistakes or errors are still to be found in the following pages, it is due solely to the negligence and shortcomings of the author.

Seoul Tai-Yoo Kim
August 2013 Almas Heshmati

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Abbreviations

AEG	Accelerating Economic Growth
APF	Aggregate Production Function
APP	Average Physical Product
BDP	Battle Deaths per Population
BT	Bio Technology
CC	Cumulative Causation
CRS	Constant Return to Scale
DEG	Decelerating Economic Growth
DNA	Deoxyribonucleic Acid
DRS	Decreasing Returns to Scale
DS	Distributive Services
DW	Durbin Watson Statistics
EC	European Community
ECM	Error Correction Model
EMPC	Electrical Machinery, Post and Communication
ERS	Expansive Reproduction System
EU	European Union
EU	KLEMS European Union Industry Database
FBS	Finance and Business Services
FDI	Foreign Direct Investment
FN	Following Nation
GDP	Gross Domestic Product
GM	General Motors
GMM	Generalized Methods of Moment
GNI	Gross National Income
GW	Giga Watt
ICC	Interaclass Correlation Coefficient
IDA	Industrial Development Authority
IDM	Identity Management System
IMF	International Monetary Fund
IRT	Increasing Return to Scale

IT	Information Technology
ICT	Information and Communication Technology
ISI	Import Substitution Industrialization
ISIC	International Standard Industrial Classification
LCD	Liquid Crystal Display
LN	Leading Nation
MCAP	Total Market Capitalization
MEE	Manufacturing Excluding Electrical
MFP	Multifactor Productivity Growth
MIT	Massachusetts Institute of Technology
MP3	Music Player
MPEG	Moving Picture Expert Group
MPP	Marginal Physical Product
NIESR	National Institute of Economic and Social Research
NMS	Non-Market Services
NT	Nanotechnology
OECD	Organization for Economic Cooperation and Development
OGPI	Other Goods Producing Industries
OLS	Ordinary Least Squares
pGDP	Global Average per Capita Gross Domestic Product
PPP	Purchasing Power Parity
PSS	Personal and Business Services
PWT	Penn World Tables
R&D	Research and Development
RGDPCH	Real GDP per Capita
RGDPL	Real GDP per Labor
SNS	Computer Operating Systems
SUR	Seemingly Unrelated Regression
TDP	Total Military Dead of All Causes per Population
TFP	Total Factor Productivity Growth
TPP	Total Physical Product
TV	Television
UEG	Uniform Economic Growth
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US	United States
US$	United States Dollar
USA	United State of America
VT	Volume of Trading Activity
WHO	World Health Organization
Y2K	Year of 2000 problem

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Chapter 1
Introduction to and Summary of Economic Growth: The New Perspectives for Theory and Policy

Tai-Yoo Kim and Almas Heshmati

1.1 Background

While there have been many researches and numerous theories of great scholars on economic growth and well-being in the past, many people in many developing countries are still suffering from poverty, inequality and mismanagement of growth potentials. According to the United Nations (UN), 48 countries are classified as the least-developed countries with a Gross National Income (GNI) per Capita of US $1,000 or less and the total population of these countries is 700 million or greater. Among them, 50 % are living with $1 or less and in 10 of the countries, 40 % of the population is undernourished. However, the fact that only four countries[1] have escaped from being classified as the least-developed countries since the 1970s it shows how difficult it is to escape from poverty and destitution.

Late-starting industrialized countries also feel limitations in their economic growth. In the case of South America, which had started industrialization through import substitutive industrialization after the Great Depression of 1929, it had a higher

The online version of this chapter (doi:10.1007/978-3-642-40826-7_1) contains supplementary material, which is available to authorized users.

[1] Except the case of Sikkim which was incorporated into India in 1975, only Botswana (1994), Cape Verde (2007), and Maldives (2011) are escaped from the list of least-de4veloped countries.

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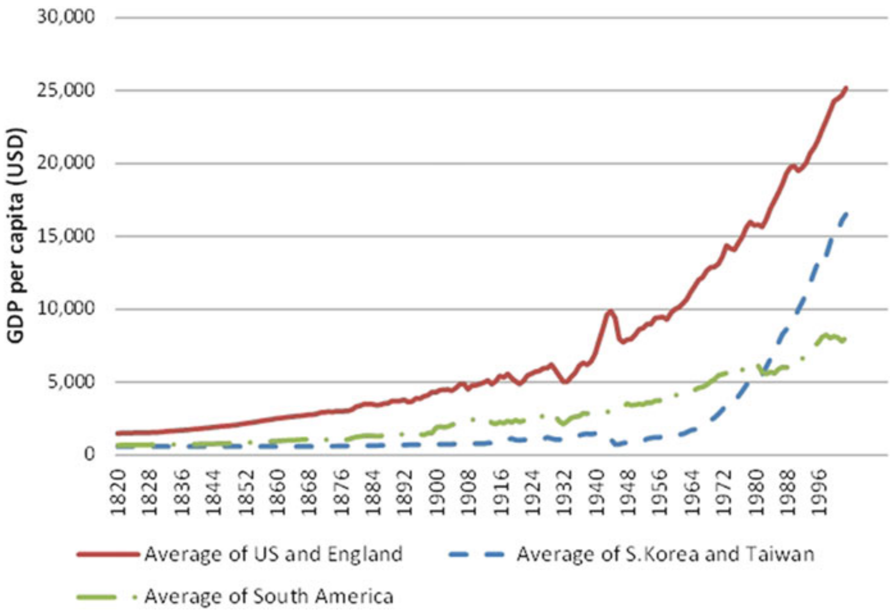

Fig. 1.1 Comparison of GDP per capita between early and late-starting industrialized countries

percentage of manufacturing industries than that of the United States or England.[2] However, the produced merchandises of the manufacturing industries were at a level to satisfy domestic demand without having ability to compete at the international market. As a result, these countries have not been able to catch up to the early industrialized countries even until now since the economic situation worsened after the financial crisis of the 1980s. To the point of being called the phenomenon of repeating the recession again after overcoming the economic crisis temporarily known as the "South American Syndrome," the barrier of challenge of reaching the early industrialized countries by South American countries is a formidable one. Although Korea and Taiwan are maintaining the gap with early industrialized countries as they are experiencing more rapid growth than South American countries since the 1980s as shown in Fig. 1.1, they have still been unable to join the rank of developed countries.

While the newly emerging industrial countries of China and India are growing rapidly with inexpensive labor as a factor of their competitiveness, cost competitiveness cannot be maintained permanently. In fact, the average minimum wage of China in 2012 has increased by 12.6 % compared to that of 2008 (China Briefing 2013). In addition, the average wage of 2011 was shown to have increased by as much as 12 % compared to the previous year (China Daily 2012). Also, it is difficult to focus on just

[2] In 1975, while the percentages of manufacturing industries of the United States and England were 29 % and 33 % respectively, those of Argentine, Brazil, and Chile were 35 %, 33 %, and 39 %, respectively.

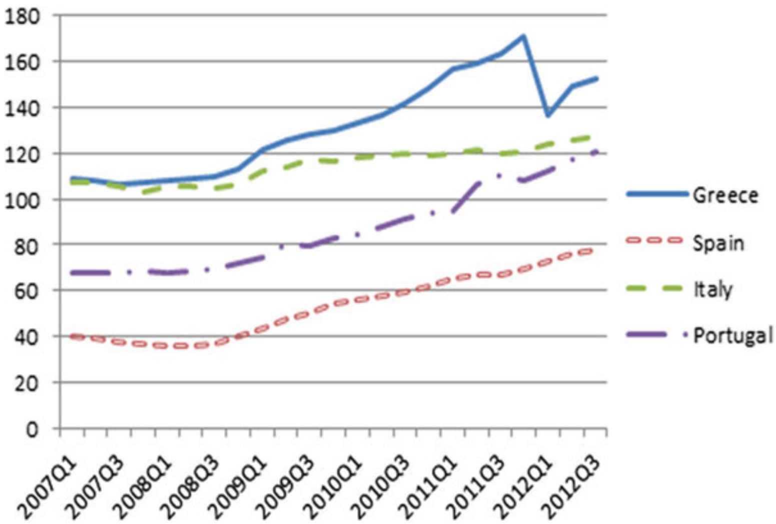

Fig. 1.2 Government debt to the GDP ratio of Euro zone countries (Eurostat website: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/)

growth as income inequality[3] and in particular regional inequality is becoming an increasingly serious social problem. After all, the rapid growth of newly emerging industrial countries might be merely temporary and it is uncertain whether they will be able to rise to the rank of early industrialized countries based on technology level and innovative capability. The fact that only 11 developing countries[4] have risen to the rank of developed countries shows how difficult it is to join the rank of early industrialized countries. It should be noted that the achievement is merely measured in terms of GDP or value generation rather than innovativeness.

Economic growth has slowed down for even industrialized developed countries have been experiencing periodic depression, stagnation and economic crisis. The average economic growth of OECD countries[5] is gradually slowing down as evidenced by their growth rate: 5.31 % in the 1960s, 3.69 % in the 1970s, 2.91 % in the 1980s, 2.58 % in the 1990s and 1.87 % in the 2000s. The same trend can be found in G7 countries. However, the problem is not only the decline of the economic growth rate. While Greece, Ireland and Portugal have received financial assistance from the IMF in response to the fiscal crisis, as is shown in Fig. 1.2, the

[3] The Gini coefficient of China has increased from 0.32 of 1978 to 0.61 of 2010 (Bloomberg, 2012) while this is far greater figure than those of Sweden (0.23), Korea (0.31) or Japan (0.38) and is at the standard of not having much difference with Namibia (0.71) showing the highest Gini coefficient in the world.

[4] Hong Kong (1997), Israel (1997), Singapore (1997), South Korea (1997), Taiwan (1997), Cyprus (2001), Slovenia (2007), Malta (2008), Czech Republic (2009), Slovakia (2009), and Estonia (2011) became developed countries.

[5] Belgium, France, Italy, Luxembourg, Netherlands, Germany, Denmark, Ireland, United Kingdom, Greece, Spain, Portugal, Austria, Sweden, Finland.

Euro zone itself is under a financially difficult situation as the fiscal crisis has spread to countries with greater economic scale such as Italy and Spain.

Even in the case of the United States recently, while it had maintained a zero interest rate after the financial crisis, it suffered by having its credit rating lowered by Standard & Poor's for the first time in its history in August, 2011. This was the result of an inadequate amount of national debt cutback and the concern of a double dip continues since the economic growth rate has been lower than expected. That is because the government debt per each U.S. citizen at the end of 2012 reached up to $53,400, which is 35 % higher than that of Greece, which is suffering from a serious financial crisis. The outlook is that it is difficult to continue quantitative alleviation for this reason and economic recovery through stimulated consumption also would not take place easily. The International Monetary Fund (2009) saw that the recent financial crisis will continue for a long time and recovery will take quite some time based on the investigation of 122 economic recessions throughout the world. Japan, which had risen to the rank of developed countries the fastest among the Asian countries in the past, also fell into a long-term depression in the 1990s so that the average GDP growth rate in the 2000s is merely 0.8 %; additionally, Japan has been experiencing negative growth rate since the financial crisis. Also, both stock prices and real estate prices are currently 1/3 that of the prices at the end of the 1980s. This situation is a result of the asset bubble collapse and the subsequent shrinking consumption has proven to be a stumbling stone for economic growth.

The conditions described above indicate that the existing theories on economic growth have clear limitations in the aspect of how much they can effectively contribute to actual economic growth. Therefore, a proper theory on economic growth for countries and leaders promoting economic growth will be presented through this book. This book is basically centered around the theory of economic growth and theory of national development written for agricultural developing countries pursuing industrialization and late-starting industrialized countries pursuing advancement. Despite this fact, this book hopes to make a significant contribution even in the development of human civilization through the accompanied growth of developing countries, late-starting industrialized countries and early industrialized countries throughout the world, as well as in the economic growth of early industrialized countries (developed countries) tormented by economic anxiety and the crisis of stagnation. That is because a proper national development theory or economic growth theory can be consistently applied at all times in its general theory whether it is targeting early industrialized countries, late-starting industrialized countries or the entire world.

1.2 Assumptions About Economic Growth

In past agricultural societies, there was always a lack of supply to satisfy the demand when it came to almost all kinds of goods. When products were produced, they became consumed as soon as they were supplied; thus, Say's rule that production induces demand was valid. After the advent of industrial society, however, due to the industrial revolution and mass-production technology, supply exceeded demand, and demand could not catch up with supply, thus leading to economic crisis. Likewise, since in today's early industrialized countries and late-starting industrialized countries, supply exceeds demand, Say's rule is no longer valid. However, in future knowledge-based society, because new demand that results in new products created through new technology will play leading roles in triggering economic growth, we will encounter the era when supply once again genuinely creates demand. At a glance, the phenomenon of supply fulfilling the demand that has already existed but has not been able to be satisfied due to the shortage of supply in agricultural society seems similar to the phenomenon of new products creating a new demand that had never existed due to new technology in a knowledge-based society.

For instance, in agricultural societies, because the food supply could not meet the demand, the infant death rate was severely high. During the Roman period, one of the representative agricultural societies, the infant death rate was very high at over 30 % (Soren and Soren 1999). In industrial societies, however, food was supplied sufficiently, so the infant death rate was reduced to half that of agricultural societies. In fact, the infant death rate of the industrial society of nineteenth-century England decreased to 15 %, which means that the excess demand that had resulted from the lack of supply was fulfilled by additional supply. Meanwhile, in knowledge-based societies, as new products such as smartphones are being created through the use of new technology, new demand is explosively increasing. As a matter of fact, only 2 months after the release of the iPhone made by Apple Inc. in July, 2008, more than 6.9 million phones had been sold throughout the world.[6] This demand for the iPhone was even greater than that of TVs[7] in the past. Therefore, this book will call the rule of creating demand by supply based on new technology as the *new Say's rule* and identify economic growth with the increase of value creation, such as supply or production.

As mentioned earlier, in industrial societies, demand could not follow supply, so Say's rule was not valid. But this was the case that often occurred in advanced or leading countries that initiated world economy in the early stage of industrial societies. Also, this is a phenomenon that appears theoretically when economists assume a certain country or world economy as a closed economy. However, even in an industrial society where Say's rule is not valid, late-starting industrialized countries that can supply or produce products with price competitiveness can induce export demand as much as possible through industrialization or advancement. In the enormous global market, such niches always exist. Even though there is some concern that it would be limited for supply to create enough demand since the size of the niche market is too small, if late-starting industrialized countries are

[6] Apple Press Info (http://www.apple.com/pr/library/2009/01/21Apple-Reports-First-Quarter-Results.html).

[7] Color TV was released in the beginning of 1950s. In US, 3.88 million color TV sold during the first year (http://www.tvhistory.tv/facts-stats.htm). In UK, only 17 % of households bought color TV by 1972 and it was very slow diffusion pattern (http://freespace.virgin.net/mymail.athome/features/colour/colour.html).

able to replace the vast demand that has been dominated by early industrialized countries, this will turn out to be an ignorable problem.

Demand creation can be classified into three types. In one type, the demand that resulted from the existing supply that could not fill it fully due to the lack of supply is satisfied. In another type, the demand that encroached on the demand supplied by another supplier or producer before is replaced. And in the last type, new demand is created by being induced by new technology that did not exist before. To differentiate this type from the types of demand creation previously defined, it is also called "new demand creation." Although most of the demand creation in agricultural societies satisfied the existing demand, after the advent of the mercantile community, eastern regional products like spices created some new demand as well. However, in industrial societies marked by rapid technological innovation, not replacement demand that either fills the existing demand or encroaches on another supplier's demand but new demand induced by new products plays a crucial role in accelerating economic growth. In other words, in agricultural societies where there is an absolute shortage of supply, most production and consumption activities are simply oriented toward eating for survival. However, after the advent of industrial society, food, clothing, and shelter occupy a relatively smaller portion, and the production and consumption of products that can satisfy new demand increased.

In regards with the above discussion in the U.S., food expenses occupied 24.3 % of family expenditure in 1960 but reduced to 13.1 % in 2002; however, transportation & communication expenses and culture & entertainment expenses have increased constantly up to now (U.S. Department of Labor 2006). This situation is also true in Europe. In terms of the family consumption expenditure structure in France, food expenses, which formed the largest part in the 1960s at 30 %, were reduced to 15 % in the 2000s, and food and clothing expenses except for housing expenses decreased from 51 % to 33 %. Meanwhile, reflecting the demand for new products, the ratio of entertainment & culture expenses has increased consistently for the last 40 years. Seen from this perspective, economic growth in advanced countries cannot help depending on new demand creation. In developing countries, however, demand creation can still be realized through replacement demand through price competition resultant from their relative low wages. Successful late-starting industrialized countries, including Germany, Japan, Korea, Taiwan, and China began their economic growth through such a replacement demand with no exception in the beginning of their economic growth period. The strategies of those late-starting industrialized countries whose technology and capital fell far behind those of early industrialized countries cannot help as they are considerably relying on their government's industrial policies.

1.3 The Characteristics of Economic Growth

Economic growth can be divided into two broad categories: quantitative growth and qualitative growth. In quantitative growth, production is increased by mainly increasing input under a given technological level and industrial structure. In qualitative growth, production is improved by technological advancements resulting from innovation or an enhanced industrial structure and by new products which create new demand. In agricultural societies, qualitative growth is slight because technological advancements are slow to occur, and quantitative growth gradually decreases because of agriculture's characteristic of diminishing marginal returns. Therefore, growth becomes stagnant. In agriculture societies, in the perspective of economic growth, the economy gets caught in a vicious cycle because of simple reproduction character. In industrial societies, however, even though short-term production shows diminishing returns, qualitative growth is possible due to the comparatively fast rate of technological advancements; at the same time, quantitative growth is possible due to capital investment and accumulation. If industrial societies just rely on quantitative growth, an economic vicious cycle such as an economic crisis is inevitable because supply eventually surpasses demand. However, if industrial societies are marked by qualitative growth due to technological advancements, a virtuous cycle which accelerates the economy is possible because new products will continuously create new demand. Thus, from an economic growth perspective, the agricultural economy which decelerates and the industrial economy which accelerates have different characteristics; in other words, they are different organisms that possess different genes in the context of economic growth.

Indeed, the consumption of new products at the beginning can be limited to a certain stratum of consumers which has higher income, but as time goes on, the practice will spread to the general public, and the virtuous cycle resulting from network effects will be possible as new products once again encourage new demand. This trend is similar to the case of spices in early commercial society being considered the exclusive properties of certain nobility but as time went on, spices spread as products for the general public. However, in commercial societies which were based on agricultural societies, continuous expansive reproduction was impossible because another innovative product which can create new demand did not continuously appear after spices. But industrial society is different. Figure 1.3 shows the group of various products which were newly produced to create new demand over a span of 100 years.

In 1900, only less than 10 % of U.S. households possessed telephones; in1915, 1930, and 1945, less than 10 % of U.S. households had automobiles, refrigerators, and air conditioners. Color TVs, microwaves, and cell phones were considered luxurious products used by less than 10 % of households in 1960, 1975, and 1990, respectively. However, in the following decades, all of these products became essential goods used by almost all households, and the speed of consumption is recently accelerating as can be seen in Fig. 1.3. Based on this fact, in knowledge-based societies, as the spreading speed of new technology becomes much faster, the appearance of new technology will immediately lead to new demand. This phenomenon also occurs within the same product group. Figure 1.4 demonstrates how the radio, TV, and phone have evolved.

In the case of the radio (dotted line in Fig. 1.4), after the AM radio receiver appeared in 1920, the FM radio receiver appeared when the demand for AM radio was saturated. When the FM radio was saturated, new devices like the CD player

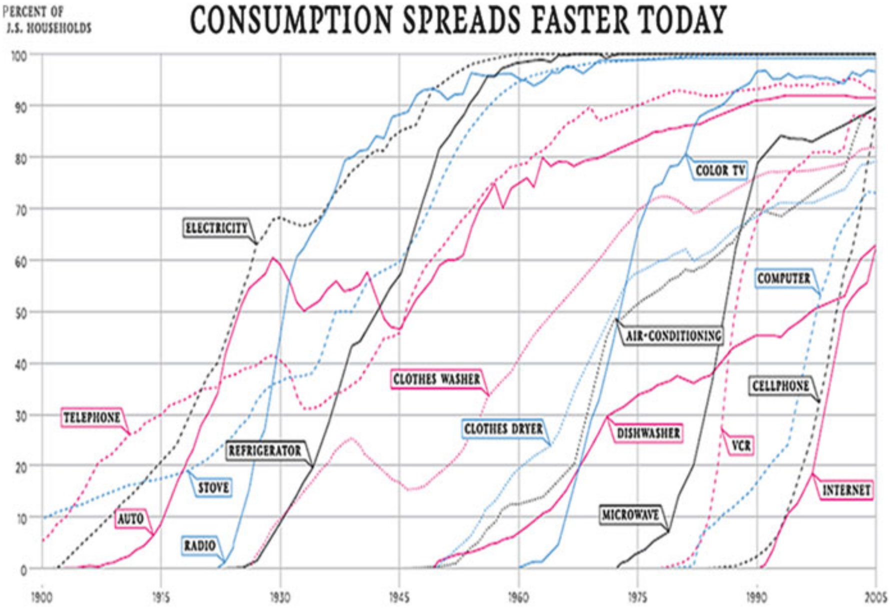

Fig. 1.3 The 100-Year March of Technology (The Atlantic 2012)

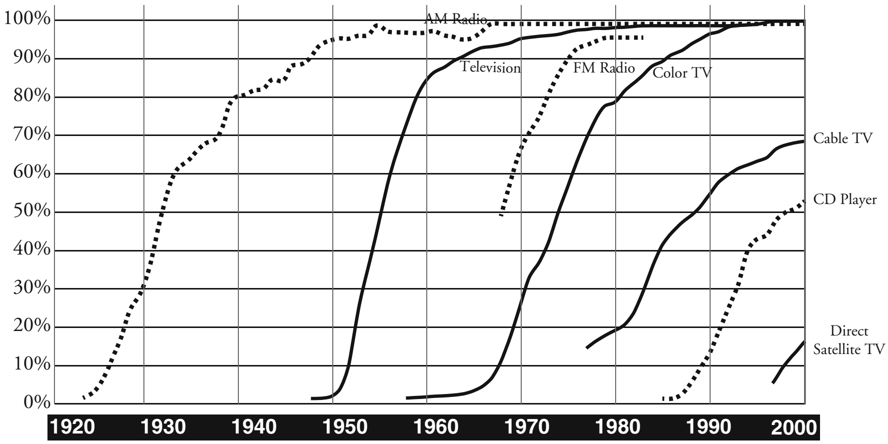

Fig. 1.4 Diffusion of IT technologies (A.C. Nielsen company 1996)

appeared. In the case of the TV, color TV appeared after black-and-white TV, and new TV services like cable TV and satellite TV continuously created new demand. In other words, in industrial societies, diverse groups of products are newly produced to create new demand, and even within the same group of products, new demand is created through continuous incremental and radical innovations.

Economists think that if the economic growth speed is fast in the short term, it means that economic growth is occurring at a satisfactory rate, and if the economic growth speed is slow, it means that economic growth is problematic. However, the important aspect in long-term economic growth is whether economic growth is accelerating or not. Even though the speed of economic growth is fast in the short-term, in a decelerating agricultural economy, growth will be eventually stagnant in the long run. On the other hand, even if the speed of economic growth is slow, in an accelerating industrial economy, growth will be faster in the long run. After the Industrial Revolution in England, those who could not understand this fact were skeptical about the Industrial Revolution. Right after the Industrial Revolution, the speed of economic growth was not fast enough so that even skepticism about economic growth was raised. However, after all, all of the industrialized countries experienced much faster economic growth than agricultural countries. Eventually, the key factor of economic growth is the technological level (industrial structure), not short-term growth speed. In other words, in industrial societies, quantitative growth cannot be the indicator of economic growth; only qualitative growth can be the correct indicator.

The change from a decelerating agricultural society to a society with accelerating economic growth is not a continuous but a discontinuous phenomenon. This phenomenon is the mutation of the economic system rather than its evolution. During the thousands of years in human history, a spontaneous mutation had occurred only once in the UK. After late-starting industrialized countries learned from and imitated based on the British industrial revolution, they directly reflected their knowledge in their agricultural societies. Thus, this situation is different from the British industrial revolution, which is a spontaneous mutation. If the British industrial revolution had not occurred, agricultural countries such as China, and those in Eastern Europe as well as others would probably still be decelerating agricultural societies. The reason is that the possible waiting time for generating a spontaneous mutation such as in the British case requires a 1,000 years.

Many researchers have studied the British case, which is an unusual mutation. First, the main reason is due to the expansion of commercial society, the glorious revolution and so on. In the process, the advanced capitalism system of the Netherlands was introduced to the UK. Thus, an expansive reinvestment system was established in the UK. Second, a lot of industrial technology planning which protects the infant industry and develops industry-leading technology by using the Marin law, wool law, patent law and other laws were implemented. Lastly, the necessary conditions for an industrial revolution just happened to be met namely: abundant coal reserves, the Atlantic trade, the huge American colonies and so on. Besides, there are many researchers who emphasize the exception of the UK from a different angle. However, this book does not deal with this discussion, but it is important to note the exception of the UK, which is characterized by a genetic variation of an economic mutation that is not common in any agricultural economy under a general economic situation. Therefore, since the industrial revolution in the UK, all successful industrialized countries carry forward industrialization by using protective trade, industrial policy, technology policy and other measures. Of course, the British industrial revolution also received

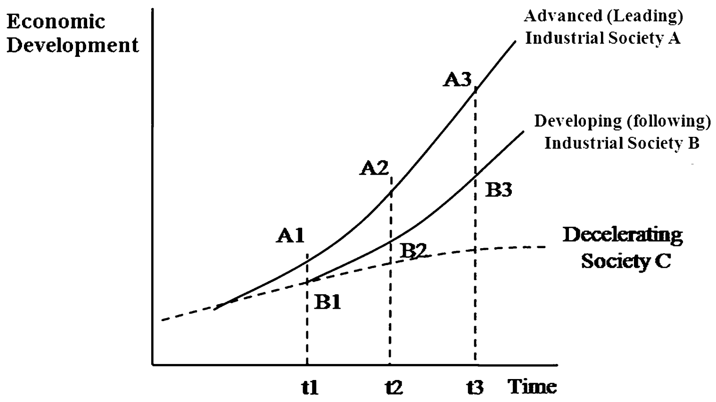

Fig. 1.5 Divergence model of industrial development

help from government policy. However, late-starting industrialized countries tend to rely solely on the role of government policy.

In this manuscript, the fact that we would like to add regarding industrialization and the state rule is as follows: Late-starting industrialized countries such as Germany, Japan, and Korea have effectively carried forward industrialization in a short period of time compared with early industrialized countries such as the UK. These countries would have been almost similar to early industrialized countries such as the US if the late-starting industrialized countries had adopted appropriate industrial policy. However, among industrialized countries, the gap between early industrialized countries which prepared an extensive reproduction system earlier and late-starting industrialized counties which adopted an extensive reproduction system later is increasingly expanded, so divergence occurs (see the Fig. 1.5 above). The divergence is discussed in detail in the next section.

1.4 Divergence of Economies

One of the important properties in economic growth is 'divergence'. The divergence between a decelerating agricultural economy and an accelerating industrial economy is obvious. In addition, the economic development level between early industrialized countries and late-starting industrialized countries is also diverging. The early neo-classical school of thought claimed the prevalence of absolute convergence hypothesis, which stated that long-term income levels are converging in countries which have the same early-stage income levels. However, the income levels are not actually converging because all countries have different conditions and production functions. The conditional convergence hypothesis which accounts for specific conditions emerged to overcome the above problem, but the hypothesis is also criticized for the reason that the conditions are excessively simplified and are not based on realistic assumptions. Eventually, convergence between early industrialized

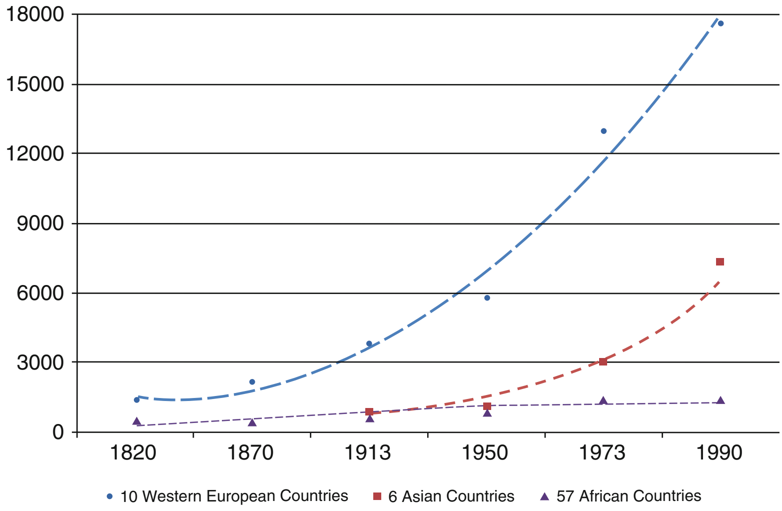

Fig. 1.6 Trace of GDP per capita by national group (international dollar in 1990). Ten Western European countries: Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland and England. Six Asian countries: Malaysia, South Korea, Singapore, Taiwan, Thailand, India (Maddison 2001)

countries having similar starting points and conditions is possible, but it is difficult for convergence in which late-starting industrialized countries catch up to early industrialized countries to occur, both theoretically and historically.

As shown in Fig. 1.5, the economic level differences between early industrialized countries and late-starting industrialized countries coincide with historical facts. The traces of economic growths from 1820 to 1990 in Western European countries, Asian countries and African countries are shown in the Fig. 1.6 above, proving the divergence of the economic development level between early industrialized countries and late-starting industrialized countries.

Geometrically, if the starting points of the two accelerating curves are different, the vertical interval between the two curves is gradually diverging. Of course, there would be many skeptical opinions against this argument. The authors in this book have reasonable surrebuttals for these opinions, but due to limited spaces an in-depth discussion on this point will be placed on hold in the next time for fulfilling the purpose of this book.

The phenomenon that the economic development levels between leading industrialized countries (advanced countries) and following industrialized countries (late-starting developing countries or underdeveloped countries) are diverging under the usual economic condition is advantageous for leading industrialized countries, but unfavorable for following industrialized countries, relatively speaking. Most economists do not deeply consider economic growth from a relative viewpoint. They usually judge that the economic growth of a country is proceeding at a satisfactory rate if the pace is fast. From a relative viewpoint for industrialized countries and late-starting developed countries, divergence means the specialization by international trades: industrialized countries are specialized in manufacturing industries and late-starting developed countries are specialized in agricultural commodity sources and food production. In addition, there is a difference between early industrialized countries and late-starting industrialized countries. The early industrialized countries are specialized in higher value-added products while the late-starting industrialized countries are specialized in lower value-added products. The per capita income in agricultural countries is usually below US$800[8] and the per capita income in late-starting industrialized countries producing lower value-added goods is usually below US$10,000.[9] The per capita income in early industrialized countries producing higher value-added goods can be above US$40,000.

Thus, the specialization toward a decelerating agricultural dominated economy in late-starting developed countries results in the preservation of the agricultural economy so that they lose the opportunity to industrialize and thus experience stagnant growth pattern. This phenomenon is similar to the case in which late-starting industrialized countries are specialized in the low value-added industries compared with early industrialized countries that are specialized in the high value-added industries because late-starting industrialized countries lose the opportunity to enter the higher value-added business. Of course there are conditions to be satisfied attached to entry to higher valued added based development path.

Therefore, the existing evaluation suggesting that economic growth should be achieved in all late-starting developed countries whether their economies are agricultural economies or lower value-added industrial economies is improper. This means that the short-term quantitative economic growth is not so bad, but the countries which concentrate on short-term quantitative growth rather than long-term qualitative growth will ultimately have more disadvantages than advantages in terms of development of the national economy. Quantitative economic growth, of course, would be better than an economy that does not grow immediately for the countries which wish to settle for an agricultural economy or a lower value-added industrial economy structure. However, if the countries wish to be advanced countries and develop in the long run, they should pursue qualitative economic growth although they would have to relinquish much quantitative economic growth. The important fact in this regard is that the qualitative economic growth of following industrialized countries depends heavily on the government policy under an open economy, compared to the leading industrialized countries (advanced countries).

Thus, the divergence between agricultural countries and early/late-starting industrialized countries, or that between early industrialized countries and late-starting industrialized countries, occurs in industrial societies. Because of international free trade, in addition, agricultural countries are specialized for agriculture, while

[8] Average nominal GDP of 21 countries where agricultural sector occupies above 30 % among entire industries in 2011.

[9] Average nominal GDP of 66 developing countries by IMF where industrial sector occupies above 30 % among entire industries in 2012.

late-starting industrialized countries are specialized for the lower value-added industries, and early industrialized countries are specialized for the higher value-added industries. The economy in agricultural countries grows with the decelerating property. Meanwhile, the economy in late-starting industrialized countries grows with the accelerating property, but the specialization toward the lower value-added industries causes the problem of low growth because the acceleration, compared with advanced countries, is at a lower rate.

In the future knowledge-based society, however, if all knowledge-based industry countries create a new demand from new technologies in each specialized industry such as information technology (IT), biotechnology (BT) and nanotechnology (NT), the economic growth between these countries will be similar because the values between the specialized industries are similar. This will imply that the divergence problem between high-growth and low-growth countries can be solved. Furthermore, the entry of early industrialized countries into the future knowledge-based society provides a space in which late-starting industrialized countries become early industrialized countries and agricultural countries become late-starting industrialized countries. This process leads to a virtuous circulation in which the global economy is upgraded step by step and the economies of countries throughout the world grow together. The issues of virtuous cycle and the vicious cycle in an economy will be discussed in more detailed form in the next section.

1.5 Virtuous Cycle and Vicious Cycle in an Economy

There can be several viewpoints of war, but in this book, war is considered as a kind of economic activity. In most cases, the cause of war is linked to the economy, both directly and indirectly. In addition, even if war seems to be irrelevant with economy in a few cases, war considerably influences economy and its development through constructive destruction of old technology and its replacement with new and more advanced.

The agricultural economy is a simple reproduction economy; thus it does not achieve a virtuous circle of economy in itself because this economy is not growth oriented but stagnation. In times past, war was considered as a way to create growth in a stagnant agricultural economy. It is impossible to break the pattern of decelerating growth and stagnation through the extension to adjacent marginal farmland except in special cases such as finding the New World. This is because improvement in production in a pure agricultural society where technological progress is very slow is impossible due to the absence of new technologies such as mechanized farming techniques, chemical fertilizer and the improvements of seeds that exist in industrial societies. Eventually, the growth of a pure agricultural society in the past could be achieved through expanding territories (farmlands and farmers) and increasing the total amount of agricultural production, in other words, through the creation of a virtuous cycle by the interaction of conquest war and economy. The growth process of the Roman Empire and the unification process of Shih Huangti in the warring states period of China followed the above virtuous cycle. It is the true nature of the great conqueror which clearly shows the justification in the agricultural empire for the national development process.

The essence of economic growth in industrial societies is expansive reproduction that enables the growth of economy with increasing speed. More and more raw materials and energy resources are needed for the virtuous cycle of the expansive reproduction system. In addition, bigger and bigger commodity markets are required. If the resources and markets fall short, the expansive reproduction system strays from the virtuous cycle. In this case, the way to make an economy of the developed country grow steadily is by securing abroad resources and markets through trade; otherwise, armed conflicts are inevitable. The history of breaking colonies in the age of modern imperialism demonstrates the above phenomenon properly. First, empires demanded that weak countries engage in trade with them, and armed protests were conducted if the weak countries did not comply. By extension, empires tried to conclude the treaty forcibly by making pretexts such as protecting the lives and properties of their nationals. In the case that the economic colony system described above was not effective, another tactic of empires was making a political colony by occupying the country directly. This suggest that, the purpose of early industrialized countries was finally "resources and markets," no more and no less.

Victory in warfare in an agricultural society is decided by the fighting powers on battlefields. But, as the society develops into an industrial one, the economic and technological powers, and the production ability of arms and supplies become more important in deciding who wins the war. The age of total war has come, where the wins and losses of wars depend on the production capabilities in the rear rather than on the battles on the battlefront.

This also means that in this age, late-starting industrialized countries cannot defeat early industrialized countries and agricultural countries cannot defeat industrial countries. Such a state of affairs also points to the fact that the diversity of the levels of economic development of early industrialized countries and late-starting countries leads to the diversity of their technological levels and the diversity of their weapons systems. Another interesting fact about warfare in industrialized societies is that wars actually have a great effect on post-war economic development. For example, after the Second World War, the defeated nations showed faster economic growth compared to the victors after. This phenomenon is called the Phoenix Effect (Organski and Kugler 1977). Organdki and Kugler argued that the destruction of former political systems allowed a more efficient distribution of resources, whilst Kulger and Arbetman argued that the new technology introduced by the victors in a conquered nation allowed faster development. But, such arguments cannot fully explain how the US, which has never been conquered nor destroyed, and Germany and Japan, which have been struck hard after the war, have all become leading nations after war. It also cannot fully explain how the traditionally victorious nations of the UK and France have both been overtaken by Germany and Japan, which are defeated nations. Therefore, it will be more appropriate to say that the preparations for the war, taking part in the war itself, and the production technology and talented personnel acquired for and during the war, all contributed to the speedy developments after the war. In an age where the economy and technology of a nation decide the outcomes of the war, the preparation and the very experience for and of the war very likely determine the speed of post-war development.

In an agricultural society, wars were inevitable because the growth of a nation would stall after a certain point. In an industrialized society, wars were inevitable to acquire resources and markets. But, in the knowledge-based society, in the age of information technology, warfare is no longer inevitable. From a supply point of view, this is because in the knowledge-based society, in contrast to the industrialized society which relied on mass productions of low-value products, added-value is created from high-value goods which are smaller and compact in size and quantity.

In an industrialized society, the important resources are material, fuel and energy but in a knowledge-based society, the cost of resources is much lower and the advent of replaceable energy will change the most important resource to advanced technology. This means that production is now dependent on the research and development of new technology, not warfare to secure resources and fuel. Also, from a consumer's point of view, warfare and competition were inevitable in an industrialized society because the growth of demand was much slower than the growth of mass-production capabilities. However, in the knowledge-based society, where new demand creation through product developments from new technology will take up most of the demands, there is no longer the need for war. Victory on the battlefields won't even lead to conquering the new demand creation. For the demands in old industrialized societies such as the demand for textiles, metal, cars and home electronics, there were many arguments in the trading sector. However, in the knowledge-based society, there are no trading disputes over semiconductors, LCDs, Computer Operating Systems, SNS, and smartphones.[10] The age has come where there is no need for war or any kind of conflict concerning people's demands.

Therefore, it can be said that the speed of the postwar development of a nation depends on how much it invested in technology and engineers during the war, rather than on the victory or defeat itself. If a nation spends enough on industrial technology or research and development, it can benefit from the Phoenix Effect without having to take part in a war. Especially, in the production sector, intellectual factors such as information and technology have become so much more important than material factors such as resources and energy, which means that there is no longer a need to fight over the limited resources. New demand creation through new technology and new products will make wars useless in the knowledge-based society, and allow economic development through technological advancements.

The above arguments suggest that the economic development in a knowledge-based society, and the virtuous cycle of expansive reproduction, depends solely on

[10] Recently, the patent war between Apple and Samsung has resulted in affecting the release dates of smartphones in both firms, but this does not affect the supply (production) of smartphones (new technology). Therefore, in knowledge-based societies, conflicts over patents are different from trading disputes, thus not dealt with in this book.

the research and development of advanced technology. Only a small fraction of all the money that would have been spent to win a war in an industrialized society will bring a much greater effect on the nation's economic growth. This is the new war-free Phoenix Effect in the knowledge-based society. Here, like how in the old days, government policies had a strong effect on the war, the development, research and investment in new technology also depend on government policies.

1.6 Economic Growth Based Industrial Classification

In the early twentieth century, ever since Fisher (1939) and Clark (1940) classified industries into primary, secondary and tertiary industries, such a classification has become the foundation of all basic industrial classifications and understandings of the industries, as well as the International Standard Industrial Classification (ISIC) system. However, as time passed and industries have become more diverse, a growing number of critics pointed out that Fisher and Clark's classification no longer provides an adequate representation of the different characteristics of industrial environments. Especially, concerning the tertiary industry, the service industry, the various industries that were the subcategories were too diverse and different to be classified as a single industry. This was due to Fisher and Clark's classification method of naming all industries that were not part of A: primary industries which gathered resources directly from nature, nor B: secondary industries which transformed and processed the gathered resources. To solve such problems, there were many attempts to reclassify industries, like Baumol (1985)'s attempt to divide tertiary industries into two according to their productivity: progressive sector and stagnant sectors, or Scharpf (1990)'s study to reclassify industries according to their relationship with manufacturing industries, and Evangelista (2000)'s attempt to reclassify industries according to their innovative performances.

There can be many standards proposed to newly classify industries and resolve their different natures, but the need for a standard to represent economic growth, explained so far, has become greater than ever. This is the classification of industries according to their methods of value creation. In this manuscript attempt is made to introduce such classification system below consistent with economic growth.

According to their methods of value creation, industries can be largely classified as industries which create values (value-creation industries) and industries which transfer the created values (transferred value industries). Value-creation industries are industries which deal with originals that can be reproduced and stored systematically. Originals are not just materials with form but everything that can be owned with an economic value. Program software, recorded music, filmed educative lectures, and patents are all types of originals. But not all industries that deal with originals are value-creation industries. The aim of the proposed classification is to contribute to economic growth, so the value-creation industries suggested in this research are industries which only deal with originals that 'can be reproduced and stored systematically'. The ability to be stored and reproduced systematically is an important characteristic required for expansive reproduction, and is necessary for accelerating the economic growth of an industrial society. Handcrafted goods and artworks are similar products but cannot be reproduced systematically, and therefore are inadequate for expansive reproduction. In the case of program software, they do not have any tangible form but can be expansively reproduced, which makes the computer programming industry a value-creation industry.

It should be noted that, in different cases, the same original can be classified in value-creation industries or transferred value industries. For example, for a hamburger recipe, the recipe itself is an original but when it takes the form of a franchise like McDonalds and can be systematically reproduced to store capitals, it is deemed as suitable for expansive reproduction and thus categorized as a value-creation industry. Value-creation industries such as the one mentioned above actually create value through originals and actively participate in depositing capital assets, thereby contributing to economic development. Value-creation industries can be divided into base value industries which actually create originals, like manufacturers, and extended value industries, which improve the value of originals through marketing and distribution.

On the other hand, transferred value industries are the rest of the industries which do not use systematic, accumulatable and replicable originals as distance objects. In other words, transferred value industries are different from value-creation industries, so they do not create originals or increase value, and they take on the role of transfer/distribution by using created value. Because transferred value industries do not create value, they do not increase a country's net wealth and thereby no economic growth.

Transferred value industries are divided into three types: one type is the production support service industries which are highly correlated with value-creation industries and also directly help to produce originals. Financial services, legal services and consulting services are included in this first category. Another type is the private service industries, which include beauty, art and medical services. The final type is the public service industries, which include education and national defense. Particularly, among these three types, although the production support service industries do not directly create value, they contribute to the economic growth. Financial services, which are the representative service in production support services industries, assist in the accumulation of capital. Additionally, financial services also increase liquidity of capital to more quickly and more productive industries, so they contribute to the efficient distribution of capital. Particularly, Schumpeter (1911) mentioned that the proper functions of finance services such as mobilizing savings, evaluating projects, managing risk, monitoring managers, and facilitating transactions are necessary for economic development. Under Schumpeter's logic, many countries planned the development of finance as well as economic development. In fact, the Table 1.1 below shows that if a country has a higher economic development level, the financial level is also higher.

However, due to the excessive development of finance in early industrialized countries, it is difficult to explain the advent of the recent economic crisis using the existing theory of economic development. For instance, in the case of Ireland,

Table 1.1 GDP level, financial development in sub-group

	Low income[a]	Middle income	High income
	Average		
GDP LEVEL[b]	6.42	22.33	70.89
FINANCIAL LEVEL[c]	0.72	0.86	0.96

[a] According to classification standard of world Bank data (http://data.worldbank.org/about/country-classifications), we divided 94 countries by income level
[b] Real gross domestic product per capita relative to the United States (G-K method, current price) in Penn world table (https://pwt.sas.upenn.edu/) is used
[c] It is defined that the ratio of commercial bank assets to total financial assets. Generally, a commercial bank has better risk managing and potential returns than central bank. Thus, if the value is closed to 1, the financial development is high

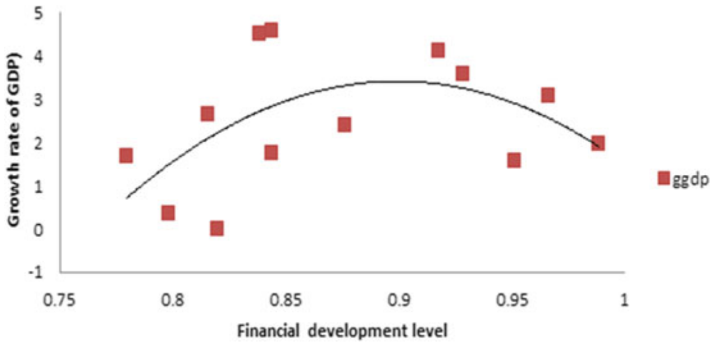

Fig. 1.7 The relationship between the financial development level and the economic growth rate (the mean value of each income group)

excessive financial development which is not related to the manufacturing industry led to the failure of economic development, so an economic crisis occurred. In fact, the relationship between the financial development level and the economic growth rate has the form of a parabola, as shown in the Fig. 1.7 below. In other words, if the financial development level increases to rise over a certain level, it is expected that financial development will have a negative effect on the economic growth rate.

The results of the empirical analysis on the impact of financial development on economic growth show that financial development has a significantly positive impact on economic growth. However, the important thing to remember is that if financial services are not related to the manufacturing industry and are excessively developed, financial development will have a significantly negative impact on economic growth. A detailed analysis of this issue is provided in Chap. 9.

The current industrial classification makes it difficult to distinguish industries according to the value-creation method, so it is difficult to know which economic activities actually contribute to national economic growth. For instance, the industries involved in the production of vehicles are base value industries, the industries involved in the sales of the vehicles are extended value industries and the necessary financial and legal services during the production process are production support service industries. However, because the current industrial statistical classification cannot clearly distinguish these classifications which are mentioned above, the size of value-creation and transferred value industries cannot be evaluated, therefore, it is necessary to conduct a reclassification of industries and a recalculation of statistics by using better classification criteria. The new classification is according to value creation, which would better explain economic growth of countries.

1.7 Conclusion

For economic growth, the deconstruction of discourse between the role of government from Keynes' point of view and the role of market from Hayek's point of view are historically conflicting. After the Great Depression, the role of government from Keynes' point of view became a mainstream of economics. Subsequent to the phenomenon of stagflation and Reagan-Thatcher era, the free-market theory from Hayek's point of view became a mainstream of economics. After the recent economic crisis caused by the sub-prime mortgage in the US, the neo-liberalism showed a limitation in explaining economics again. Therefore, no one has yet been able to clearly decide which of the two theories is superior. However, if we consider the difference of the relative condition between developed countries and late-starting developed countries as the premise for this debate, the answer becomes clearer.

Because an industrial society has the property of accelerating economic growth, there are several features under the free-market system. First, the economic gap between industrialized countries and developing countries which are decelerating agricultural societies has to show divergence. Second, because of the differences of economic condition and technology level between early industrialized countries and late-starting industrialized countries, the economic development level between these countries has to show divergence. Thus, if we consider the relationship between developed countries and late-starting developed countries, late-starting developed countries have the disadvantage of having to catch up with developed countries because developed countries have a relative advantage in the free market and free trade policy than late-starting developed countries. Therefore, all successful late-starting developed countries such as Germany, Japan, Korea, Taiwan, China and etc. without exception promote industrialization and economic growth dependent on government industrial policies.

In conclusion, if we consider the debate based on the changing viewpoint among developed and late-starting developed countries rather than jumping into the debate between Keynes and Hayek, developed countries have a relative advantage in free-market theory and late-starting developed countries have a relative advantage in the theory of the government's role in the development process. The national development theory or economic growth theory can be consistently explained by using a general theory. This theory can facilitate accompanied growth and prosperity considering the virtuous cycle of the economy as well as the relative condition among early industrialized countries, late-starting industrialized countries and developing countries.

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Chapter 2
Decelerating Agricultural Society: Theoretical and Historical Perspectives

Tai-Yoo Kim, Almas Heshmati, and Jihyoun Park

Abstract In general, societies are divided into agricultural and industrial types. This study presents theoretical and historical perspectives on decelerating agricultural societies. Agricultural demand and supply play major roles in society development. Three descriptions of an agricultural society and theories of its deceleration patterns are presented: the neo-classical production function, stage theory, and induced innovation. Two important cases of decelerating agricultural societies and their ultimate replacement by industrial societies, Europe and the United States from preindustrial to the early industrial era are examined. The limitations of decelerating

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agricultural societies with a focus on structural problems, impacts of industrial structure, and problems of agriculture in market and non-market areas, are also discussed. The position of agriculture as described by economic development theory is established by analyzing the stages of economic development, the theory of structural change, and the theory of leading industry. Finally, the transition from an agricultural to a commercial society is described with a focus on the formation, development, value creation, and structural limitations of a commercial society.

Keywords Agricultural development • Agricultural society • Commercial society • Decelerating society • Economic growth • Induced innovation • Simple reproduction • JEL Classification Numbers: L16, O11, O47, O13

2.1 Introduction

2.1.1 Background and Motivation

According to the neo-classical production function, the relationship between input and output shows diminishing returns to scale; that is, the rate of increasing output gradually decreases. Long periods of economic growth can be described as the path of input according to time, which is determined by the production-function relationship between input and output. If a society is sluggish in technology development for a long time or its range of technology development continuously deceases, then it will also show a gradual decrease in the rate of long-run economic growth.

Agricultural societies before the Industrial Revolution showed a gradual decrease in rate of economic growth. Simple-reproduction societies, they differed from those with an expansive-reproduction structure[1] created by technology development and capital accumulation. As a result, the agricultural society reached an economic growth limit as time elapsed. At the end of an agricultural society era, the limit was overcome by expansive reinvestment of capital via trade and the appearance of a commercial society, which experienced a gradually increasing economic growth rate. However, commercial societies also reached a growth limit because the technology advancement that would keep up the expansive-reproduction lagged behind.

Solow (1957) insisted that exogenous technology development shifts the production function. Hence each period has a different production function in which the amount of shift differs by the intensity of technology development. By expanding this theory, we can explain the decelerating economic growth of an agricultural society. The deceleration of economic growth can be seen by looking at

[1] Simple reproduction means that neither capital is accumulated nor increases in productivity sustained. “Expansive reproduction” describes the case where capital is accumulated to facilitate an increase in production. We discuss how expansive reproduction serves as a feature of industrial and commercial societies.

the production function at different time points and observing the slow technological development as manifested by trace outputs according to input levels (i.e., the development of output–input relationships over time). By applying an induced innovation model, Hayami and Ruttan (1971) insisted that the long-term production function is restricted by technology development. The decelerating pattern can be also shown when Hayami and Ruttan's meta-production function is applied to an agricultural society where the amount of technology development over time is small and the speed of development is reduced.

We discuss the economies of pre-industrial societies that were based entirely upon agriculture; we define these economies as "pure agricultural societies." For example, before the Industrial Revolution, England was a purely agricultural society. Pure agricultural societies spanned a very long period in history: from the time when mankind first started to cultivate land to the beginning of the Industrial Revolution. The populations of agricultural societies had been relatively stable for thousands of years. Meanwhile, agricultural technologies were developed gradually in these societies. Technology advancement could not overcome the production constraints inherent in agricultural societies, such as limited land for cultivation. We content that because production constraints are greater than technology-related productivity, technology development in agricultural societies is sluggish.

In this study, we consider the decelerating agricultural society from a historical long-term perspective. The time spans are much longer than those in the usual long-term analysis used in economics. Therefore, we ignore economic factors that influenced production in the short terms within our study period and investigate the impact of technology advancement in history. The technologies in agricultural societies discussed include all kinds of knowledge, skills, and tools developed for improving agricultural productivity.

2.1.2 Objective and Scope

In this article, we define a society experiencing a long period of declining economic growth as a "decelerating society" and explain it through the characteristics of an agricultural society. By examining the theoretical and historical descriptions about the economic growth of an agricultural society, we can understand the reasons for decelerating economic growth and investigate the effect of technology development on long-term economic growth.

To verify a decelerating society, we first review the mechanism of a decelerating society using theories of Solow (1957) and Hayami and Ruttan (1971) among those of other scholars who explained the relationship between technology development and economic growth. Second, we describe all developments of an agricultural society by reviewing the pre-existing theoretical and empirical research of scholars who studied different aspects of agricultural society development.

Through the methods described above, we explain characteristics of a decelerating society. The main cause of deceleration is the speed and the amount of technology development over time. Nevertheless, some societies tried to overcome the decelerating pattern of economic growth through trade and capital reinvestment. Some commercial societies, which successfully established the Industrial Revolution and regarded technology development as their basis of economic growth, could achieve continual development and thus overcome decelerating economic growth patterns. By summarizing these historical cases, we confirm that the driving force of never-ending economic growth is technology development.

This study is organized as follows. In Sect. 2.2 agricultural societies are defined and the important role of agricultural demand and supply in the development of societies is also discussed. In Sect. 2.3, the theories for decelerating society are presented. Numerous theories that describe the rise of an agricultural society and its deceleration patterns are described in Sect. 2.4. The deceleration of an agricultural society and its replacement by an industrial society in Europe and the United States are investigated. Discussion of the growth limitations of a decelerating agricultural society is found in Sect. 2.5. The position of agriculture within economic development theory is established in Sect. 2.6 by an analysis of the stages of economic development. The transition periods from the decelerating agricultural to accelerating commercial societies are discussed in Sect. 2.7. Finally, Sect. 2.8 summarizes this study.

2.2 Definition and Characteristics of an Agricultural Society

2.2.1 Definition of an Agricultural Society

Societies are historically divided into agricultural and industrial types. They might be characterized with only one descriptor, but in reality they are a combination of both types. Factor endowment and specialization in production result in societies with different degrees of the two components. For example, a society's agricultural employment as a share of total employment is an indicator of the importance of agriculture to that society. Another indicator is the agricultural share of total value of production. Compared with an industrial society, an agricultural society is relatively easy to define despite its complexity and multidimensionality.

Agriculture involves cultivating crops and managing livestock. Stavenhagen (1982) defined an agricultural society as that in which the majority of a country's population is living in rural communities and the society has an agriculture-based economy. In an agricultural society, activities mainly cover agricultural production, where farmland and farmers are the most important resources of the national economy. Bowler (1996) described the first agricultural revolution, which started thousands of years ago through the power of man and animals. Agricultural communities were formed in the center of a farming civilization, and agricultural production supported population growth. Until the second agricultural revolution around 1650, labor-intensive self-sufficient agriculture was the norm due to the lack of agricultural technology development.

Toffler (1990) and van Bath (1963) also provide two other views about different development waves in agricultural societies. By focusing on aspects of food consumption, van Bath (1963) divided Western Europe agricultural development from A.D. 500 to 1850 into two periods. From A.D. 500 to 1150, the Middle Ages were an era of direct agricultural product consumption. Most people simultaneously supplied themselves and produced a surplus of goods to the non-agricultural population group consisting of priests or nobles. After 1150 A.D., the exchange of surplus production expanded the agricultural society. The emergence of commercial societies added other dimensions to agricultural society development. Therefore, markets were developing and agricultural product prices were market determined. Toffler (1990) introduced a description of the first wave of development, where an agricultural society is characterized by a focus on self-sufficiency without incentives for increasing production. A society is considered self-sufficient when slave labor and self-consumption characterize the production pattern. Most agricultural products were consumed by the producers and their families or by privileged minorities who could afford the cost of the surplus food.

In an agricultural society, the majority of people were farmers living in small and half-independent communities. They had no way to preserve food for a long period and no roads to transport crops to distant markets. They had little incentive to develop production technology or produce more crops because outputs were given to landlords. In this first period, commercial activities became increasingly important because cities were dependent on the supply of food from rural communities.

In the descriptions of an agricultural society, we identify a few key indicators applicable to a definition of the term. First, self-sufficiency is of vital importance in understanding an agricultural society. However, because of the limited production possible by single farming families, the society becomes a community with natural interdependency in many sectors and among many components. The interdependence leads to many forms of cooperative behavior among society members. Second, agriculture and agricultural production are determined by the key production factor: land. If the right to control the land is given to specific people, the producers depending on the land are set in a community relationship. The manor of medieval Europe represents the kind of economic community structure where land is controlled by noble persons.

Even though large cities and civilizations evolved in medieval Western Europe, they could not become centers of the agricultural society. Instead, the manor was the heart of the agricultural district, which in turn, formed a bigger society with complementary characteristics that generated large-scale self-sufficiency. In other words, the agricultural districts, as smaller versions of the bigger society, were established with the surplus of agricultural production.

2.2.2 Characteristics of an Agricultural Society

In this section, the characteristics of an agricultural society will be examined from the viewpoint of short-term agricultural production as well as demand and supply of agricultural products.

2.2.2.1 Characteristics of Production in an Agricultural Society

An agricultural society's short-term production function follows the neo-classical production function (van Bath 1963). That is, it shows diminishing returns to scale, where the increase in output, as a result of increased input(s), decreases. The agricultural production function with two key input factors is defined as Y = F (Land, Labor), where the functional form F is quasi-concave and increasing in both arguments. In the short-run, land is fixed and labor is variable, but in the long-run both inputs are variable.

According to van Bath (1963), agricultural management is largely affected by regional and economic factors. First, agriculture is affected by climate, quality of soil, and the condition of the agricultural water supply. The quality of soil determines the crops that can be cultivated and the water supply condition determines whether the main source of livelihood will be stock raising or farming. Second, in past agriculture societies, both farming and stock raising were not managed intensively. The area of land for cultivation was very limited because it was dependent on the extent of fertilization. The ways of recovering fertility of soil after land usage were (i) leaving the cultivated land fallow for quite a long time, (ii) leaving some part of land fallow for 1 year and then fertilizing enough by muck produced from agricultural communities, and (iii) fertilizing the mixture of humus soil from the non-cultivated land—wilderness and wild pasture—and the muck from agricultural communities. However, all of these were very restrictive alternatives for recovering the fertility of farmland. Third, in the pre–Industrial Revolution period of Western Europe, the general ratio of the quantity of sown seeds to harvest of some major crops, such as rye or wheat, was 1:3 or 1:4. Because of the low sown-seed/harvest ratio, a relatively large portion of the land was allocated for producing seeds for the next year. When the sown-seed/harvest quantity ratio is high, the increased harvest quantity is cumulative (see van Bath 1967). However, the cumulative effect decreases gradually with the decrease of the ratio. Fourth, in pre-Industrial Europe, reclaiming marginal farmland was the only way to increase agricultural production because of the degree of low technology development. However, indiscreet reclamation of marginal farmland deteriorated the fertility of land and it increased the sown-seed/harvest ratio. In the thirteenth century, the high degree of exploitation of marginal farmland led to a dearth of farmland to reclaim.

2.2.2.2 Characteristics of an Agricultural Society in Terms of Demand and Supply

The demand for major agricultural products has characteristics of inelastic price and income responsiveness (Johnson 1950). Therefore, the expansive reproduction of an agricultural society is impossible because of the limited demand for agricultural products where, at a certain level, demand will not show further increases. Low elastic or inelastic price of demand is due to the nature of agricultural products as foods and other necessities. Also the income elasticity is low because the demand for agricultural products decreases relative to the improvement in general economic conditions and is replaced by rapidly growing consumption of non-agricultural products.

The inelastic demand of agricultural products due to price changes means that demand does not increase even when the quantity of products increases and the prices of them decrease. Therefore, the capital accumulation from agriculture does not grow sufficiently large. The inelasticity of demand for agricultural products with respect to changing income implies that even if the national per capita income in a society increases, the increased demand for agricultural products remains small. As a result, the capital accumulation process is expected to be rather difficult and slow.

For various reasons, forecasting of agricultural supply is rather difficult, and the change of supply can be very large because controlling production conditions such as temperature, rainfall, and insects is impossible. This instability lowers the balanced economic growth in the long term. Also, the growing period for the agricultural product is long and seasonal. These nature-related factors place constraints on supply. Therefore, the supply cannot be flexible to meet the real demand and price changes of the agricultural products. Once the predicted price has determined the production quantity, which is done at seeding time, the supply cannot be controlled to reflect prices that have changed by harvest time. Therefore, due to the inelasticity of demand and supply, the characteristics of agricultural products may cause large price fluctuations.

Ezekiel (1938) introduced the cobweb model to examine the theoretical analysis of gradual changes in equilibrium in one market and to determine whether the gradual equilibrium ultimately converges to the level of static equilibrium. According to this theory, the demand reacts rapidly to price changes. Meanwhile, because supply does not readily react to price changes, a time difference emerges such that the real equilibrium price is reached after passing through several temporary equilibrium points. So, price and demand converge or diverge to and from the equilibrium point according to the extent of supply and demand elasticities. The phenomenon is named “cobweb” because the graphic of the supply and demand curves take the form of a cobweb. When the price elasticity of supply is smaller than the price elasticity of demand, convergence to equilibrium can be obtained after several subsequent chain reactions of demand and supply to the price change. However, the fluctuation increases or diverges in a case where the price elasticity of supply is bigger than the price elasticity of demand.

According to the cobweb model, agricultural production shows unstable divergence because of slow reaction of agricultural product supply to the rapid demand changes. Figure 2.1 shows the development of the real price of livestock sold in the United States and livestock production from 1875 to 1940. The change of livestock and milk cow prices shown in the graph reflects the change in livestock numbers. The alternating price and production can diverge in the form of a cobweb. In this kind of divergence model, the demand and supply increase unstably until they meet the limit of resources, and then the price change drops to 0.

Farmers respond to different risk problems in agriculture with various instruments (Just and Pope 2003). First, they control aggregate supply with respect to changes in prices and yields. Diversification and hedging of assets are other control methods. Crop insurance can be a possible alternative method, but feasible only under

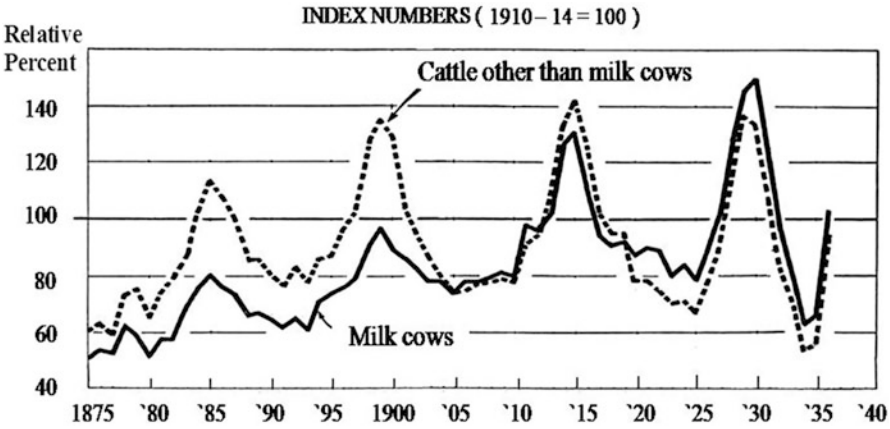

Fig. 2.1 Divergence patterns of purchasing power per head of milk cows and other cattle, 1875–1940 (Source: Ezekiel 1938)

provision of significant government subsidies. Contract farming is another method applied to reduce farmers' price risk by specifying prices in advance. Farmers also intend to reduce risks by using certain inputs such as pesticides and irrigation.

2.2.3 *Lessons Learned from the Definition and Characteristics of an Agricultural Society*

The characteristics of an agricultural society affected its long-run growth pattern prior to the Industrial Revolution, while self-sufficiency and land dependency limited the motivation to increase the yield. Even though some attempts were made to reform agricultural production, the low level of technologies available could not leverage the effect of those attempts. Moreover, inelasticity in demand, instability in supply, and price divergence prevented the capital accumulation needed for reinvestment in agricultural technologies. All of these factors created a vicious circle such that agricultural production could not boom. As a result, the agricultural society showed a long-term decelerating growth pattern in history.

2.3 Theory of Decelerating Society

The relationship between time and output in an agricultural society can be understood through the lenses of technical change and the induced innovation of products and processes. These two points of view reveal that the rate of production growth in an agricultural society decreases in the long run. The economic growth rate gradually decreases because of the simple-reproduction structure as well as production factors (e.g. land) and technology limits.

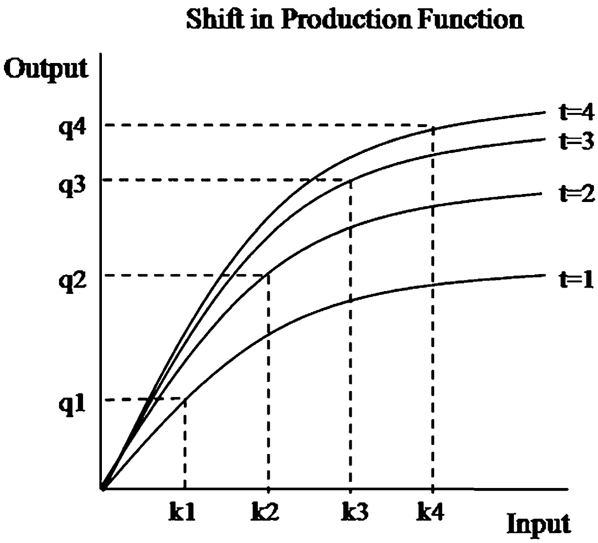

Fig. 2.2 Relationship between output and time as seen by shifts in APFs over time in an agricultural society

2.3.1 Viewpoint of Neo-classical Technical Change

Solow (1957) modeled the effect of exogenous-technology advancement on the production function.[2] In Solow's model, increased output is decomposed into a shift of production function and the movement along the production function due to the increase of input(s). Solow concluded that technology advancement creates this kind of production-function movement.

The Fig. 2.2 shows the patterns of aggregate production function (APF) drawn for an agricultural society from the viewpoint of technical change. Each APF reflects the technology level at a specific time. To apply Solow's (1957) model to agricultural societies, k represents the land, which is the most important production factor in agricultural societies and synonymous to the capital input in industrial societies. The increase of k means that farmland area is enlarged. Figure 2.2 shows that the degree of shift in APF is small in a pure agricultural society. The small level is due to sluggish technology advancement, and also the agricultural society is decelerating because the annual shift in production is gradually decreasing over time.

Figure 2.3 illustrates the trace of output at each period calculated from the production function of corresponding periods shown in Fig. 2.2. We assume that the output levels are constant, and equi-distanced time intervals are used to make a

[2] In Debertin's (1986) view, agricultural production follows the neo-classical production function model. We describe Solow's model of technical change and the aggregate production function. Although Solow applied the model to an industrial society accumulating capital, the analogy with an agricultural society is straightforward.

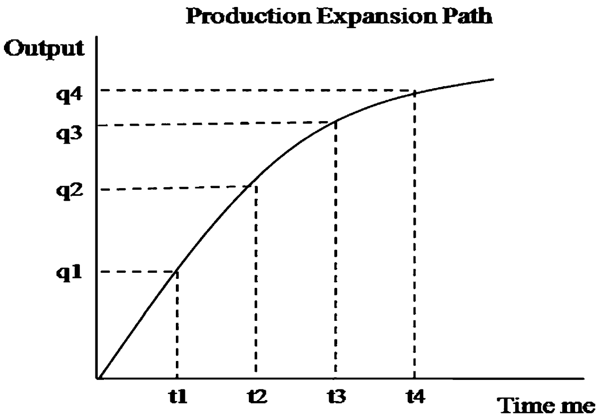

Fig. 2.3 Relationship between output and time of an agricultural society as seen through a production expansion path

simple model that illustrates how agricultural technologies affect agricultural output over time.

We define "APF expansion path" as a trace of production according to the time of each APF. The APF expansion path illustrates when the APF shifts in response to technology change. The APF expansion path of Fig. 2.3 shows the typical long-term production curve of an agricultural society.

In Fig. 2.3, q2-q1, q3-q2, and q4-q3 indicate that the increased amounts of production are decreasing over time because the range of short-term production-function shift is decreasing. The decreasing pattern is due to slow technology development in a purely agricultural society.

2.3.2 Viewpoint of Induced Innovation Model

Hayami and Ruttan (1971) suggested the meta-production function form for the induced innovation model in agriculture. The meta-production function is a potential production function suitable for describing agricultural production and society. As shown in Fig. 2.4, it is the envelope around the neo-classical production function. It is restricted by technology advancement in the long run. In other words, the output change is dependent on the increase of the output/input ratio according to time.

As shown in Fig. 2.4, the short-run production function of an agricultural society shows diminishing returns to scale. In the figure, 2.4.A1 and 2.4.A2 are the times used to establish each technological development, and 2.4.B1 and 2.4.B2 indicate the increased production through technology advancement. When the movement of the short-run production function gets smaller due to technology development, as expressed by the meta-production function, the economic growth rate decreases and finally it reaches the limit and becomes sluggish. In conclusion, output according to time in an agricultural society takes a form similar to the short-run production function that shows a gradual decrease in the rate of output increase.

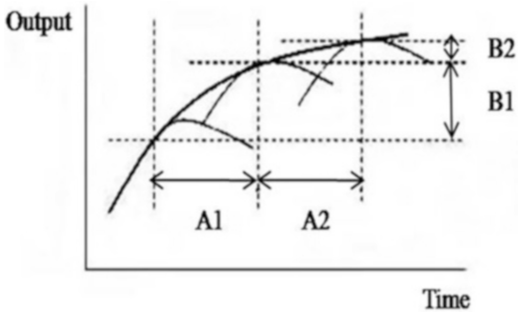

Fig. 2.4 Relationship in an agricultural society between output and time per the induced innovation model

In a pure agricultural society, the technology advancement is very slow, and as a result, the movement range of the production function is very small and decreases gradually. Therefore, the graph clearly shows the diminishing relationship between input and output of an agricultural society. It thus reveals the decelerating relationship between output and time.

2.3.3 Lessons Learned from the Theory of Decelerating Society

The movement of the neo-classical production function is caused by technology advancement according to time, which can be expressed by the APF expansion path (i.e., the trace of output) or by the meta-production function (i.e., the envelope around the neo-classical production function). The decelerating characteristics of an agricultural society can be explained clearly by the two curves in Figs. 2.3 and 2.4.

2.4 Theoretical Explanations About a Decelerating Agricultural Society

In this section, the opinions of Hayami and Ruttan (1971), Debertin (1986), and Johnston and Mellor (1961) will be featured as the theories that explain the decelerating nature of an agricultural society. Debertin (1986) explained that agricultural production shows diminishing returns to scale, and the ratio of production factor, which has a high fixed cost, will cause production to be lower than the maximum level. Johnston and Mellor (1961) suggested that agriculture develops in three stages. In the first stage, the pure agricultural society experiences a very low increase of production, while in the second and third stages expansion of production is based on labor- and capital-intensive techniques. By using the induced innovation model, Hayami and Ruttan (1971) explained the deceleration of increasing production of an agricultural society in the long term.

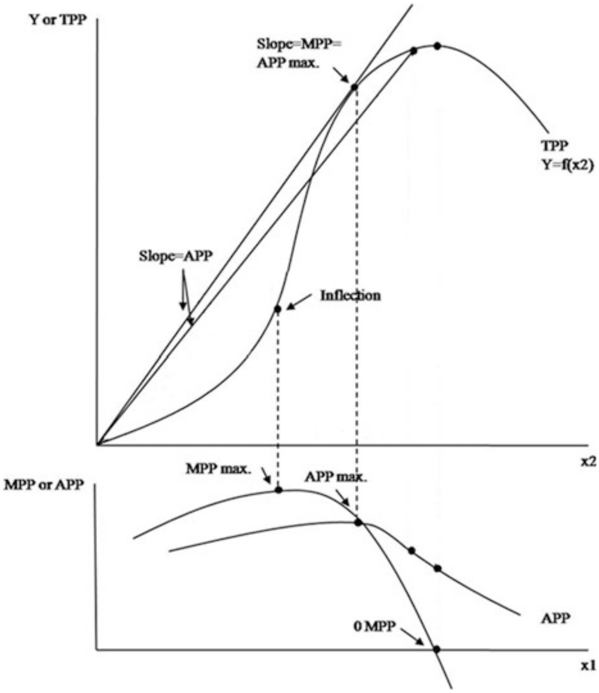

Fig. 2.5 General forms of the neo-classical production functions

2.4.1 Debertin's Explanation of Agricultural Production

The neo-classical production function, as it applies to agricultural societies, explains the short-term production relationship that shows diminishing returns to scale. In Fig. 2.5, in accordance with the Debertin's (1986) explanation, the production function is illustrated by the marginal physical product (MPP), average physical product (APP), and total physical product (TPP). As the input (x1) increases, the production capacity of the input factor also increases at first. After reaching the point of inflection the accelerating production capacity starts to decelerate. Here the TPP is still increasing. However, as the function passes its maximum point, even though the input of variable production factor (x) increases, the TPP decreases. In other words, more of an input factor, such as fertilizer, damages agricultural returns.[3]

In the case of agricultural production, productivity drops quickly because the rate of production factor, which is a fixed cost, is high and the production period is long (Debertin 1986). Prior to the seeding moment, most of the production factors are variables, but after the seeding they are fixed. Thus, when production factors are used, the production cost is regarded as fixed. For a production function with two

[3] However, a profit-maximizing farm will never produce when MPP $<$ 0. That is, the declining part of the TPP schedule is irrelevant, and without loss of generality it can be deleted.

variable production factors, such as fertilizer and labor, the maximum production is possible when the overall profit is maximized and minimum production cost of the combined factors is realized. However, for the production function in which only one input is a variable, the profit is maximized at an output level that is less than the production maximization level. In this one-variable scenario, growth decelerates at a higher rate than in the two-variable scenario.

2.4.2 Johnston and Mellor's Stage Theory of Agricultural Development

Johnston and Mellor's (1961) theory of agricultural development consists of three stages. The first stage is labeled as development of agricultural preconditions. Most of the agricultural sectors in underdeveloped countries are classified as belonging to the first stage. The sector is described as self-sufficient and family centered. Productivity is low because of lack of resources, education, and technology. Even though increase in total production is impossible, potential productivity by technology changes. Traditional agriculture has a number of specific characteristics. For instance, the production increase is very slow because of the stagnated rate of technology change. The income increases are not sustainable because the production is increased by more traditional inputs such as land and labor. Without the application of industrial technology, the continuous productivity increase cannot be realized even with farmland reform and fertilizer introduction, which are considered innovations within a pure agricultural society.

The second stage is defined by expansion of agricultural production based on labor-intensive techniques that rely heavily on technological innovations. An increase of agricultural productivity in this stage is achieved with the use of inter-complementary inputs. Institutional and non-traditional input factors such as technology, education, and extension services are increasingly utilized in the production process. The important factors for agricultural development in the second stage are institutional, such as research, education, and technology diffusion, rather than the traditional physical resources, such as land, capital, and labor. Some agricultural technology is not obtained by farmers themselves but is financed and developed by public institutions. This stage is affected by the industrial society and its development.

The third stage is referred to as expansion of agricultural production based on capital-intensive and labor-saving techniques. It is a dynamic agricultural development stage in which machinery substitutes for labor. It is a mechanical-technology advancement stage where labor is saved through policies that can bring gradual growth of production, distribution, and circulation. This stage is a feature of agricultural sectors in industrial societies. Johnston and Mellor (1961), with regard to the development of agriculture, agree that the deceleration rate of output growth in a pure agricultural society characterizes the traditional agriculture stage.

Without going through the second and the third stages, through which technologies and products of an industrial society are introduced, the society cannot grow and deceleration cannot be escaped.

2.4.3 Hayami and Ruttan's Agricultural Development Theory

To understand agricultural development, Hayami and Ruttan (1971) surveyed five existing models of agricultural development: exploitation, conservation, location, diffusion, and a high pay-off input. Then, they introduced a sixth model, the induced innovation model, as the most promising one to enhance understanding of agricultural development.

2.4.3.1 Survey of Agricultural Development Models

First, the exploitation model (Hayami and Ruttan 1971) is seen as a frontier paradigm where agricultural production increases through an augmentation in farmland. Early agricultural development in Africa, Asia, Europe, and the United States is explained by the exploitation model. In these areas, the problem of food insufficiency caused by population increase was solved through the expansion of farmland. Among other features of the exploitation model, low productivities caused by slash-and-burn farming or shifting cultivation are observed. In this traditional sector, resource development leads to exportation and sustainable economic development by trade. The theory is systemized with the first-products trade theory and surplus-product discharge theory (Hayami and Ruttan 1971). The exploitation model characterizes the traditional decelerating agricultural society.

The conservation model is based on the practice of plantation rotation and livestock farming in medieval England (Leighty 1938). It is predicated on diminishing returns of the land with respect to the input of labor and capital. It informs a methodology designed to prevent a drop in agricultural productivity. In medieval England the land was classified and used as permanent farmland and permanent grassland. This model focuses on keeping the fertility of the land, which contributed to the 1 % yearly growth of agricultural production. However, this growth was insufficient to satisfy the explosively growing population and demand.

The location model (Ruttan 1955) is also called "the urban-industrial impact model." While regional differences of agricultural development are not considered in the conservation model, the development level is different in the location model. von Thunen (1966) explained how agricultural density and labor productivity differ geographically around an isolated city. Schultz (1953) found that the agriculture factors and product markets located near the city, where the income level was increasing, were being managed most effectively in United States. These theories suggest that an agricultural society itself cannot achieve expansive reproduction and that the demand-pull of the urban population leads to the development of the agricultural sector and thereby the accelerating or decelerating nature of the society.

The diffusion model is characterized by the expansion of improved farming methods. Under this model, improved seeds and breeding stock are considered two of the essential factors for improving agricultural productivity. Additionally, differences are noted between farmland and labor productivity among farmers. This model focuses on the efficient extension of technological knowledge and reduction of productivity differences among geographical locations and farmers of different specializations. It is explained by the technology diffusion model introduced by Griliches (1957). It proves that the introduction of industrial technology is a viable method to solve the deceleration problem of an agricultural society. The model, which insists that agricultural productivity can only be improved by the introduction of industrial technology, proves that the pure agricultural society decelerates.

In the high pay-off input model, agricultural technology is strongly based on geographical characteristics and the level of development and absorption capacity of the agricultural society. The technology of advanced countries cannot be transferred directly to underdeveloped nations because of differences in weather, resources, and capability of the labor to understand and adopt such technology. The failure in technology transformation is not because the farmers of the underdeveloped countries have lower productivity, but because their technological and economic opportunities are limited. Hayami and Ruttan (1971) and Schultz (1964) developed this theory.

Overall agricultural productivity is increased by three main factors: investments in inputs, which create an agricultural test bed for new knowledge; an industrial sector for developing, producing, and selling new technological inputs; and farmers who efficiently use modern agricultural inputs. The agricultural policy of industrial societies is associated with a high agricultural growth rate, and it has provided the necessary condition for modern economic growth. The introduction of industrial technology can overcome the deceleration of an agricultural society.

2.4.3.2 Hayami and Ruttan's Induced Innovation Model

The induced innovation model of Hayami and Ruttan (1971) is based on the premise that technology innovation is the most important factor for agricultural development. According to the model, induced innovation by private and public sectors, interaction between technology innovation and system development, as well as the dynamic relationship between technology innovation and economic growth are among the most important factors of agricultural development.

The induced innovation model was applied to an empirical study that explains the process of agricultural development in Japan and the United States. The results suggest that both countries made rapid progress in the modernization of their agriculture sectors, but the two countries show different characteristics in modernization and progress. In Japan, the yield per unit of land was high in the early stage of development, mostly because of improved seeds and sufficient access to fertilizer. In the United States, even though the yield per unit of land was not lower than that of Japan, the substitution of machinery for unskilled labor was a successful practice, and as a result, the labor productivity in American agriculture increased dramatically compared to that of Japan and other countries. The differences in the development were explained by different conditions in production factors and their relative cost differences between the two countries. Therefore, technology development in this model is not determined entirely by exogenous factors but by the country's own endowment conditions.

In this model, the long-term trend of agricultural production is expressed by the meta-production function, which is an envelope of short-term production functions for the period. The change between short-term production functions in successive periods is regarded as technology advancement. The shape of meta-production functions for a pure agricultural society shows a decelerating form according to time because technology innovation is very slow. As a result, the moving range or shift of the production functions by the force of technology innovation is narrow (Hayami and Ruttan 1971).

The role of the induced innovation theory has been regarded as a key explanation to understanding the trend of technology development in agriculture. However, it was criticized by Olmstead and Rhode (1993) for implicitly mixing two different concepts: change variant and level variant. According to the empirical research of Olmstead and Rhode, the induced innovation cannot be simply supported without a full investigation of regional differences, various factors in the innovation process, dynamics of settlement, and biological changes (Olmstead and Rhode 1993). However, in a later study, Thirtle, Schimmelpfennig, and Townsend (2002) with a more econometrically advanced methodology tested the induced innovation theory in American agriculture. Their work verified the basis of the theory as an explanation for the agriculture development in America.

2.4.4 Lessons Learned from the Theoretical Explanations About a Decelerating Agricultural Society

The scholars, who have studied the economic growth of agricultural societies, including those whose theories we have examined so far, explain that a pure agricultural society shows evidence of inefficient economy and the society stagnates with a gradually decreased speed of growth in the long run. Debertin (1986) insisted that, due to the high ratio of fixed production factors in agriculture, production is always below the maximal level. This inefficiency of short-term production accumulates over the long run so that it reduces the speed of growth.

Johnston and Mellor (1961) explained the development of agriculture with three phases. They also cited remarkably low production power and stagnated technology levels in the pure agriculture (stage one) phase as the reason for the decelerating growth of an agricultural society.

Hayami and Ruttan (1971) showed that all models that had been invented, such as the exploitation, conservation, location, and high pay-off input models, fail to incorporate the ability of the agriculture sector to induce production increases through technology development. The efforts to accomplish economic growth in agricultural society have been focused on increasing production by increasing labor and land. Hayami and Ruttan (1971) insisted that the most important factor in the development of an agricultural society is technological innovation. However, at the same time, they admitted that agricultural development through technology development is decelerating due to reduced long-run technology development.

Based on various scholars' opinions regarding the economic growth of an agricultural society, we can conclude that a pure agricultural society decelerates in the long run. The key factors causing decelerations are inherited inefficiencies and low agricultural-specific technology innovations. Technology is not developed specifically to increase agricultural productivity in modern industrial societies. Rather, it spills over from manufacturing. The non-adapted technology innovations, inefficiencies, and low productivity reinforce each other to dampen technology use and subsequent productivity growth. These factors lead to the decelerating nature of an agricultural society, which is particularly evident when the manufacturing sector is used as a benchmark.

2.5 Limitations of a Decelerating Agricultural Society

In this section, we discuss the limitations of a decelerating agricultural society. In particular, we focus on handicaps caused by the structural problems in agriculture that prevent the economy from leaping over the stagnation level of growth. Four structural problems of agriculture are distinguished: lack of economies of scale in traditional agriculture, inefficient farming practices, immature agricultural markets, and institutional conditions. In addition, we take a glance at how modern agriculture deals with these problems.

2.5.1 Scale-Related Structure Problem

Basically, traditional agriculture cannot achieve economy of scale because it is based on peasant and family farms. The inability to take advantages of economies of scale in production is an important structural problem that hinders growth of traditional agriculture.

Schultz (1953) indicated that peasant behavior is rational but he or she is unable to achieve agricultural production equilibrium due to a number of natural and institutional characteristics of agriculture including: (i) uncertainty inherent in agriculture,

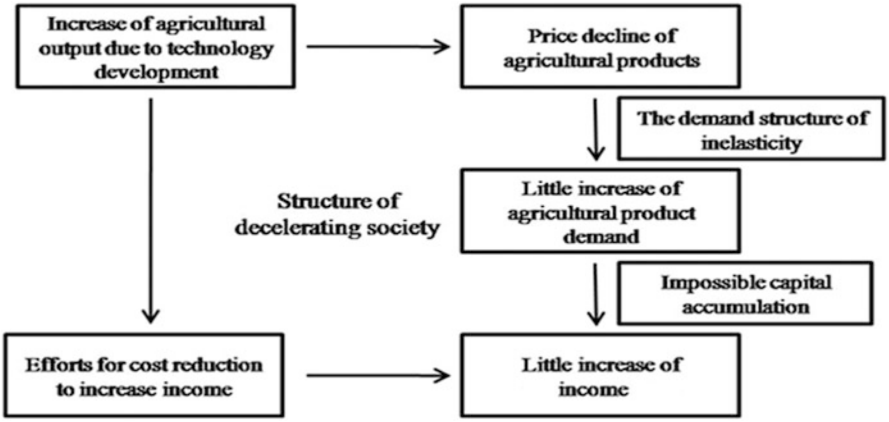

Fig. 2.6 The structure of a decelerating society (Source: Gabre–Madhin et al. 2003)

(ii) risk aversion of the producer whose low income discourages investment in technology development, (iii) differences between family and employment operated farms, (iv) characteristics of land, and (v) an incomplete capital market.

The self-sufficient structure and the lack of economies of scale result in an inability to sustain capital accumulations in a pure agricultural society (Olmstead and Rhode 1993). To develop an economy continuously, capital should be accumulating as technology advances, thereby forming a positive cycle of expansive reproduction. However, in a pure agricultural society, which is under demand inelasticity, capital accumulation is impossible. Eventually, the lack of economic growth decelerates the society. This phenomenon is called "the treadmill effect" (Gabre-Madhin et al. 2003). It is explained in detail in Fig. 2.6. The only way to increase income is by reducing the production cost, because the low increase of output due to agricultural productivity improvement does not guarantee increased revenues. In other words, capital is not accumulating because the surplus capital is invested in continual cost reduction.

According to Gardner (2002), American agriculture started to experience economies of scale after World War II when large farms emerged by aggressively using technology, capital, marketing, and vertical integration through supportive public policies. Gardner concluded that this concentration could make the living standard of average farming families higher than the average level of their urban counterparts at the end of the twentieth century.

2.5.2 Productivity-Related Structure Problem

A pure agricultural society experiences economic growth limits because of its low level of productivity. Rostow (1960) described a pure agricultural society in terms of a traditional society. He concluded that the traditional society inevitably experienced a growth ceiling because of the low productivity resulting from lack of modern technologies. For this reason, modern agriculture is inferior to other industries, and according to the stages of economic growth hypothesis, the transition from an agricultural to an industrial economy moves the society to a more developed state. Likewise, under Johnston and Mellor (1961), movement of productive resources from agriculture to industry promotes economic growth. In other words, economic growth is achieved by transferring the input factor from a simple-reproduction sector to an expansive-reproduction sector.

Conventionally, agriculture is considered a basic industry that stimulates economic growth. In accordance with this view, a significant improvement in agricultural productivity is necessary for a society to attain economic development (Rostow 1960). However, Matsuyama (1991) argued that low productivity in agriculture may promote industrialization of an economy because relatively low income encourages labor to move into higher productive manufacturing. Matsuyama also warned that high productivity in agriculture hinders the development of manufacturing, because the surplus of agriculture production may trap people in choosing a career in agriculture. Thus, according to Matsuyama's study, a self-fulfilling expectation of future job opportunities can play a key role in the economy's adjustment processes.

2.5.3 Market-Related Structure Problem

The agricultural market is vulnerable for several reasons. First, production of organic matters and mechanization of agricultural production are difficult tasks. As previously mentioned (in Sect. 2.2.2), producers of agricultural products have difficulty responding quickly to changes in market conditions, and the supply is therefore inelastic in product or price dimensions.

Second, the relationship between income and consumption of agricultural products follows Engel's law (Engel 1895): Little relative increase in agricultural product demand will be seen as the income level increases at a relatively fast rate. Schultz (1953) indicated that the relative importance of agricultural production decreases as the economy grows, even when the gross national product per capita increases, because income elasticity of agricultural products is less than that of industrial products. Engel's law is the basis for labeling a country as developmentally inferior.

Kelley, Williamson, and Cheetham (1972) and Yamaguchi and Binswanger (1975) contributed to the literature on agricultural problems and industrial structure through their models of an equilibrium theory. Because the relative importance of the agricultural sector is decreased as the economy is developing, the improvement rate of industrial technology contributes much more to the economic growth than the improvement rate of agricultural technology. In equilibrium theory, constraint of demand, which is attributed to low income elasticity, acts as the fundamental limit of agricultural growth.

2.5.4 Institution-Related Structure Problem of a Post-agricultural Society

Agricultural development is confined by country-specific institutional conditions. In the colonial period, subject nations had to endure the ruling country's policy. In eighteenth century Bourbon, Mexico, (Gardner and Stefanou 1993) the major industry was agriculture, and economic growth along with population growth was explicitly observed. However, the growth could not lead the country to economic progress because the colonial policy put emphasis on the fiscal health of the mother country. Thus, capital accumulation in Bourbon, Mexico, was not enough to invest in agricultural technologies such as cultivating new land and building irrigation systems. Landowners often reduced their production, even though their capacity was not low, to control the price. These conditions not only caused short-term famines and food shortages but also a faltered colonial economy.

In modern times, different performances in economic structure transformation among developing countries are explained mainly by agricultural productivity levels, which comprehensively reflect the taxation, regulation, property rights, institutions, and natural environments of each country (Gollin et al. 2002). As the productivity of non-agriculture is higher than that of agriculture, the capability of the agriculture sector to release resources to non-agricultural sectors eventually contributes to economic development. One of the reasons that today's poor countries cannot initiate the industrialization process and economic growth is lack of infrastructure that would improve agricultural productivity.

Mundlak (2000) claimed that agricultural development should be investigated not only within the sector but also in the context of the general economy. Policies, particularly those regarding government expenditure and trade, affect the productivity and human capital resource accumulation in agriculture. When those policies become unfavorable for the modern agricultural sector, large amounts of capital and labor migrate from the agricultural sector to other sectors. This migration is affected by changes in input factor availability and technology as the economic growth progressed.

During the transition in Central and Eastern European countries, the absence of reliable institutions to replace the collapsing traditional economic structure, characterized by vertical integration, central planning, and a contracting economic system, caused serious problems (Gow and Swinnen 1998). To restore efficient agricultural production in these countries, direct investment by foreign multinational corporations was suggested to induce the positive spill-over effects from technical assistance, training, and financial supports that would stimulate economic growth.

Even with the support of modern technologies that increase yields dramatically, agricultural production in Western Europe and North America still depends on public subsidies. Thus, the government-financed extension is another influential variable that contributes to agricultural development. The U.S. government allowed antitrust law exemptions in the agricultural sector during the 1920s agricultural crisis: the Capper-Volstead Act in 1922, the Cooperative Marketing Act in 1926, and the Agricultural Marketing Act in 1929 (Hoffman and Libercap 1991; Barnes and Ondeck 1998). After these laws were issued, farmers aggressively adopted a cooperative model to restrict outputs and raise prices for agricultural products. The U.S. government also provided direct interventions in the market. On one hand, tariffs were used to subsidize local farmers against foreign supplies. On the other hand, excessive supplies in domestic markets were purchased and exported to the world markets. Similarly, the common agricultural policy of 1968 was a supporting instrument for the agricultural industry in the European Union (EU) (Daugbjerg 2003). This policy manipulated high prices for agriculture products by import levies, stockpiling, and export subsidies. However, those direct interventions in the market were challenged by pressures of a budget burden and international trade liberalization. The MacSharry reform of 1992 and Agenda 2000 shifted the EU's agricultural policy to a more market-based pricing system.

2.5.5 Position of Agriculture Within the Economic Development Theory

According to economic development theory (Yoo 1998), an agriculture society is always the precondition for industrialization. Therefore its development is limited by mobile agricultural inputs being transferred to an industrial society, which is a better stage for economic development. The economic-development stage theories of Marx and List, the theory of structural change by Fisher and Clark, and the theory of leading industry as discussed by Rostow (1960) support this hypothesis.

Marx's economic development theory consists of five sequential stages: primitive communism, ancient slavery, medieval feudalism, industrial capitalism, and socialism. He emphasized the growth of agricultural productivity as a precondition to industrial capitalism. In List's four stages theory, economic development is divided into four stages: savage, pastoral, agricultural, and agricultural-manufacturing commercial. For the economic development of a society where agriculture and industry coexist, the agricultural sector must produce a surplus over base exports to develop the national industry. According to List, the development of other industries is more important than agricultural development.

Fisher and Clark suggested the theory of structural changes. In their view, any society has to pass through structural changes of industry. In other words, as the economy grows, labor and investment shift from the primary (agriculture, mining, forestry) to the secondary (manufacturing and construction) and further to the tertiary (services, commerce, transportation) sectors.

Rostow's sequential five-stages reflect a theory of leading industry (Rostow 1960): traditional society, precondition for takeoff, takeoff, drives to maturity, and mass consumption. In Rostow's view, economies of modernization pass through each of these stages and the technology innovation of leading industries is the most important factor in the leap between any two stages.

2.5.6 Lessons Learned from Limitations of a Decelerating Agricultural Society

The discussed stages of development theories all give considerable attention to the role played by agriculture to initiate structural changes in industry and the leading industry impact on the industrialization and developmental outcomes. In our view, no single theory completely describes the different economic developments; rather they complement each other in explaining a variety of development situations.

2.6 Historical Perspectives on Countries Experiencing a Decelerating Agricultural Society

In this section, we confirm that a pure agricultural society's economic growth decelerates for a long time. We inspected the agricultural production changes of key European countries from 1300s to 1800s and the increased agricultural productivity of the U.S. from 1700s to 1900s.

2.6.1 Agricultural Production of Medieval European Countries

This section is based on Allen (2000). Figure 2.7 shows the agricultural output per capita of nine countries: Austria, Belgium, England, France, Germany, Italy, Netherlands, Poland, and Spain from 1300 to 1800. The numerical value of the output per capita of sixteenth- century England is set to 1, serving as the reference to which the other data are relatively calculated and compared.

Looking at the data for the nine countries featured in Fig. 2.7, one sees that the agricultural productivity per laborer was sluggish or decreasing during the Middle Ages except in Belgium and Netherland before the 1700s. The decrease in the agricultural population is reason for the exceptional increases in the agricultural productivity of England and the Netherlands after 1600. The rural population declined due to the revitalization of the urban economy and population convergence to the cities.

2.6.2 Agricultural Production of Italy

Figure 2.8, by Federico and Malanima (2004), shows the index of the total agricultural productivity of Italy from 1300 to 1820. When the total agricultural productivity from 1860 to 1870 is set to 100, the total agricultural productivity between

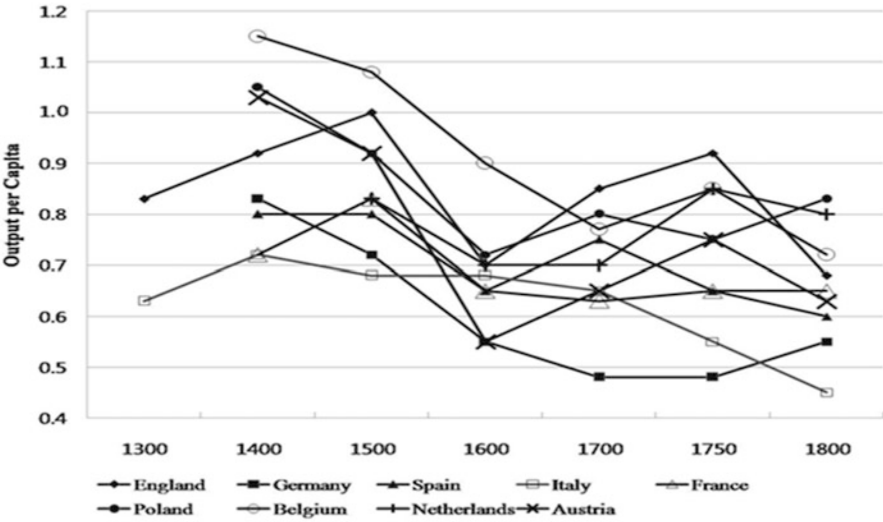

Fig. 2.7 Agricultural output per capita, 1300–1800 (England in 1500 = 1.00) (Source: Allen 2000)

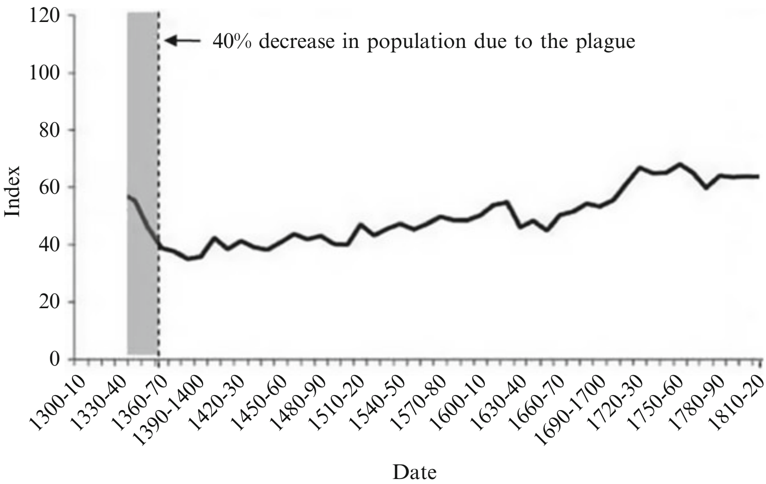

Fig. 2.8 Gross agricultural product in Cuneo Italy, 1300–1870 (1860–1870 = 100) (Federico and Malanima 2004)

1300 and 1820 (520 years) was sluggishly reaching index levels of 40–60. The agricultural productivity fall between 1300 and 1400 was caused by the plague, which broke out between 1348 and 1349, when 40 % of the Italian population died. The population recovered slowly after 1400. The authors mention that agricultural production increased little by little, but the data show that it remained sluggish and in simple reproduction until 1820, just before Italy became an industrial society.

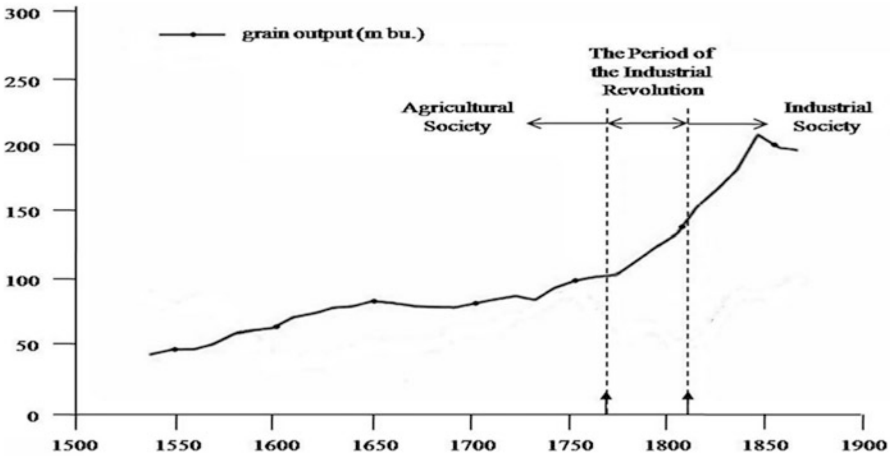

Fig. 2.9 Grain output at constant consumption per output, England, 1541–1860. (Source: Clark 1991). Notes: Output is measured in the equivalent of millions of bushels of wheat. The grain wage is an index with 1845–1854 = 100. At the dates indicated by *arrows* on the horizontal axis the grain wage was at similar levels

2.6.3 Total Crop Production of Medieval England

Figure 2.9 shows the information on total crop production in England from 1540 to 1860, which is estimated on a million-bushel basis (Clark 1991). Until 1770, the total production of crops decreased gradually. Clark suggested that the increase in crop production was caused by a sudden decrease in wages in the late eighteenth century and the introduction of industrial technology. The Industrial Revolution helped agricultural production escape a decelerating trend.

2.6.4 Agricultural Productivity of the United States of America

The development of U.S. agricultural productivity from 1755 to 1975 is reported in Fig. 2.10. According to Plucknett (1994), the period is divided into four disproportionately distributed sub-periods distinguished by source of power: manpower, horsepower, mechanical power, and scientific power. The patterns show that the pure agricultural society experienced decelerating growth over 160 years (i.e. the three sub-periods until 1930). However, after the development of industrial technologies, the decelerating pattern vanished and accelerating growth started to emerge with the effects of industry development in the forms of equipment, fertilizer, and improved seed. In less than 45 years, the productivity index rose from over 50 to 110, indicating that agricultural production in the United States had doubled. The graph also shows that neither the Civil War nor the world wars (WWI and WWII) negatively impacted the productivity of agriculture.

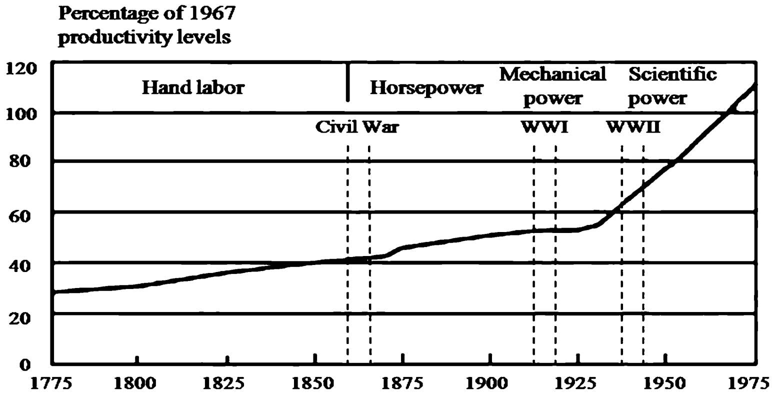

Fig. 2.10 Agricultural productivity levels of the United States, 1775–1975 (Source: Plucknett 1994)

2.7 Transition from an Agricultural to a Commercial Society

A commercial society does not exist in isolation. It marks a transition between agricultural and industrial societies. In a commercial society, agriculture is the production base of the economy but accumulated agricultural surplus, originating from the development of trade, is used for expansive reinvestment of wealth. However, because agriculture is limited in creating new demand, the commercial society also experiences limited growth potential. In this section, formation, development, value creation, and structural limits of a commercial society will be examined. The aim is to show that developing new products and generating new demand through technological advancement are essential factors to an accelerating society.

2.7.1 Formation of a Commercial Society

The formation of a commercial society is discussed in Abu-Lughod (1989). The commercial society appeared in Europe around the fourteenth century with the increase of agricultural output and vigorous commercial activities to exchange surpluses. With the development of oriental trade through the Silk Road and navigation improvements, geographical discoveries (resulting in the era being called the "Age of Discovery") marked the fifteenth through seventeenth centuries. Europe prospered in this period due to the formation of a commercial society.

At the end of the agricultural society period, as the population grew, a surplus of agricultural products was produced by advanced agricultural technology, and as a result, the commercial economy was developed. After 1050 in Europe, as the equipment and technologies related to agriculture continued to be developed, the agricultural output grew such that it had increased 3–4 times by the 1300s. Commerce was initiated through the surplus supply of agricultural products in this period. In particular, the demand for imported spices and luxuries increased because surplus goods were marketed so producers could purchase such non-necessity items. The commercial society adds value by transporting the value created by the agricultural society to the places where consumer utility is highest.

2.7.2 Development of a Commercial Society

The commercial society overwhelmed medieval European agricultural society via enlarged cities, increased population, and expanded market activities. While it was impossible to accumulate capital in the agricultural society due to inelasticity of agricultural demand and supply over time, the commercial society solved the problem through trade. When agricultural products are transported to places where the demand is high, the value of the product can be increased to a much higher level. As a result, producers could earn more profits, and this made expansive reinvestment of capital possible. Therefore, the commercial society carried out accelerated economic growth.

The market was activated through the trade of agricultural surplus and response to inflow of population to the cities (see Table 2.1). Unlike in the agricultural society, which had limited resources, the land in the commercial society showed a positive-cycle structure and the city population increased explosively. This cycle revitalized the market again. The development led to nearly all commercial activities being concentrated in the cities.

Allen (2000) mentioned that only 4.4 % of the total population of England lived in cities in 1300 but the share increased to 9.7 % in 1600 and to 16.9 % in 1700. By 1300, as much as 20.8 % of the population was living in the most commercially developed Italian city-states. In the case of Spain, which led the Age of Discovery in the 1500s, 26.3 % of the population lived in cities by 1400.

Active cultural exchange is another factor that promotes a commercial society. As the exchange between medieval European regions became more active by the development of commerce, a commercial society naturally inspired cultural development and exchanges. The representative examples include Venice and the region along the Silk Road. Venice had a period of prosperity as a rich commercial city from the thirteenth to the fifteenth centuries while seizing the trade of the Mediterranean Sea and oriental countries. The political force of Venice, which had been a small city-nation, became large enough to rule the whole Mediterranean Sea. The people of Venice had contributed to the exchange of goods between the East and the West by following the routes from the Mediterranean Sea to the Indian Ocean as indicated in Fig. 2.11. In addition, the cultural interchanges between the Western and oriental countries generated a culture nurtured by the Silk Road that subordinated the culture of regional countries.

Table 2.1 Estimated population distribution, 1300–1800 (millions)

	Total	Urban	Rural non-agricultural	Rural agricultural
England				
1300	5.0	0.22	0.96	3.82
1400	2.5	0.20	0.46	1.84
1500	2.5	0.18	0.46	1.85
1600	4.4	0.43	0.96	3.03
1700	5.2	0.88	1.47	2.86
1750	6.0	1.39	1.95	2.70
1800	9.1	2.61	3.23	3.23
Spain				
1400	6.0	1.58	0.88	3.54
1500	7.5	1.38	1.22	4.90
1600	8.7	1.85	1.37	5.48
1700	8.6	1.75	1.44	5.41
1750	9.6	2.05	1.59	5.96
1800	13.0	2.54	2.20	8.26
Italy				
1300	11.0	2.29	1.74	6.97
1400	8.0	1.93	1.21	4.87
1500	10.0	2.21	1.56	6.23
1600	13.3	3.00	2.27	8.03
1700	13.4	3.03	2.49	7.88
1750	15.5	3.49	2.88	9.13
1800	18.5	4.06	3.75	10.69

Source: Allen (2000)

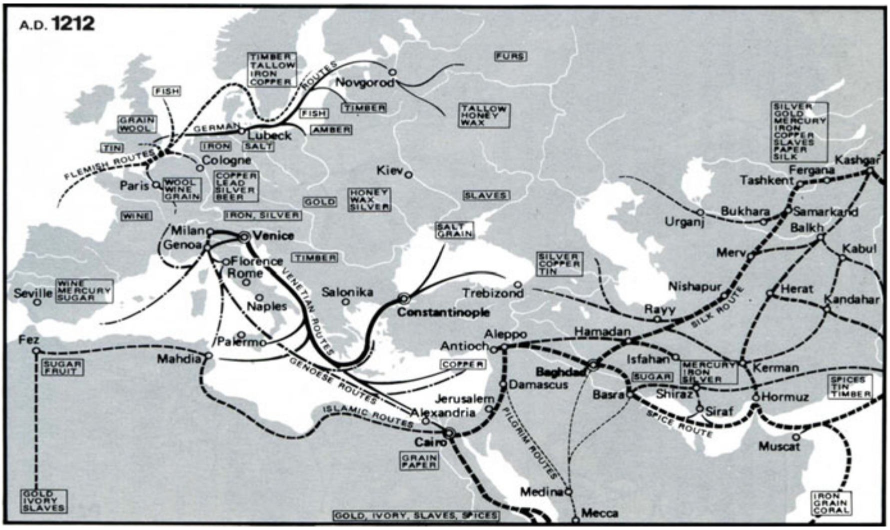

Fig. 2.11 Development of commerce and exchange between regions. (Source: Abu–Lughod 1989). Notes: The *lines* show flow of goods between two destinations

Possession of a strong army is another factor enhancing the formation and development of a commercial society. In the European agricultural society, regional armies had only the minimum defense mechanisms to guard against those who steal grain. In the commercial society, the export and import of goods to and from distant markets and production places needed safeguarding. A strong army that defended a nation's existing commercial route, merchants, and markets thus also helped establish new commercial routes.

The growing number of people willing to invest capital in commercial activities contributed to commercial society development in Europe. Expansive reinvestment was possible in the new society. Commenda, Societas, and enterprises developed in the Mediterranean countries in the early Modern era are representative examples that reflect the results of expansive reinvestment.

Development of the currency economy was a final and major step in the development process. Transaction costs were reduced by making exchange easier. The barter system was initiated and then the currency economy played an important role in the development of the commercial society.

2.7.3 Limitations of a Commercial Society

Three forms of limitations characterize the commercial society: limitations of value creation, transportation, and product quantities. Each of these is described below in more detail.

2.7.3.1 Limitations of Value Creation

In a commercial society, value is created by expansive reinvestment of commercial capital so the value created increases exponentially, as illustrated in a compound interest graph (Fig. 2.12). Therefore, although the major products are agricultural, value creation accelerates in a certain period. However, the accelerating development of growth in a commercial society is limited because of the technological, physical, and economic reasons for maintaining an agricultural society (i.e. the basis for value creation in the commercial society is agriculture).

2.7.3.2 Limitation of Transportation

Because commerce relies on transportation of products, the profit of a commercial society is directly related to transportation. In the 1700s, the Netherlands used its 400 miles of waterways for transportation, which were more efficient than land routes. The growth of gross domestic product (GDP) per capita from 1500 to 1700 was as follows: the Netherlands 52 %, England 28 %, and France 15 %. In 1293,

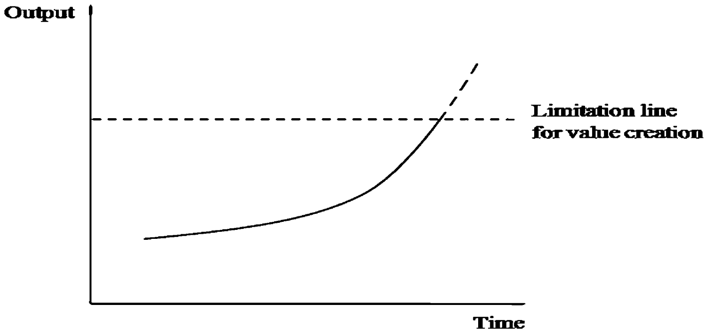

Fig. 2.12 Relationship between output and time in an accelerating commercial society

the overseas trade of Genoa was 3 times greater than the total production quantity of France, which was a strong nation at that time.

Transportation has limits. Quick travels over land were restricted because of poor road conditions and natural obstacles. In practice, long distance hauling by land route is more expensive than by sea. For marine excursions, ship building materials were limiting factors. In medieval Europe, problems with obtaining material were aggravated by the fact that a wooden ship by nature could not be longer than 60 m nor weigh more than 1,600 t. In addition, the quantitative expansion of sea transportation was limited because the area of a paddle, the length of the sail, and the power system are limited. Even though the cost of water transportation was lower, travel by sea was slower than by land.

2.7.3.3 Limitation of Products

The commercial society itself cannot create products, which are the bases of value creation. In medieval Europe, businesses were using products from the agricultural society. In the fifteenth and sixteenth centuries, the development of the European commercial society was based on the exploitation of new land and simple merchant trade and not by production of goods. (See Fig. 2.13)

The numbers of items or traded products was not enough for sustaining acceleration because simple merchant trade of imported spices, agricultural goods, and homemade handicrafts characterized the period. Development of a commercial society stalled when more products were developed from the new technologies that can create new demand.

Because the bases of value creation in a commercial society are agricultural products, commercial societies went into ruin with the advent of the industrial society. This fact is clearly seen in the cases of Portugal and Spain, which unlike England during the phase of industrial development, were limited by their agricultural products. In the commercial society, expansive reinvestment was finite because new demand was not created with new products. A historical lesson

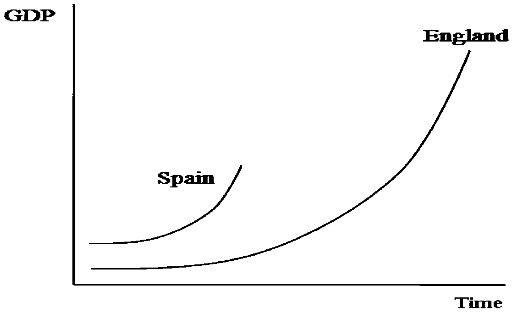

Fig. 2.13 Limitations of products in medieval European commercial society

Table 2.2 Spain (Castile) debt, 1515–1667

Year	Debt (million ducats)	Interest
1515	12	0.8
1560	35	2.0
1575	50	3.8
1595	85	4.6
1623	112	5.6
1667	130	9.1

Source: Cipolla (1993)

suggests that the basis of value creation for expansive reproduction is essential to maintain sustainable development.

In the sixteenth century, Spain accumulated enormous national wealth by geographical discoveries during the Age of Discovery. However, the Netherlands and England caught up to it because they were developing the wool manufacturing industry while Spain was basically an agricultural society mainly involved in merchant trading (Wallerstein 1976). Increasing imports of precious metals caused an increase in the amount of currency in circulation, and prices rapidly rose. This "price revolution" formed advantageous conditions in commerce development. However, Spain lacked manufacturing technology and skilled workers, so production could not catch up to the increased demand. Hence imports increased, and it caused unbalanced trade and increased debt (see Table 2.2). As a consequence, Spain started to weaken (Cipolla 1993). Figure 2.14 shows that Spain's wool exportation declined in 1660–1750, but it recovered somewhat prior to 1780. However, the increase was short of compensating for the weak conditions in Spain's development of commerce. See also Phillips (1982).

England started to accumulate wealth by gradually substituting wool, which was the major export product, with processed goods, which yielded a higher value-added price (see Figs. 2.15 and 2.16).

England, by producing various products besides wool, such as steel, zinc, silk, and glass, among others, became strong. The development of industry ushered in the Industrial Revolution (see Table 2.3).

In 1588, England started to get ahead of Spain due to the Invincible Armada victory. In particular, England took over Jamaica, which had been a Spanish colony, in 1655. This event provides the historical evidence that the power of England was greater than that of Spain (Kim 1995).

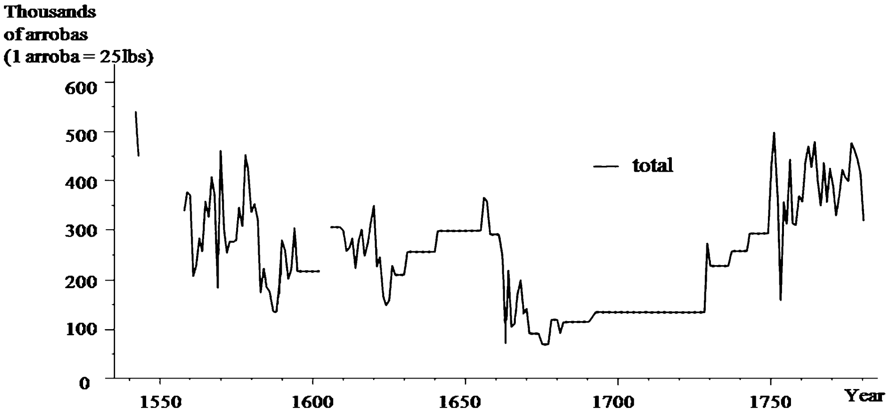

Fig. 2.14 Spain's wool exportation trend, 1540–1780 (Source: Phillips 1982)

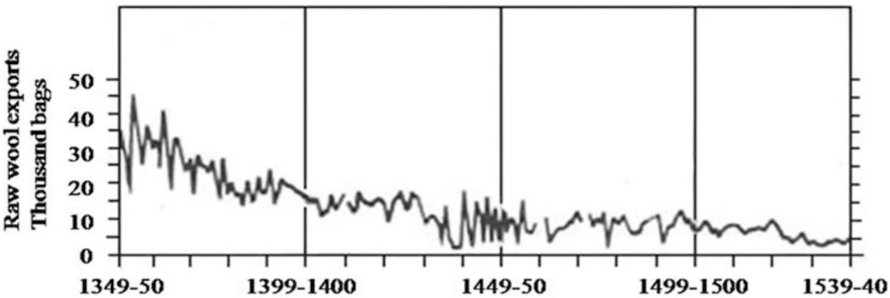

Fig. 2.15 Wool exports of England, 1349–1540 (Source: Darby 1976)

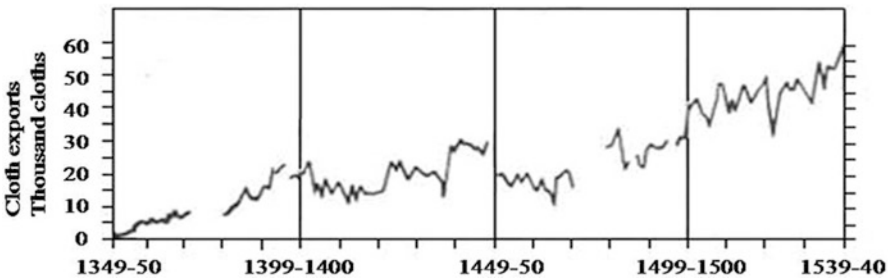

Fig. 2.16 Woolen clothes exports of England, 1349–1540 (Source: Darby 1976)

Figures 2.17 and 2.18 show that the GDP per capita of England, which was successfully industrialized, was growing at an accelerated rate from 1500 to 1820, while the GDP per capita of Spain and Italy, which had remained in commercial societies, had stagnated. The graphs clearly show that a commercial society not accompanied by the industrialization process has limited growth potential.

Table 2.3 Melting furnace and steel production of England, 1530–1709

Year	No. of meltingfurnaces	Avg. production permelting furnace (ton)	Total production (1,000 t)
1530–1539	6	200	1.2
1540–1549	22	200	4.4
1550–1559	26	200	5.2
1560–1569	44	200	8.8
1570–1579	67	200	13.4
1580–1589	76	200	15.2
1590–1599	82	200	16.4
1600–1609	89	200	17.8
1610–1619	79	215	17.0
1620–1629	82	230	19.0
1630–1639	79	250	20.0
1640–1649	82	260	21.0
1650–1659	86	270	23.0
1660–1669	81	270	22.0
1670–1679	71	270	19.0
1680–1689	68	300	21.0
1690–1699	78	300	23.0
1700–1709	76	315	24.0

Source: Cipolla (1993)

Fig. 2.17 GDP per capita in England, 1500–1820 (Source: Pamuk 2007)

The simple merchant trade, which was centered around Spain, did not evolve into an accelerating industrial society. Meanwhile, industrialized England entered into an accelerating society and thus Spain and England experienced reverse economic fortunes over time.

A commercial society cannot sustain accelerating economic growth because it relies on reinvestment of capital without any industrial technological development.

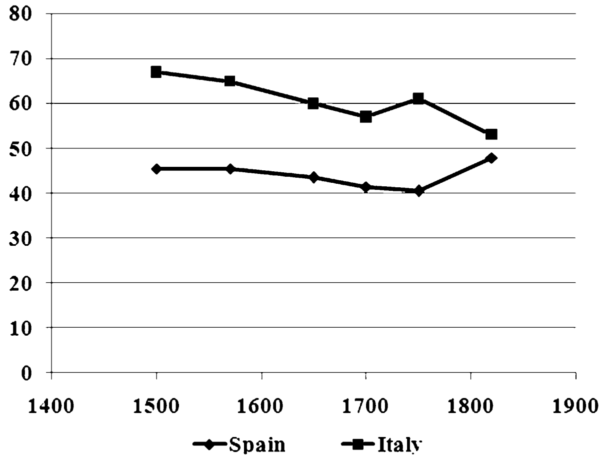

Fig. 2.18 GDP per capita in Italy and Spain, 1500–1820 (Source: Pamuk 2007)

Because it was a commercial society still firmly set in an agricultural economy, Spain failed to achieve continuous economic growth. As we can confirm with the case of England's industrial revolution, creation of demand is required to pull development and attain accelerating economic development. New demand is created through new technology and products. Hence we can confirm that, for any society, technological development is the essential factor needed to accomplish ceaseless economic growth.

2.8 Summary and Conclusions

Agricultural societies, which have existed for thousands of years since civilization originated, have maintained a self-sufficient level of economic activities without any particular technological advancement. In an agricultural society, one of the major methods to increase production is to improve the harvest/sown-seeds quantity ratio or cultivate new farmland. These efforts had large effects in the early stages of the European agricultural society, but the effects gradually waned. Also the agricultural society has a structural limit: All surplus values are used for the maintenance of the status quo and not for the reinvestment of surplus production.

For the reasons mentioned above, the historical, general, and economic growth trends of the agricultural society show a gradual decrease in the development rate over time in terms of agricultural output and productivity. Because an agricultural society is incapable of developing new products or generating new demands by technological innovations, it experiences a decelerating economic pattern. In the process of accelerating economic growth, the positive-cycle structure—new products are developed by technology innovation and this generates new demand and production, and this production causes capital accumulation, and the accumulated capital, in turn, is reinvested in technology innovation that improves production—of expansive reproduction must be realized. However, the simple reproduction in agricultural societies is far different from this ideal structure.

The study of medieval Europe shows that the commercial society started to accumulate capital by generating new demand through trade. Expansive reinvestment of accumulated capital for larger volume and expanded areas of trade made the commercial society show an accelerating economic development pattern over time. However, without development of new products to support this process continuously, expansive reinvestment of capital from the merchant trade cannot maintain the accelerated growth pattern. Commercial countries that pursued economic development by trade were outrun by the industrial countries that developed new products by technology innovation. The development led to the vanishing commercial society in Europe.

In this study, by a number of well-established theories and several cases, we prove that the agricultural society is decelerating (i.e. the rate of economic development gradually decreases). We verify that a commercial society with an agricultural basis quickly reaches growth limits, even though an acceleration of economic development has been experienced. From the discussion above, it is clear that without technology innovations that bring new product development and the subsequent creation of new demand, the economic growth of the agricultural society reaches its limit. It is possible to expand this argument to other activities in the primary sector such as the fishery, forestry, livestock, and mining industries. All these sector activities have shown diminishing returns to scale in production, suggesting the society will experience decelerating growth. Historically, the transition process for the leading industrialized countries to the secondary and tertiary industries is slow and takes a long time. These transition periods can be shortened for the different tier of follower countries encouraged by government incentive policies (Lemoine and Unal-Kesenci 2004). Thus, the deceleration phenomena of the pure agricultural society are explained, in general, on the basis that its dependence solely on natural resources will lead to inherent supply limitations and slow technological progress.

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Chapter 3
Accelerating Economic Growth in Industrial Societies: The Process of Expansive Reproduction

Tai-Yoo Kim, Seunghyun Kim, and Jongsu Lee

Abstract Industrial societies are characterized by accelerating growth. Such growth is generated by expansive reproduction, a process by which economic growth occurs through the accumulation of capital, reinvestment, and technological innovation. This pattern of growth is fundamentally different from that of agricultural societies, which is decelerating. The findings presented herein provide both a more accurate understanding of economic growth patterns over time and a basis for the formulation of policy for achieving accelerating economic growth. In addition, the implications of the findings offer insights into the elucidation of economic growth trends of late industrializing economies.

Keywords Expansive reproduction • Accelerating economic growth • Technical change • Economic growth • Exponential growth • JEL Classification Numbers: L16; O11; O47; O14

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3.1 Introduction

The Agricultural Revolution enabled humans to escape the subsistence-level, hunter/gatherer lifestyle in which they had been trapped for many thousands of years by creating conditions for the development of advanced civilization. However, in societies in which agriculture is the principal economic activity (henceforth “pure agricultural societies”; see Stavenhagen 1982[1]), the rate of productivity gradually slows over time and the creation of agricultural economic value cannot surpass the rate of population growth. This phenomenon is what led Malthus to conclude that there would be a return to subsistence-level conditions once population growth outpaced agricultural production. In reality, Malthus’s predictions did not eventuate. Population levels stagnated for millennia (see Fig. 3.1a), and rather than returning to subsistence-level conditions, the slowing rate of food production in pure agricultural societies led to limited livelihoods in which there was no surplus production and thus low or no population growth.

In contrast to a pure agricultural society, an industrial society is a marvel, simultaneously achieving exponential growth in a country’s overall wealth while maintaining an explosive population growth.

Figure 3.1a illustrates changes in the world’s population and Fig. 3.1b illustrates pGDP. Although both population and per capita income were stagnant during the pre-Industrial Revolution period, both grew exponentially following the transition to industrial societies. This fact provides sufficient evidence that economic growth, which is an index for measuring the creation of value, does indeed accelerate in an industrial society.

The term accelerating economic growth (AEG) in this paper is used to reflect the absolute change in economic growth and it is derived by dividing pGDP changes by time (i.e., it is not a ratio). This is similar to the concept of speed, which denotes the rate at which distance is covered and which is usually expressed in miles per hour. However, AEG denotes the rate at which economic growth increases, for example, in terms of dollars per year per year. This is similar to the concept of acceleration, which denotes the rate at which speed increases, usually expressed in miles per hour

[1] Stavenhagen (1982) defines an agricultural society as one in which the majority of the population lives in rural communities and thus where an agriculture-based economy prevails. In an agricultural society, economic activities mainly cover agricultural production, where farmland and farmers are the most important resources of the economy. In addition to this definition, we define a “pure agricultural society” as one in which the economy is based entirely upon agriculture before the Industrial Revolution.

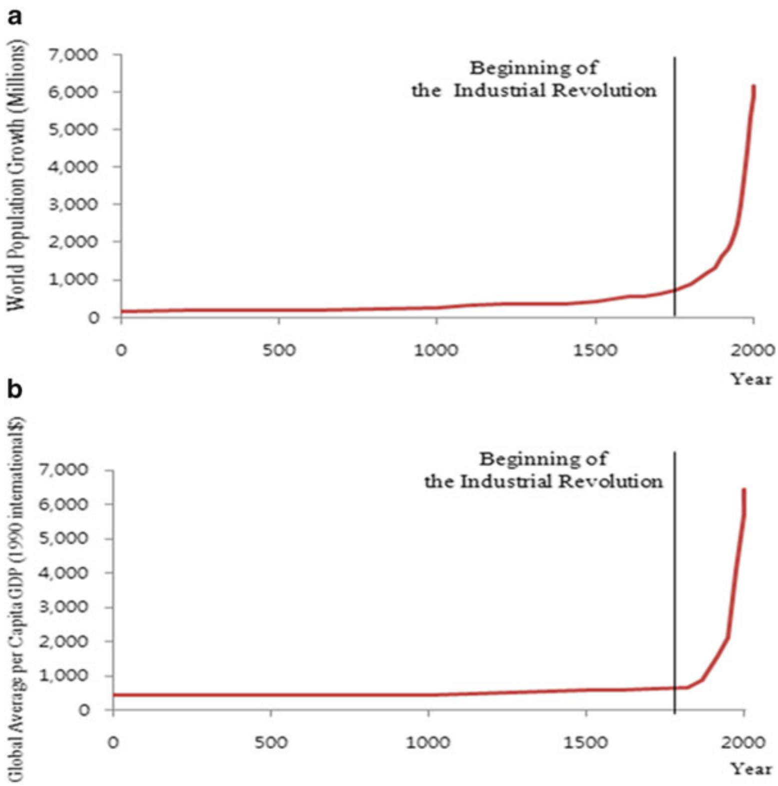

Fig. 3.1 (**a**) World population growth. (**b**) Global Average per Capita GDP (pGDP) (Data Sources: (**a**) Kremer (1993); (**b**) Maddison (2001)

per second.[2] Using uniform economic growth (UEG) as the benchmark, namely the rate at which economic growth occurs over time is constant, decelerating economic growth (DEG) refers to a growth rate that is slower than the benchmark and AEG

[2] The economic growth rate generally shows the rate of change in pGDP as a percentage; if we assume the discrete time interval ($t_0 < t_1 < t_2$), we mean the increase in the rate compared with a base time period, or $\frac{pGDP_2 - pGDP_1}{pGDP_1}$. Thus, the economic growth rate represents the relative increase in the size of economic growth, but it does not necessarily reflect the absolute size of economic growth. For instance, a country with a pGDP of $40,000 that has a growth rate of 2 % has an increase of $800, while a country with a pGDP of $400 that has a growth rate of 10 % would have a $40 increase. Herein, the concept of "economic growth speed" (the speed at which the economy grows) is used, which accurately reflects the absolute increase in economic growth. In other words, herein, the acceleration of economic growth is defined as the accelerating speed of economic growth for all t. Extending this continuously, when the first derivative with respect to time increases (convex function), we say that it shows acceleration.

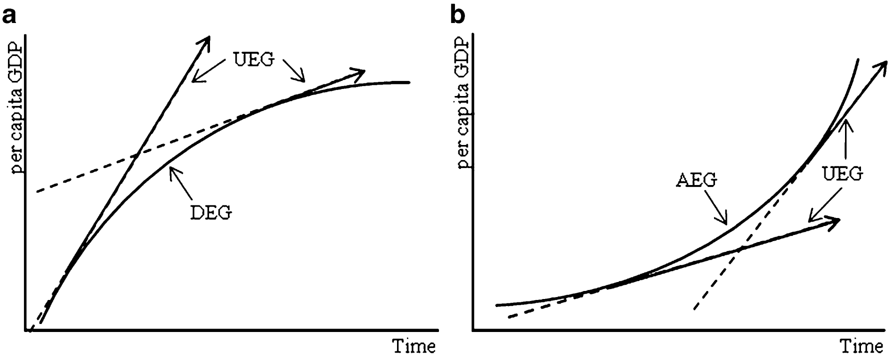

Fig. 3.2 Time–output relations: (**a**) DEG (Agricultural Society). (**b**) AEG (Industrial Society)

refers to growth that is faster than the benchmark.[3] Figure 3.2 shows cases in which economic growth is (a) decelerating with respect to UEG and (b) accelerating with respect to UEG.

The concept of accelerating growth is used as an index to measure economic growth in order to avoid misconceptions that could arise with the use of percentage growth rates. For example, if growth rates were used, it might be thought that a developing country with a high growth rate would be able to reduce the gap between it and a developed country that has a slow growth rate. However, in the framework of accelerating growth, as explained in Footnote 2, a developed country that has slow growth may have a greater increase in pGDP than that of a developing country that has fast growth, which might result in the actual gap increasing. In addition, after a certain level of economic growth when increase in income have been achieved, growth slows to a rate equivalent to the growth of a developed country, thereby essentially eliminating the possibility that a developing country can outgrow a developed country.

To the authors' knowledge, few studies have successfully identified the particular growth pattern of an industrial society despite the academic achievements of previous macroeconomic studies of economic growth, which have been based on formulating functional relationships and using macroeconomic indices to find growth patterns. However, it is not surprising that a pattern has not yet been identified because the task is difficult. First, there are confounding factors to be eliminated, such as business cycles, financial crises, and the Great Depression. Further, it is difficult to build mathematical models that express economic growth over time, to gather information for an extremely long period of time, and to filter out the short-lived and coincidental events that affect economic growth patterns. Second, and more fundamentally, it has proven difficult to formulate general laws based on macroeconomic indices of countries that have different growth properties

[3] Economic growth does not have a direct causal relationship with time. Because of this, we cannot express economic growth trends as a function of time. However, to facilitate understanding, if we assume a continuous time–output function, the cases are relevant in which the first-order derivative > 0, the second-order derivative < 0 (decelerating growth), the first-order derivative > 0, the second-order derivative $= 0$ (uniform growth), the first-order derivative > 0, and the second-order derivative > 0 (accelerating growth).

(i.e., agriculture-based versus industry-based countries) and of countries with a mix of both agricultural and industrial economies. This is not surprising, because there is no inherent reason why agricultural and industrial societies should follow the same growth patterns.

The principal goals of the present paper are twofold: (1) to identify the growth patterns in industrial societies by assessing real-world cases and (2) to find the driving force behind the internal (or inherent) structure for AEG in industrial societies.

In order to achieve these goals, we adopt the following assumptions. First, with respect to the sources of added value, different modes of production will inevitably result in a different structure for the creation of value and a different pattern of economic growth, because economic growth is based on production. In other words, fundamentally different modes of production between primitive agricultural societies and industrial societies bring about different economic structures.[4] Second, the analysis presented herein spans a time period long enough for the specific properties of the relevant economic growth pattern to be detected. Therefore, ways need to be found of excluding the effects of (a) countless coincidences and singular events and (b) changes in societal thought processes and national policy from political, economic, social, and cultural perspectives. This study does not address issues that arise in existing macroeconomic theories on economic growth; rather, it aims to show that AEG is a manifestation of properties that are inherent in and specific to the mode of production of an industrial society and that this is based on a system for the creation of value that existing theories of economic growth have failed to address. Third, the study population includes only those industrial countries that mainly engage in manufacturing and manufacturing-based service industries. In other words, the economy of a sampled society is assumed to be an economic unit that does not rely on international trade or the production of natural resources. Moreover, studied countries are assumed to have territories and populations that can, to a certain degree, support an independent economy.

To achieve these goals, this study will theoretically analyze the acceleration of output over time. This analysis will be conducted by expanding existing growth theory and showing that the accelerating growth pattern of an industrial society results from historical evidence. Then, the driving force behind AEG will be analyzed in terms of internal production structures, focusing on the virtuous cycle of expansive reproduction.

3.2 AEG in Industrial Societies

As stated in Sect. 3.1, none of the previous studies of economic growth patterns and their inherent structures has focused on industrial societies, and most have concentrated on the deduction of the equilibrium or growth rate rather than the

[4] There is a fundamental difference between the economic growth pattern of an industrial society and that of an agricultural society, namely “simple reproduction” in agricultural societies (Kim et al. 2010) and “expansive reproduction” in industrial societies (this will be further discussed in Sect. 3.3).

deduction of growth patterns over time. Nevertheless, ideas, implications, or similar meanings about AEG can be found from existing economic theories.

First, the feasibility of AEG in an industrial society has been investigated in these theoretical discussions: (i) Smith's division of labor (1776), (ii) Marshall's theory of returns to scale (1920), (iii) Chandler's theory of increasing returns Chandler (1990), (iv) Myrdal's theory of cumulative causation (CC) (1957), (v) endogenous economic growth theory, and (vi) the theory of learning by doing.

In *The Wealth of Nations* (1776), Adam Smith illustrates the theory of the division of labor by describing the case of the pin manufacturing process. This idea is connected to production efficiency, and Blaug (1979) later claims that the division of labor leads to production expansion. In an industrial society, technology development and process innovation lead to the division of production stages, and this is consistent with the principles of expansive reproduction that will be discussed in Sect. 3.3.

Marshall's (1920) study of increasing returns to scale also discusses the concept of AEG. He describes in detail the difference between internal and external economies of scale. When a company reduces costs and increases production through scale economies, internal economies of scale are achieved. By contrast, external economies of scale can be achieved by industrial development. Therefore, if these two conditions are achieved, increasing returns to scale can be possible. Compared with Marshall (1920), Chandler (1990) studies economies of scale and scope by analyzing liquidity in industrial capitalism. From the viewpoint of the scale of production, mass production in an industrial society reduces the cost of manufacturing products. In other words, in an industrial society, the same manufacturing facility can be used for many purposes and the same machine parts can be used to manufacture a variety of products in contrast to an agricultural society. Economies of scale and scope in production increase productivity per unit, which reduces total costs. In effect, when the utilization of manufacturing elements increases and mass production is achieved, production becomes more efficient. This principle forms the basis for supporting AEG in an industrial society.

The most significant characteristic of CC theory (Salvadori and Panico 2006) is that it does not recognize the self-stabilization function of a social system. Myrdal (1957) found that the system moves continuously in order to break the balance of power rather than strike a balance. CC theory explains this unequal growth phenomenon through two main effects: the backwash effect and the spread effect. Overall, this theory shows the possibility of AEG through unbalanced economic growth. In follow-up studies, Kaldor (1978) state that growth in production induces growth in productivity via increasing returns. Salvadori and Panico (2006) show that increasing returns to scale have more positive effects in developed countries than they do in less developed countries, and that increasing returns owing to the CC effect are considered to contribute more to the economic development of advanced nations.

Romer's endogenous economic growth theory (1990) introduces the role of technology as an endogenous variable. By using this new production function to describe economic growth, it follows that growth can be achieved through enhanced technological innovations, the expansion of a number of intermediate inputs invested, and the qualitative improvement of each intermediate material (Barro and Sala-i-Martin 2004). Concerning the latter, according to the quality ladder model of Grossman and Helpman (1991), when technological development results in an improvement in the quality of a single intermediate input, it influences other intermediates (this is also termed the spillover effect) and thus gradually increases input–output efficiency. All these studies highlight the importance of investigating the role of technology in industrial societies. In a similar context, Arrow (1962) uses the learning by doing concept in order to explain production efficiency in industrial societies. Learning causes an *ex post facto* decrease in marginal cost. Therefore, learning by doing theory can also be applied to the accelerating development of an industrial society through decreases in expenses.

Although the above studies lay the platform for our study, four further studies are closer to our research in terms of economic growth over time: the Business Cycle (Schumpeter 1939), Sudden Stop and Output Drops (Calvo 1998; Chari et al. 2005), Demographic transition and Economic growth (Galor and Weil 2000; Hansen and Prescott 2002; Croix and Doepke 2003; Fernandez-Villaverde 2003), and Growth Accelerations (Hausmann et al. 2005; Ben-David and Papell 1998; Perron 1989).

The theory of the business cycle investigates the repetition of fixed cyclic patterns of economic activity (Schumpeter 1939). The term "business" refers to the level of an economy's overall activities or the comprehensive movement of macroeconomic indexes, including those for the real economy, the financial sector, and the export sector. The term "business cycle" refers to the repetition of a pattern in overall economic activity that moves from depression, to recovery, to prosperity, and finally to recession. In the stage of prosperity or expansion, AEG is shown. However, these studies aim to identify an economy's cycle itself (not the exact level of pGDP), rather than the long-term tendencies of economic growth that may be present irrespective of the repetitions of the cycle. In this study, we investigate the long-term economic growth tendency over time.

Studies on sudden stops and drops in output seek to identify the relationships between different kinds of sudden declines in capital flows,[5] for example the relationships between abrupt declines in capital inflows and large declines in output, which are two features of financial crises that occur in emerging markets (Chari et al. 2005). Studies of sudden stops investigate why an economy that has maintained continuous growth suddenly faces a financial crisis, such as insolvency. Examples of studied crises are Mexico's Tequila Crisis in 1994 and the Asian Financial Crisis in 1997/1998. In this context, this study can easily be misunderstood as constituting counterexamples to the sustained accelerating growth pattern in an industrial society that is suggested herein or as presenting obstacles to accelerating growth. However, on closer examination, it becomes evident that such findings do not contradict the views presented herein; rather, they simply offer differing perspectives for three reasons. First, this study focuses on the financial economy in relation to cash inflows

[5] The term "sudden stop" was inspired by the following adage among bankers: "It is not speed that kills, it is the sudden stop" (Dornbusch et al. 1995).

and emphasizes the value creation system of the real economy. Second, the periods of financial crises caused by sudden stops were not sufficiently long to affect the very long-run point of view, which is the basis of this study. From the perspective adopted herein, a sudden stop is considered to be a short-term shock, namely one that does not significantly impact development when economic growth is examined from a hyper-long-run point of view. Third, the studies mentioned above are concerned solely with short-term shocks to economic growth that occur as a result of incidents that impede the normal operation of the value creation system of an industrial society. They do not contradict the nature of that system; rather, they offer analyses that complement the view presented herein regarding the nature of the system of value creation.

For *demographic transition and economic growth*, Galor and Weil (2000) analyzed the qualitative change in human capital by assessing changes in population and education in the Malthusian age, post-Malthusian age, and present economic growth age under the framework of a single growth theory. We can consider the Malthusian age to be that of agricultural society and the latter two periods to be that of industrial society. However, Galor and Weil's study differs from ours in the way it represents capital accumulation. Galor and Weil assume that the quantity of capital is determined endogenously at the level at which the marginal product is set equal to the interest rate. However, our study assumes that one of the greatest differences between the development of an industrial society and that of an agricultural one is the contribution of the accumulation, and the subsequent investment, of capital to economic growth (Domar 1946; Kaldor 1961; Junker 1967; Turnovsky 2009). It is essential to procure investment capital in order to cover the high start-up costs and subsequent R&D costs necessary for the successful mass production of goods in an industrial society, and capital accumulation in industrial societies differs fundamentally from that in agricultural societies (Kim et al. 2010).[6] Although Galor and Weil's study may explain observable results regarding economic growth, it is hard to say, in light of the underlying reason behind historical economic phenomena and the differences between different eras, that the inherent cause of economic development had been found.

Lastly, the term *growth accelerations* (Hausmann et al. 2005) might cause confusion because herein we use it to mean AEG. However, our and Hausmann et al.'s usages are not the same. Whereas growth acceleration in this study has an amplifying effect as industrialization progresses, Hausmann et al. (2005) use growth acceleration to mean an increase in per capita growth of two percentage points or more. (In particular, the increase in growth has to be sustained for at least 8 years and the post-acceleration growth rate has to be at least 3.5 % per year.) In our research, periods of 8 or 16 years are too short for the effects of accidents and random events not to be severe. Furthermore, Hausmann et al. (2005) focus on the

[6] In referring to this, Kaldor (1961) notes that the "rate of profit on capital" is greater than is the "pure" long-term interest rate in developed capitalist societies. Further, Brown and Weber (1953) show that profits per capita increased greatly when the UK underwent its Industrial Revolution in the period 1870–1914. Thus, it is impossible to find a pattern of economic growth that is specific to industrial societies via the same process of the investment and accumulation of capital that is present in agricultural societies.

short-term causes of growth accelerations. However, we view the fundamental structure of an industrial society that is experiencing accelerating growth as a single economic system. In particular, Hausmann et al. (2005)'s research uses data on various countries, including agricultural societies, in order to ascertain the causes of growth accelerations. This is different from our research, which focuses on the inherent economic system in an industrial society.

3.3 Model of AEG in an Industrial Society

3.3.1 AEG Patterns and Historical Evidence

AEG patterns can be elucidated and induced through the application of existing growth models, such as Solow (1957)'s neoclassical model and Ruttan (2001)'s induced innovation model.

First, Solow (1957) stated that aggregate production is affected by the degree of technological change (see Fig. 3.3), thereby shifting the production function in accordance with the level of technology that was available during the corresponding period. The bottom curve in Fig. 3.3 represents the production function of investing k1[7] during the period t = 1 and producing q1, and the top curve represents the production function of investing k2 during the period t = 2 and producing q2. The production function used here is the production function of the neoclassical model (Solow (1957) named this the aggregate production function (APF)), and the curve was shifted by the technical change between t1 and t2.

In order to derive an accelerating growth pattern, it is crucial to identify the characteristics of technological change because technological innovations determine the range of values within which the production function can shift when

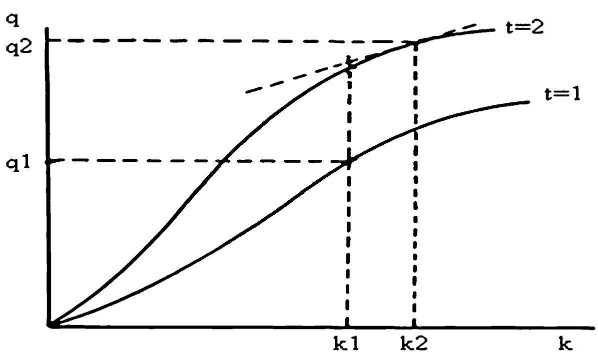

Fig. 3.3 Shift in the APF according to exogenous technological development (Source: Solow 1957)

[7] k is the ratio of capital input per unit of labor input (K/L), where K is capital input and L is labor input.

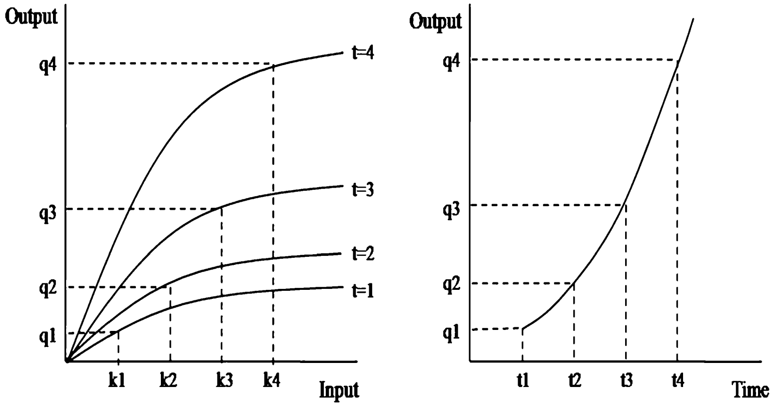

Fig. 3.4 Time–output relations as per Solow's APF shifts

deriving the production curve of an industrial society from the very long-run point of view. An industrial society enables a virtuous cycle of economic growth in which the accumulation of capital and technological development increases production and consumption geometrically and simultaneously through the repetition of expansive reproduction. Sect. 3.2 includes an in-depth discussion on this topic. Support for the view that technological development accelerates in an industrial society can be found in Solow (1957) and Crafts and Mills (1997). Solow analyzes industrial US data in two periods: 1909–1929 (Period 1) and 1930–1949 (Period 2), and finds greater technical change in Period 2 compared with in Period 1. He also shows that the increase in GDP per man-hour that was generated by technical change was greater in Period 2 ($0.395) than it was in Period 1 ($0.275). Crafts and Mills (1997), in a study of production during the Industrial Revolution in the UK, find that the rate at which production grew in the manufacturing industry increased until 1900. As above, when accelerating technological progress in an industrial society is applied to the Solow model, it is possible to obtain an accelerating production curve (Fig. 3.4).

Figure 3.4 shows the inducement of the shift in Solow's APF from the very long-run point of view. As technological development accelerates in an industrial society, the range within which the APF can shift also increases. However, the point at which actual production takes place on the APF is one point in each period ((k1, p1), (k2, p2), (k3, p3), (k4, p4), etc.), which means that it is possible to derive the production curve in terms of time–output on the right by connecting these points. In addition, it is possible to see an acceleration of production from the long-term point of view.

Another production model is the induced technological innovation model. The basic concept of this model is that relative expenses between input elements change over time, and that the company develops a production technology that uses elements as inputs that cost less than they did previously (Ruttan 2001). According to Ruttan (2001), when a company uses less expensive elements as inputs, as a result of a change in relative prices between input elements owing to cost-effective production, if the production technology does not change, the input ratio required to achieve maximum production levels also does not change. This eliminates the possible options required

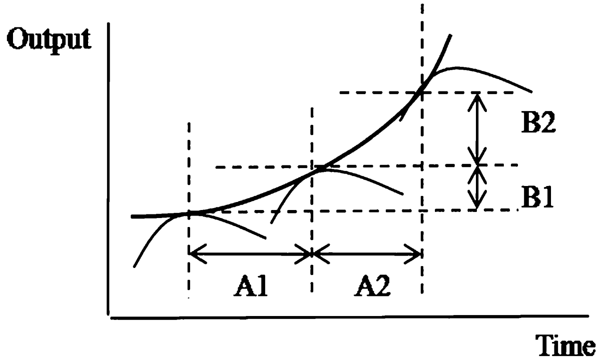

Fig. 3.5 Time–output relations in an industrial society from the point of view of the induced innovation model

to pursue maximum production with minimum cost through factor substitution. Such a limitation motivates the development of new technology for improving the input ratio, the achievement of which will generate a shift toward a new production isoquant. The envelope around the shifted production isoquants is introduced as the meta-production function in the induced innovation model (Hayami and Ruttan 1970).

3.5 shows the meta-production function over time from the perspective of the induced innovation model. As the meta-production function envelops different production functions, the accelerating production curve is derived when the evolving production technologies of an industrial society are taken into account. A1 and A2 are the times used to establish each technological development, and B1 and B2 indicate increased production owing to technological development.

In contrast to the deceleration of economic growth in a pure agricultural society (Clark 2007; Kim et al. 2010), in an industrial society, technology advances rapidly enough for economic growth to accelerate. Figures 3.4 and 3.5, respectively, show the same type of accelerating curve. An accelerating production curve represents the change in production over time from the very long-run point of view; hence, it may be called the "production expansion path," because it expands the existing production function in terms of time. In Sect. 3.2, we discuss the idea that expansive reproduction is an inherent property of an industrial society that causes the production expansion path to accelerate.

It is a challenge to confirm empirically the hypothesis of accelerating growth in an industrial society because, for countries that industrialized early such as England (as early as the eighteenth century; Deane 1979), sufficient data are usually lacking. Furthermore, in recently industrialized countries, rapid growth seems to have been influenced more by political or economic short-term shocks (financial crises, trade imbalances, friction with developed countries, etc.) than by fundamental and structural long-term factors. Nevertheless, the AEG pattern induced by the application of existing economic growth models can be supported by the following four pieces of historical evidence.

The first case shows the growth curves of these nine countries before and after the Industrial Revolution. As shown, all countries had limited growth and DEG before the Industrial Revolution. However, with the advent of the Industrial Revolution in the mid-eighteenth century, the UK was able to leave behind the stagnant growth group. The US, Germany, and France followed in the nineteenth century

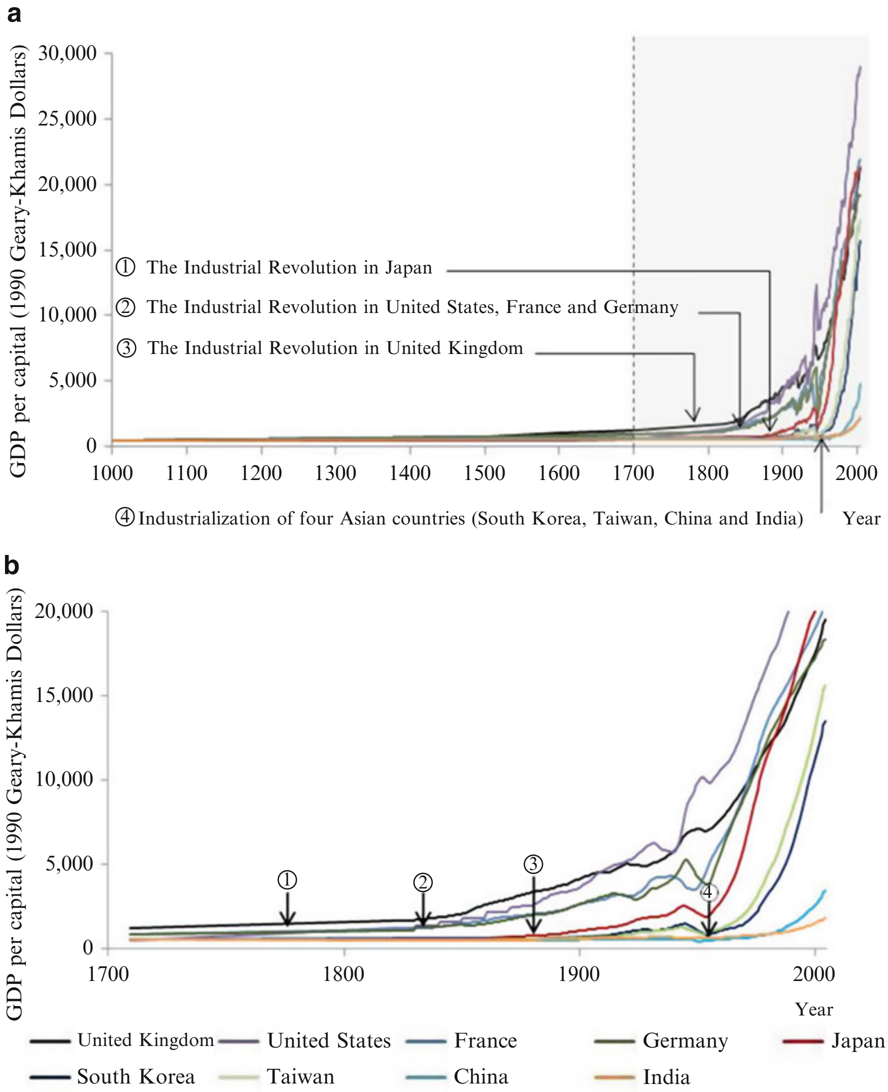

Fig. 3.6 (**a**) The trend of economic growth in nine countries: the UK, the US, France, Germany, Japan, South Korea, Taiwan, China, and India until 2000. (**b**) Enlarged and smoothed economic growth trends of the shaded area of (**a**) (Date Sources: Maddison 1995, 2001, 2003). Notes: (**a**) is drawn using a two-period moving average trend line, whereas (**b**) is drawn using a 10-period moving average trend line in order to smooth the short-term fluctuations in pGDP data (In the short-run growth of an industrial society, many disturbing factors make the graph fluctuate; in order to minimize this, we used the 10-period moving average in Fig. 3.6b)

with their own industrial revolutions, successfully outperforming the stagnant growth group. The five Asian countries also increased performance dramatically following their industrial revolutions.

The case above shows empirically the AEG that is specific to an industrial society in the following ways. As shown in Fig. 3.6, the point at which each country

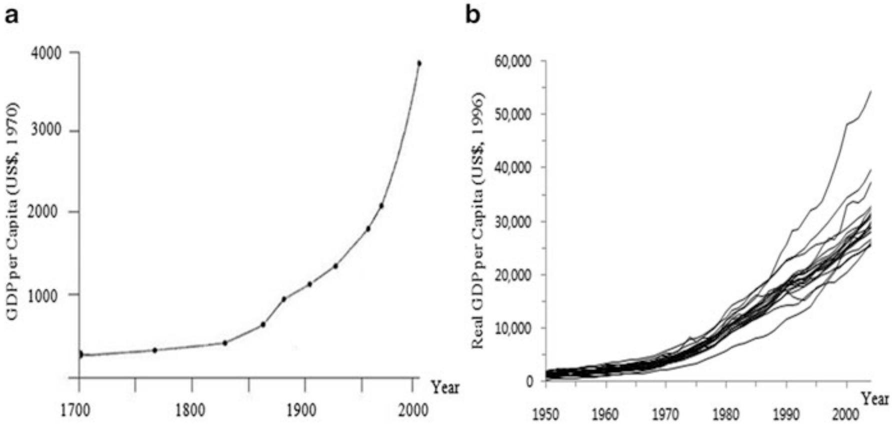

Fig. 3.7 (**a**) pGDP in England (1970s US$), 1700–2000. (**b**) pGDP in OECD Top 20 Countries, 1950–2004 (Data sources: (**a**) Maddison 1982; (**b**) Heston et al. 2002). Notes: In Fig. 7b, the 20 countries are Italy, Finland, New Zealand, Japan, Germany, Belgium, Sweden, France, the Netherlands, the UK, Iceland, Ireland, Austria, Denmark, Canada, Australia, Switzerland, Norway, the US, and Luxembourg

undergoes an industrial revolution is different, but without exception and concurrent with industrialization, economic growth always begins to accelerate. Once an industrial society has emerged, economic growth accelerates in the long run, despite short-term fluctuations owing to such factors as war, oil shocks, and financial crises. This growth pattern is consistent with that of the existing growth model.

Figure 3.7 also shows an accelerating growth pattern. As shown in Fig. 3.7a, an industrial society shows a slow slope close to the baseline at the beginning of the economic growth stage and later displays AEG with a rapidly increasing slope, with pGDP also increasing exponentially. Figure 3.7b shows the change in pGDP after the 1950s, when the current top 20 OECD nations became substantially industrialized.

Figure 3.8 shows that although the selected Western European and Asian countries show AEG, the African nations, which had not industrialized by 1990, show DEG, which is commonly found in agricultural societies. In addition, the 10 European countries that industrialized first show an increasing difference in growth compared with the six Asian countries, which started to industrialize later. When economic growth accelerates, *ceteris paribus*, the difference in growth between a country that industrializes early and one that industrializes late is ever increasing.

Finally, Fig. 3.9 comprises changes in the labor productivity of 12 industrial countries from 1870 to 1998. In all figures, labor productivity increases at a higher rate in the second half of the period than it does in the first. In addition, the majority of such change takes place around the 1950s, when industrialization began to increase rapidly. This is further evidence of the AEG of industrial societies in that technology develops faster and faster over time.

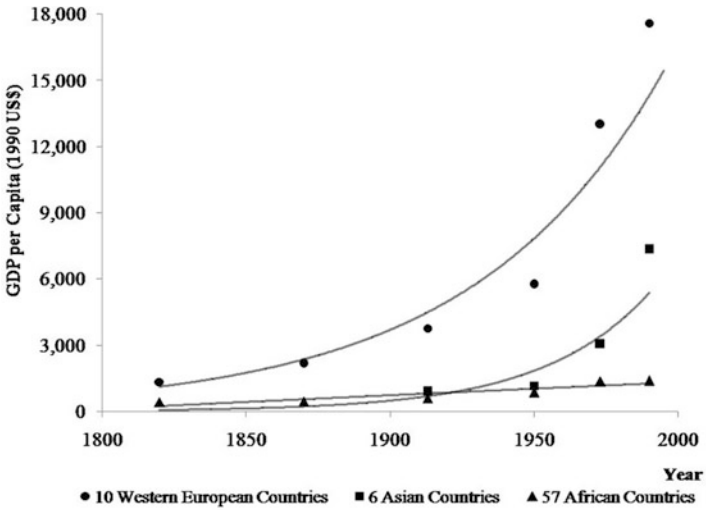

Fig. 3.8 Trends in pGDP of selected country groups (Data source: Maddison 2001). Notes: The 10 Western European countries are Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden, Switzerland, and the UK. The six Asian countries comprise India, Malaysia, Singapore, South Korea, Taiwan, and Thailand. The last group includes 57 African countries

3.3.2 Expansive Reproduction Structure as a Driving Force Behind an Accelerating Economy

As shown earlier, an industrial society displays an inherent AEG pattern compared with a pure agricultural society. In this section, the fundamental and unique driving force behind AEG, which herein is defined as expansive reproduction, is analyzed.

Accelerating growth in an industrial society is generated by the virtuous cycle of expansive reproduction, which repeats the simultaneous growth of supply and demand. This structure is supported by the accumulation of capital and technological development. When expansive reproduction occurs, the scale of gross production expands because most of the surplus secured by companies, capitalists, or an entire society through their economic activities is accumulated as capital and reinvested into production (Jalee 1977). Taken together, expanded capital, an increase in the income of production workers, a decrease in prices resulting from higher productivity, and new demand created by new products released following technological innovation (Masi 1987) create synergy effects and thus increase supply and demand at the same time. We can see more clearly how expansive reproduction occurs by comparing it with the simple reproduction cycle of a pure agricultural society (Kim et al. 2010).

Figure 3.10a illustrates the simple reproduction cycle of a pure agricultural society and Fig. 3.10b shows the change in each element (market size, accumulation of capital, net supply, and net demand) as the cycle of simple reproduction proceeds. This simple reproduction cycle shows how an agricultural economy stagnates because of constant supply and demand.

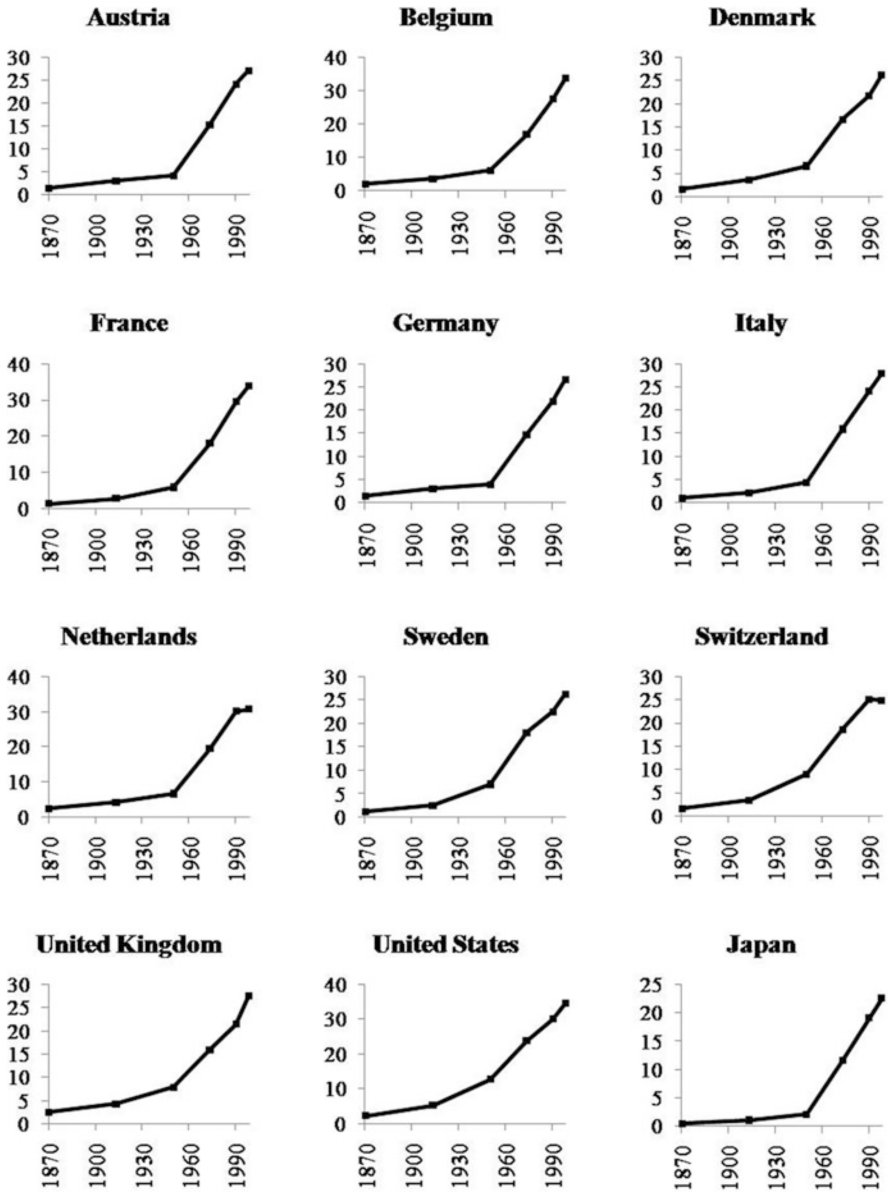

Fig. 3.9 The labor productivity of 12 countries, 1870–1998 (Data source: Maddison 2001). Notes: Horizontal axis—year, vertical axis—GDP per hour worked (1990 international $ per hour)

In a pure agricultural society, the principal factor that prevents expansive reproduction is the inelasticity of demand. There is only so much food that people can consume and/or store in preparation for bad harvests in the future. As a result of this limited demand, the amount of money that farmers can receive for their crops is

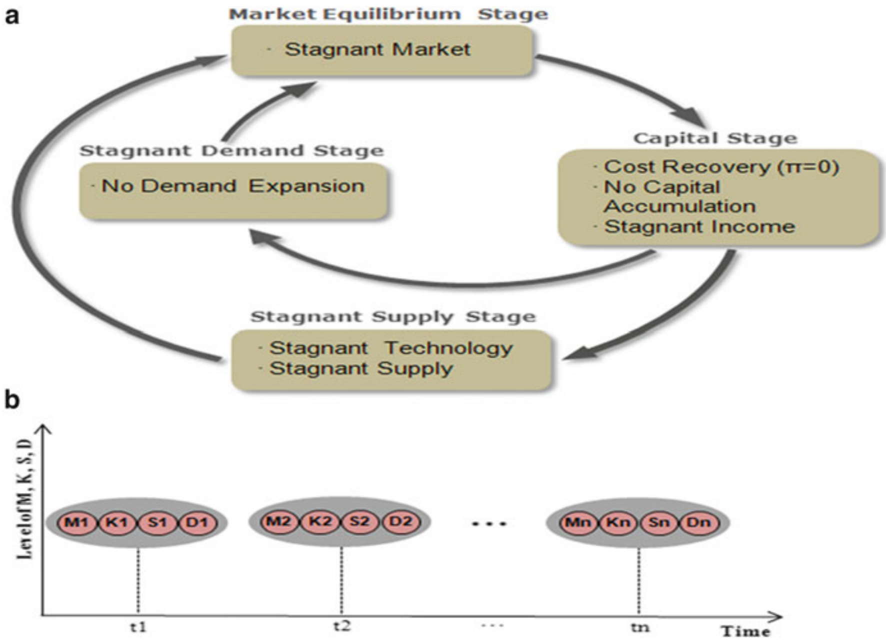

Fig. 3.10 (**a**) Simple reproduction structure in an agricultural DEG Society. (**b**) Stagnant level in each stage of the circulation of simple reproduction. Notes: In Fig. 3.10b, *M* market size, *K* capital accumulation, *S* net supply, *D* net demand

also limited; hence, it is difficult to accumulate capital and thus the development of new technology to increase yields will be slow.

Meanwhile, there are also supply-side difficulties in a pure agricultural society because production has inherent limitations owing to the amount of available land and labor. Assuming there is a fixed amount of land, production will increase as labor is increased up to the point that all the land is being used. At that point, no further growth is possible unless yields can be increased. There are two ways of doing this: using existing resources more efficiently (e.g., ensuring that the soil is appropriate for the crops being grown, using field rotation to maintain the quality of the soil, using water appropriately for crops, and double cropping) and/or introducing new technology (e.g., irrigation and ploughs). However, the extent to which yields can be increased using existing resources more efficiently will have a natural limit. Further, in comparison with the large yields produced by the initial use of the land, the increase in yields through the more efficient use of existing resources will be small. Finally, and most importantly, it is difficult to introduce new technology because of the limited profits available to farmers.

Figure 3.11 shows the stages of expansive reproduction in an industrial society and Fig. 3.12 shows the change in economic growth and related indicators that accelerate over time. The former represents the structure of expansive reproduction and shows a virtuous cycle in which supply and demand increase

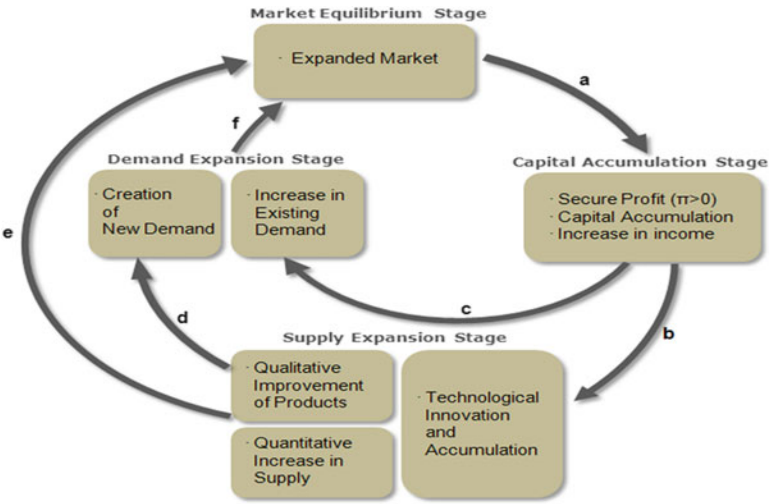

Fig. 3.11 Expansive reproduction structure in an Industrial Society experiencing AEG. Notes: Path *a*: Given the market equilibrium, capitalists can secure profits, their accumulation becomes significant capital for reinvestment, and income increases. Path *b*: Capital accumulation and an increase in income expand existing demand. Path *c*: Accumulated capital is reinvested in order to improve technological innovation and increase production. Path *d*: The launch of quality-enhanced new products, which are generated as a result of technological innovation, creates new demand. Path *e*: The expansion of existing demand and creation of new demand increase net demand in the market. Path *f*: The increase in production that occurs via the increase in production capacity and improvements in productivity, and the launch of new products following technological innovation, increase net supply to the market

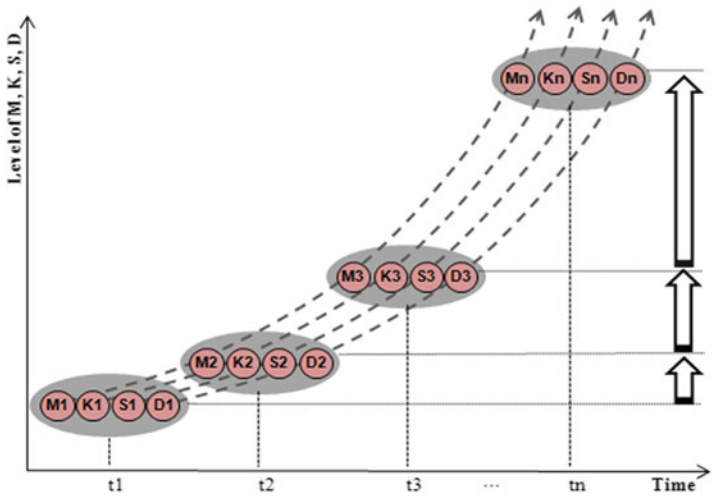

Fig. 3.12 Accelerating trends at each stage created by the circulation of expansive reproduction. Notes: *M* market size, *K* capital accumulation, *S* net supply, *D* net demand

through the accumulation of capital and the economy grows through expanded market equilibrium in an industrial society. In relation to this, the latter shows that from the very long-run point of view, the economic indicators that constitute the expansive reproduction cycle also accelerate along with economic growth when the virtuous cycle of expansive reproduction is established.

Capital- and technology-intensive products in an industrial society generate much greater profits than do agricultural or handmade products, and this increase in profits enables the accumulation of capital and technology, leading to improvements in mass production through improvements in productivity and economies of scale in terms of supply. These increases in supply result in greater sales and hence profits, because demand increases as well. For one thing, this increase in profits enables higher wages to be paid, which gives people more money to spend. For another, the accumulation of capital after wages have been paid enables the accumulation of technology, which enables the development of new products in addition to the improvement in manufacturing capability, and these new products also create new demand. Supply and demand thus grow simultaneously. Further, the growth is geometric, because each new increase in supply and demand yields a greater accumulation of capital that can be reinvested in order to develop technology that can improve productivity further and can stimulate yet new demand by the development of new products. This is the virtuous cycle of expansive reproduction and the secret of AEG in an industrial society. This matches the accelerating growth patterns shown in Figs. 3.4 and 3.5.

This expansive reproduction cycle can be characterized as having the following four stages: Market Equilibrium, Capital Accumulation, the Expansion of Supply through Technological Innovation, and the Expansion of Demand.

3.3.2.1 Market Equilibrium Stage

In the Market Equilibrium stage, expanded production (which results from the expansion of supply capacity) and expanded consumption (which originates from the increase in demand that creates equilibrium in the market) represent the scale of the economy or market. This phenomenon of acceleration has been confirmed by a number of previous studies. Gras (1939) claims that, the industrial capitalist era witnessed excessive demand and an expansion of supply. Knowles (1924), Hammond (1925), and Hobson (1965) each claim that the existence of a market that can consume increases in industrial output is an essential condition for the development of capitalism. This is reflected in the advancement of industrial capitalism through the expansion of supply and the market; in other words, the expansion of demand.

3.3.2.2 Capital Accumulation Stage

Capital accumulation enables reinvestment into expansion by accumulating capital for the company and by increasing income for consumers. Increased profits enable higher wages to be paid, which increases the spending power of consumers. Care is taken when setting the wage level to ensure that capital can be accumulated and (after the owner's drawings) reinvested toward the expansion of production capacity (plants and equipment) and the development of new technology (R&D), which can then be commercialized in the form of new products and better-quality existing products.

In an industrial society, most investment is used for plants and equipment or R&D. As the cycle of expansive reproduction continues, successive phases will yield a successively greater accumulation of capital, which can then be reinvested. For example, Lewis (1955) reports that the reinvestment rate, which was below 5 % before industrialization, increased to 10 % or higher following industrialization. This rate was driven principally by the cotton and steel industries (Stanley 1970). The case study by Wilson (1957) demonstrates this in more detail: William H. Lever, who was engaged in the soap industry, made £50,000 profit per year in the 1880s, and reinvested most of it (he retained £400). This case of expansive reproduction in an early industrial society demonstrates how huge amounts of capital can be accumulated.

3.3.2.3 Expansion of Supply Through Technological Innovation Stage

In this stage, supply will increase through reinvestment as described before. Reinvested capital is put toward technological innovation and its accumulation. Developed technologies can be separated into two aspects: technologies for the improvement of existing products (which is quantitative) and those for the development of new products (which is qualitative). Investment into plants and equipment tends only to increase production while maintaining the existing levels of production technology. Such an increase in production increases supply in order to satisfy the increase in demand for existing products that result from the increase in consumer purchasing power. Investment into R&D tends to create added value through the development of new products based on technological innovation, which can then be commercialized. This stage is in line with the endogenous growth (Romer 1990) and learning by doing (Arrow 1962) theories. Romer (1990) identifies technological development in terms of an increase not only in the number of intermediate inputs but also in qualitative advancement (Grossman and Helpman 1991). Arrow (1962)'s learning by doing theory is related to an improvement in existing products or process innovation.

Compared with the other stages, this stage is special because expansive reinvestment into plants and equipment and R&D generates synergy effects that simultaneously increase supply and demand, thereby enabling a virtuous cycle of expansive reproduction. In other words, technological innovation can become the major force that drives AEG in an industrial society because it creates new demand through the development of new products that did not exist in previous cycles.

This hypothesis is supported by the following studies, which show clearly that technological development occurs continuously in an industrial society. Pollard

Table 3.1 Labor productivity in the cotton spinning industry

Types of cotton spinning processor	Required labor hours
Indian labor (eighteenth century)	50,000
Crompton's self-actor (1780)	2,000
100 weight self-actor (1790)	1,000
Power-aided self-actor (1795)	300
Robert's self-actor (1825)	135
Modern cotton spinning machine	40

Source: Modified from Catling (1970)

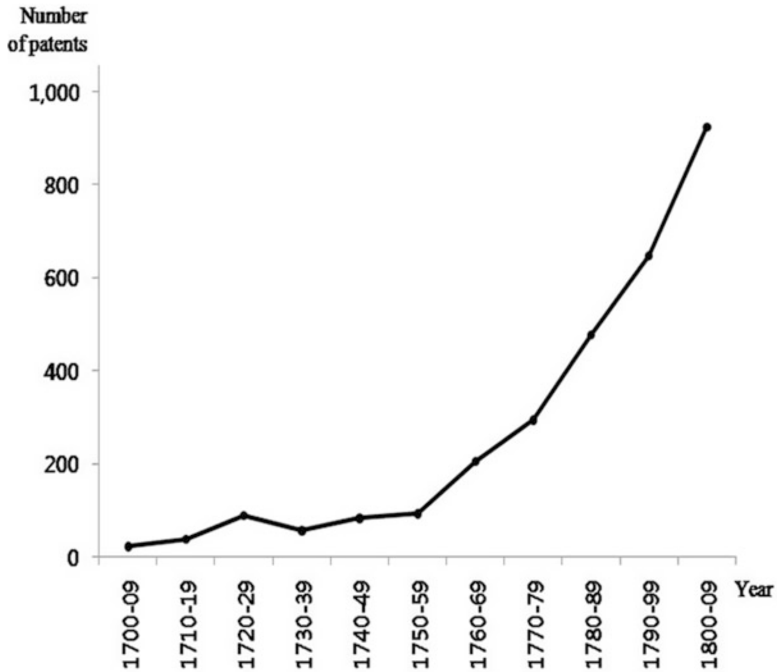

Fig. 3.13 Patent registrations in the industrial revolution Era, England, 1700–1809 (Source: Mitchell and Dean 1962)

(1965) and Smelser (1959) stated that labor improved qualitatively through an increase in investment into on-the-job training following industrialization in the nineteenth century. Using the case of the cotton spinning industry, Catling (1970) demonstrates the effect of investment into both plants and equipment and R&D on labor productivity via technological innovation (see Table 3.1).

Figure 3.13 shows the accelerating development of technology based on Mitchell and Dean's (1962) survey of the increase in patents from the 1700s to the 1800s. Qualitative technological development can be separated according to industry development: the advancement of products and the advancement of industrial structure. The former comprises the relatively short-term and small-scale

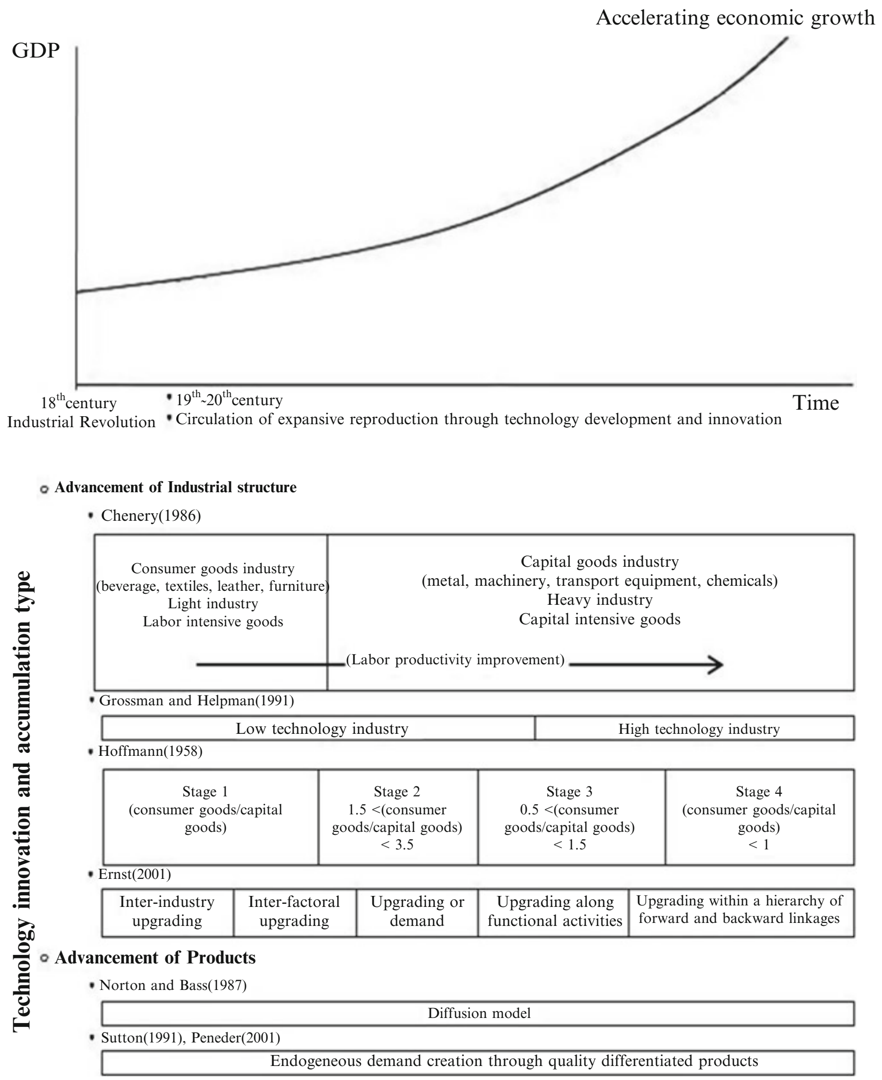

Fig. 3.14 Qualitative development in accelerating societies

phenomenon of technological innovation, such that existing products are improved, functions are diversified, and new technologies are combined to develop new products within the same industry. The latter comprises more fundamental, long-term, and large-scale technological innovation, such as a shift from labor-intensive light industry to capital-intensive heavy and chemical industries, and again to a more technology-intensive electronic and information-based industrial structure.

Figure 3.14 schematizes previous studies in terms of these two criteria. First, with respect to the advancement of products, when a product is developed, the continuous development of new technologies occurs to replace old technologies (Norton and Bass 1987). Sutton (1991) and Peneder (2001) note that new technologies are developed periodically through the innovation and differentiation of individual products, with profits and output increasing rapidly as a result of the enhancement in product performance and by creating demand and market scale endogenously. Second, with respect to the advancement of industrial structure, Hoffman (1958), Chenery et al. (1986), and Ernst (2001) show that changes in industrial structure have occurred in four stages. Grossman and Helpman (1991) show that the improvement in productivity differs by industry: low-tech industries show relatively slow improvement in productivity, whereas high-tech industries show rapid improvement.

3.3.2.4 Expansion of Demand Stage

This stage has two aspects: (a) an increase in existing demand (i.e., an increase in the consumption of existing products that have the same quality) as a result of an increase in the purchasing power of consumers and (b) the creation of new demand that results from the release of new products.

The creation of new demand is an important resource in an industrial society. The advancement of products and industrial structure in the Supply Expansion stage generates a qualitative advancement of existing products or the development of new industrial products. This replaces or expands demand for existing products or creates new demand for new products. John (1961, 1965) reports that, population and income increases in an industrial society bring about an increase in the demand for food, industrial products, and services, which then creates increased supply and eventually initiates economic growth. Masi (1987) further notes enormous demand levels as an advantage of an industrial society.

Similarly, in the commercial era, which fell between pure agricultural and industrial societies, reinvestment yielded benefits, but only up to a certain point. Reinvestment only resulted in economic growth as long as people in existing markets wanted greater amounts of existing products and as long as new markets could be found. There was no continuous creation of new demand resulting from the launches of new products created from technological innovation and its accumulation.

3.3.2.5 Virtuous Circle of Expansive Reproduction

There are clear causal relationships between these four stages of expansive reproduction. The release of new products following investment in R&D and the creation of new demand because of increased consumer spending power and strong marketing campaigns are the factors driving the qualitative aspect of economic growth. The qualitative aspect, which was absent in the simple reproduction cycle of a pure agricultural society, is thus an important causal factor that allows positive feedback in expansive reproduction to be sustained in industrial societies.

Expansive reproduction is supported by the theories of economic growth presented earlier. Smith (1776) views on the division of labor and increases in productivity explain how the Expansion of Supply stage is able to progress to the Market Equilibrium stage, in that the Market Equilibrium stage receives increased production because of (a) the production and release of new products that results from investment in R&D and (b) the increased production capacity that results from investment in plants and equipment. Marshall's (1920) theory of returns to scale supports conceptually the circulation of paths a, c, and f in the expansive reproduction cycle (Figure 11), in that it states that companies that accumulate profits or capital as a result of market expansion augment their plants and equipment through large investments, thereby improving productivity (path f in Figure 11). Chandler's (1990) theory of increasing returns also becomes the basis for the link between paths c and f. This is similar to Marshall's theory that cites large facility investment (Capital Accumulation stage), an increase in productivity through the mixed use of the same facilities because of an increase in technological compatibility (Supply Expansion stage), and an increase in production (Market Expansion stage) generate economies of scope. Finally, Myrdal (1957) theory of cumulative growth is in line with our view of what enables AEG.

3.4 Conclusion

The principal goals of this study were to identify the growth pattern that differentiates an industrial society from an agricultural society and to investigate the factors responsible for this growth pattern. By applying neoclassical theory and the induced innovation model and examining historical data from the long-run point of view, we found that an industrial society is characterized by AEG. We also proposed that this growth pattern is enabled by the virtuous cycle of expansive reproduction. The hypothesis of expansive reproduction is consistent with empirical evidence and the implications of previous studies on economic growth. The fact that this is so renders the hypothesis highly plausible.

We considered briefly how the transition from an agricultural society, with its decelerating growth pattern, to an industrial society, with its accelerating growth pattern, could occur. As described, in a pure agricultural society, there are inherent limitations to demand in terms of consumption and storage and production (crop yields) in terms of land and labor. Of course, demand will increase as the population increases and so supply will increase as well, but only up to the point that the demand of the increased population with respect to consumption and storage are met, and only up to the point that the available land and labor are exploited to the fullest extent. Beyond that, supply, and hence the population, and hence demand, can increase only as the result of the development and introduction of new technology. Thus, given the equilibrium between supply and demand, there will be insufficient profit to enable capital to be accumulated that can be invested in research for the development and implementation of new technology.

By contrast, in an industrial society, the limitations of demand that characterize agricultural society are not present to anything like the same degree. New products can be created as a result of technological innovation, and people will always find a use for new products, provided they fulfill an existing or newly created need. Further, thanks to the increased productivity that is made possible by the accumulation and reinvestment of capital, supply can always increase to meet increased existing demand. Thus, a virtuous circle of expansive reproduction is created in which economic growth accelerates. Once sufficient capital has been accumulated for this process to begin, the critical factor is technological innovation.

It should thus be noted that the virtuous cycle of expansive reproduction is the key factor in AEG, regardless of what stage of industrialization a country is in. Some early industrializers, for example England and the US, are now being caught by later industrializers such as Germany and Japan and threatened by new industrializers such as South Korea, Taiwan, and China, owing to a failure to maintain technological innovation and hence industrial competitiveness. Nevertheless, expansive reproduction is the key factor in the economic growth of all these countries, because it is caused not by the embedded value creation system in an industrial society but by external reasons such as the state of the economy, war, and so forth.

Our results have implications for both policy and research. Policymakers should formulate and implement policies that have positive effects on the cycle of expansive reproduction, because it is expansive reproduction that produces AEG regardless of the stage of industrialization or political ideology. The desire to formulate and implement such policies will influence the direction of research. First, therefore, research should be conducted in order to investigate further the mechanisms of expansive reproduction, namely the development and commercialization of new technology, reinvestment in plants and equipment, identification of existing demand, creation of new demand, and satisfaction of demand. Second, the specific research that is required and the policies that are implemented will differ according to the specific properties of the society in question. Although expansive reproduction is the key factor, a complicated matrix of factors influences the specific means by which it can be achieved. This matrix comprises factors such as politics, social structure, the availability of resources, culture, and religion.

Further, our findings have shown that agricultural and industrial societies each have their own growth patterns (decelerating growth and accelerating growth, respectively), which are generated by two distinct patterns of production (simple reproduction and expansive reproduction, respectively). However, we are already witnessing what may be the emergence of a new type of society, in which economic growth depends not on agricultural production or manufacturing but on the production of goods by the human mind, such as information and digital entertainment. It is plausible to suppose that this new type of society will have its own growth pattern, which is generated by its own distinct modes of production.

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Chapter 4
Determinants of Economic Divergence Among Accelerating Societies

Tai-Yoo Kim, Seunghyun Kim, and Jongsu Lee

Abstract Theoretical discussions about the existence of divergence among countries have advanced and are centered on convergence, the technology gap, government-leading catch-up strategies, information communication technology diffusion, and inter-country development gap expansion. By applying economic models to different societies, the income divergence hypothesis for nations can be proven. This income diversion model clearly explains not only the emergence of accelerating and decelerating societies but also the income divergence seen among accelerating societies. Therefore, in this paper, theoretical evidence about divergence is suggested based on the existing discussions related to the issue, and then the inter-country income divergence model is used to explain the differences between accelerating and decelerating societies.

Keywords Accelerating society • Decelerating society • Convergence • Income divergence • Technology gap • Income diversion • JEL Classification Numbers: L16; L50; N10; O16; O33; O47

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4.1 Introduction

The Agricultural Revolution in the Neolithic Age freed mankind from starvation, and the Industrial Revolution of the modern age has led humanity into a time of affluence (Toffler 1980). The agricultural society is a stagnant society with a decreasing economic growth rate and a development limit, whereas the industrial society is capable of accelerating economic growth through the advancement of technology. The accelerating growth of the industrial society is widening the economic gap between those who have embraced technology and those mankind groups who have not moved out of the agricultural society.

The economic growth gap between societies has been explained mainly by the income convergence hypothesis, which states that among countries facing equal initial conditions the income levels per capita converge to a certain level. According to this view, the gap between countries should decrease gradually. However, 200 years after beginning, the industrial society has reached maturation and many argue whether inter-country convergence can be seen in real-world examples. Answers to questions about inter-country convergence or divergence can be explained through various theoretical discussions and models related to accelerating societies. This paper tries to illustrate that the inter-country income levels gap diverges as society become industrialized society or knowledge-based society by analyzing preexisting theories. We use concepts of the decelerating society[1] (Kim et al. 2009a), the accelerating society[2] (Kim and Kim 2009a, b) and the faster accelerating society[3] (Kim et al. 2009b) as used in continued research.

Theoretical discussions about the existence of divergence among countries have already advanced through various fields of economics: the convergence hypothesis by Baumol (1986) and De Long (1988), the technology gap model by Fagerberg (1987), the government-leading catch-up strategy by Abramovitz (1994), as well as opinions on information communication technology (ICT) diffusion and inter-country development gap expansion as espoused by Seo and Chung (2002). By applying economic models of the decelerating society (Kim et al. 2009a), the accelerating society (Kim and Kim 2009a, b), and the faster accelerating society (Kim et al. 2009b), the inter-country income divergence model can be illustrated. Milanovic (2002) studied the world distribution of individuals' income from 91 countries and found that inequality increased from 1988 to 1993. These studies clearly explain the income divergence, not only between accelerating and decelerating societies, but also among nations within the accelerating society.

Therefore, we first suggest theoretical evidence for divergence based on the existing discussions and then we employ the inter-country income divergence model to offer an explanation for divergence between accelerating and decelerating societies.

[1] In a decelerating society, the speed of output increase is decelerated as input increases.

[2] In an accelerating society, the speed of output increases and the speed of economic growth accelerate due to technological development.

[3] In the faster accelerating society, the speed of output increase is faster than that of an accelerating society.

The argument supporting the model is made by showing the gradual increase of a per capita income gap between a late-started industrial country and an early-started advanced country when both are operating under a free-market competitive environment. The inter-country income divergence model offers theoretical support for the argument that countries who start their industrialization later (follower countries) than advanced industrialized countries (leader countries) should pursue different economic development strategies than those proven successful for advanced countries.

The rest of the paper is organized in three sections. Existing discussions regarding economic divergences, including the relationship between convergence hypothesis and divergence, divergence and the technology gap, catch-up strategy and economic divergence, and divergence in ICT diffusion and the growth gap, are investigated. The inter-country income divergence model is discussed. The discussion covers the inter-country income divergence, income divergence between accelerating and decelerating societies, as well as income divergence within accelerating societies and among faster accelerating knowledge-based societies. The final section concludes the overall report.

4.2 Existing Discussions Regarding Divergence

Economic growth theory and practical examples could explain the divergence between countries. Related academic discussions have focused on the difference in the gap of national incomes per capita over time. The following diverse points of view among academics interested in divergence are discussed: (1) hypothetical convergence as described by economic growth theory and its counterargument, (2) the technological gap approach, (3) catch-up strategy and economic divergence, and (4) ICT diffusion and expansion of the international growth gap.

Various theories and cases (Kim and Kim 2009a, b) clearly show that the characteristics of an accelerating society are the fundamental reasons for divergence. Therefore, to escape polarized conditions, the developing country must have a national development strategy that differs from those of advanced societies.[4]

4.2.1 The Relationship Between the Convergence Hypothesis and Divergence

The examples of previous research on divergence were based on convergence and divergence as outlined in economic growth theory. The economic growth-rate convergence hypothesis for countries per time is similar to our postulation of divergence. In both of the economic theory and divergence models, the means by which inter-country economic growth changes are studied as a function of time.

[4] For the historical and empirical examples of the polarized society are described in Appendix 1 and 2.

According to the neoclassical school, the term "convergence" explains the gradual decrease in economic growth rate such that it is close to a specific value in the economic growth model. However, the term "income divergence," as the counterpart to the income convergence hypothesis as it relates to an industrial society, has not been academically established. Nevertheless, it has been adopted to describe the opposite of the convergence situation.

To understand the convergence hypothesis, one must primarily comprehend the neoclassical growth theory, which Solow (1956) explained. Neo-classical economic growth theory explains per capita capital intensity and per capita income in a steady state where savings rate which shows an economy's consumption and production structure, population growth rate and per capita production function are given. The calculation of the numerical formula can lead the economic growth and gross production through a production function, which makes possible an observation of the national income per capita trends in a time series.

The convergence hypothesis was formulated by Tinbergen (1961), who assumed those countries with the same preferences, technology levels, and savings rates will achieve similar income levels. In the literature, this type of convergence is separately considered as the absolute convergence hypothesis or the conditional convergence hypothesis.

First, in case of absolute convergence hypothesis, according to the inter-country convergence hypothesis of national income per capita (i.e., the absolute convergence hypothesis) every country achieves the same income level in the long run. This result is based from the assumption that every country has the same savings rate, rate of increase in population, production function, and technological level. When these assumptions are satisfied, each country is expected to approach the same equilibrium status according to neoclassical growth theory. As a result, the variables capital (K), income level (Y), and consumption level (C), each measured per capita, are converged.

Numerous researchers have attempted to verify this conclusion according to pragmatic proof. The convergence hypothesis is applicable to a comparison of advanced countries, but it does not make sense when advanced and developing countries, which have different economic and initial conditions, are compared with each other.

The disequilibrium among disparate countries could be explained by a general application of the neoclassical economic growth model, which claims that levels of income per capita between two economies with the same production and consumption structure will converge, but when the economies are different, each will approach different equilibrium states. Thus, the conditional convergence hypothesis seems applicable in the real world.

Baumol (1986) examined the relationship between national income per capita and rate of economic growth in 16 countries from 1870 to 1979 (see Table 4.1 and Fig. 4.1). The empirical results showed an inverse proportional relationship between the national income per capita (gross domestic product [GDP]) and the rate of economic growth in 1870; the estimated coefficient was close to 1, which means a strong convergence.

Baumol assumed the following regression formula from Table 1: Growth rate (1870–1979) $= 5.25 - 0.75$ ln (GDP per work hour, 1,870), $R^2 = 0.88$. The formula

Table 4.1 Baumol's economic growth rate examination for 16 countries from 1879 to 1979 (in 1970 US$)

	Real GDP per work hour	Real GDP per capita	Volume of exports
Australia	398	221	–
United Kingdom	585	310	930
Switzerland	830	471	4,400
Belgium	887	439	6,250
Netherlands	910	429	8,040
Canada	1,050	766	9,860
United States	1,080	693	9,240
Denmark	1,098	684	6,750
Italy	1,225	503	6,210
Austria	1,270	643	4,740
Germany	1,510	824	3,730
Norway	1,560	873	7,740
France	1,590	694	4,140
Finland	1,710	1,016	6,240
Sweden	2,060	1,083	5,070
Japan	2,480	1,661	293,060

Sources: Baumol (1986), Table 1, p. 1073. The data are from Maddison (1982), p. 8, 212, 248–253

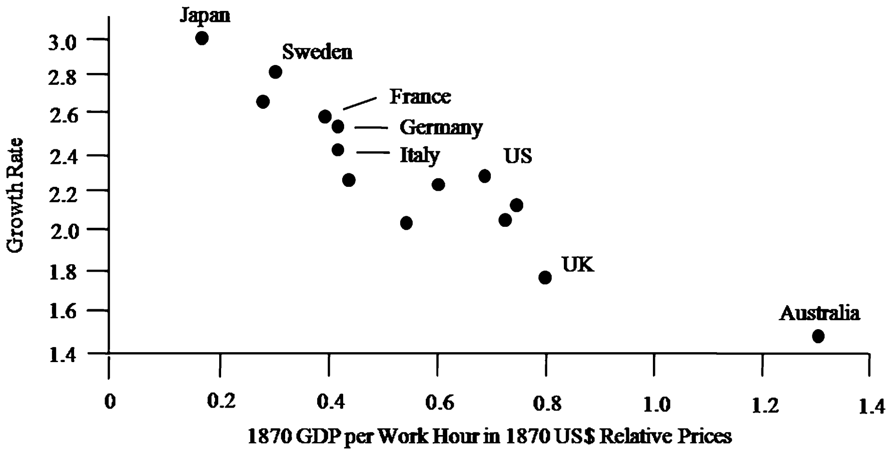

Fig. 4.1 Verification of the inversely proportional relationship between the initial national income per capita (productivity growth rate, 1870–1979 vs. 1870 Level) (Sources: Baumol 1986, Fig. 2, p. 1076. Data are from Maddison (1982), p. 212)

shows that the lower the initial income, the higher the increase of economic growth. The gap between developing and advanced countries is decreased.

Figure 4.2 shows the convergence of the growth of advanced countries (United Kingdom, United States, etc.) and developing countries (Japan, Italy, etc.) as a verification of the convergence hypothesis.

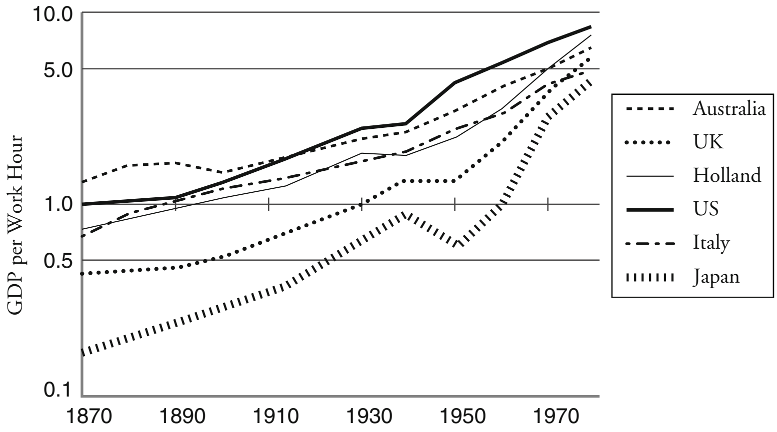

Fig. 4.2 The convergence of productivity of six nations (Sources: Baumol 1986, Fig. 1, p. 1075. Data are from Maddison 1982, p. 212)

However, De Long (1988) suggested that Baumol's samples were wrongly adopted and GDP per capita in 1870 was not precisely examined. Also, evidence of convergence was not shown. First, all of the 16 countries that Baumol chose to study became rich after World War II. Japan (the poorest among 16 countries in 1870), had an 1870 income level that was lower than that of Russia as well as European and South American countries. Finland, which was the second poorest country in 1870, should have been included in a sample with Argentina, Chile, East Germany, Ireland, Portugal, Spain, New Zealand, and other developing nations. If Finland had been included in the group of poor countries, the retrospective analysis would not have been statistically significant. See Fig. 4.3.

Second, De Long indicated that in terms of 1870 per capita income, British and French overseas investment had been included in the data of other countries such as Canada and Australia. As a result, the data are misleading (see Table 4.2).

Also, Amable (1993) hypothesized that productivity-level convergence or divergence would emerge as developing countries caught up to the level of advanced countries. He suggested a total of six models for catch-up and cumulative causation.[5] The Amable models were applied to 59 countries from which data were available from 1960 through 1985. The result (reported in Table 4.3) shows that 48 countries were unable to catch up to the advanced countries. Amable indicated that, in general, most countries show divergence rather than convergence in productivity levels.

[5] In the Amable (1993) model, determinants of productivity growth are endogenous: investment equipment share in GDP, innovative activity, and the level of schooling.

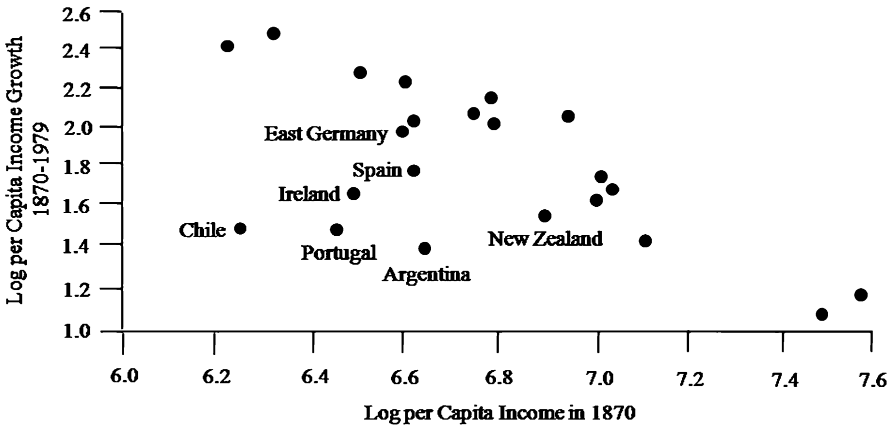

Fig. 4.3 Graph of Baumol's samples as corrected (Source: De Long 1988, Fig. 2, p. 1141)

Table 4.2 British and French overseas investments

Nation	Pounds invested per capita	Belongs to once-rich 22 country sample
Canada	86	Yes
Australia	57	Yes
New Zealand	57	Yes
Argentina	54	Yes
South Africa	27	No
Chile	26	Yes
Cuba	17	No
Mexico	10	No
Brazil	8	No
United States	8	Yes

Sources: De Long (1988), Table 2, p. 1143. Investment estimates are from Feis (1930). Population estimates are from Michell (1975)

Note 1: For the title, French investments in Latin America allocated to nations in the same proportion as British investments

Note 2: 22 countries are Australia, Denmark, Finland, East Germany, Netherlands, New Zealand, Norway, Sweden, United Kingdom, United States, Belgium, Canada, France, West Germany, and Switzerland, Argentina, Austria, Chile, Ireland, Italy, Portugal, and Spain

Note 3: New Zealand is not distinguished from Australia

As we reviewed above, the absolute convergence hypothesis is based on the assumption that all countries had the same initial income levels. Empirical studies and evidence have verified that identical income levels have scarcely been found in the real world. Each country has unique conditions and production functions, so they would not experience the same level of absolute convergence. Therefore, the conditional convergence concept was introduced. It is based on the view that countries with similar economic and development levels may show converging productivity levels. Proponents of the hypothesis contend that when specific factors

Table 4.3 Amable's results per country

Country	R*	Country	R*
Argentina	1.00	Japan	1.00$
Austria	0.95	Kenya	0.23
Belgium	1.00$	Korea	0.84
Bolivia	0.50	Luxembourg	1.00$
Botswana	0.13	Madagascar	0.37
Brazil	0.89	Malawi	0.34
Cameroon	0.49	Malaysia	0.88
Canada	0.97	Mali	0.00€
Chile	0.94	Morocco	0.32
Colombia	0.75	Netherlands	1.00$
Costa Rica	0.77	Nigeria	0.34
Denmark	0.86	Norway	0.96
Dominican Republic	0.95	Pakistan	0.17
Ecuador	0.72	Panama	0.70
El Salvador	0.64	Paraguay	0.87
Ethiopia	0.00 €	Peru	0.74
Finland	0.90	Philippines	0.83
France	1.00$	Portugal	1.00$
Germany	1.00$	Senegal	1.00 €
Greece	0.99	Spain	1.00$
Guatemala	0.48	Sri Lanka	0.69
Honduras	0.58	Tanzania	0.00 €
Hong Kong	0.98	Thailand	0.80
India	0.41	Tunisia	0.53
Ireland	0.98	United Kingdom	0.74
Israel	0.54	Uruguay	1.00$
Italy	1.00$	Venezuela	0.99
Ivory Coast	0.26	Zambia	0.06
Jamaica	0.70	Zimbabwe	0.78

Source: Amable (1993), Table A1, p. 23

Note 1: All countries belong to case 1, except countries marked with $; these belong to case 2. Countries marked with € belong to case 6

Note 2: From the definition, R is the ratio between the two levels of productivity, level1/level2 (level 1 is the rate of growth of a lagging country, and level 2 is the rate of growth of a frontier country)

are controlled, convergence can occur, and some advances in the theory suggest that country groups under specific conditions show convergence.

Barro (1989) introduced the conditional convergence concept. Through actual analysis, Barro showed that by controlling the factors that can affect long-term economic growth rates, international convergence may emerge. In another piece of research, Barro and Sala-i-Martin (1992) suggested that all the countries do not reach the same national income per capita level but settle to their own normal states. Hence, they suggest controlling for different initial conditions among the countries to examine the convergence phenomenon. In a follow-up study, Mankiw, Romer, and Weil (1992) controlled the diverse basic factors of each country, such as rate of investment, population growth, and human resources, and using the Solow theory, they analyzed the relationship between national income per capita and increases in growth rates of each country.

Barro (1989) incorporated some variables to control for all initial conditions; we regard this strategy as unrealistic. Also Mankiw et al. (1992) suggested that the Barro formula had two problems: Production functions of all countries were regarded as the same and the assumptions regarding some factors, such as technological level, source amount and climate, were wrongly included because they have nothing to do with the rates of population growth and savings. Also, in reality, most countries have different technology levels, and there is a high correlation between technology level and the rates of population growth and savings. As a result, Mankiw et al. (1992) considered that the conditional convergence model an oversimplification in which issues important to the analysis were not adequately addressed.

In addition, De Long (1988) showed that absolute convergence is applicable among some advanced countries. However, no developing countries had caught up with the advanced countries. The facts listed and discussed above support or indirectly show evidence of divergence phenomenon between developing and advanced countries.

4.2.2 Divergence in Endogenous Economic Growth and Learning by Doing

The neoclassical economic development theory has some limitations, and the endogenous economic growth theory was used to try to overcome those limitations.

In 1993, Lucas noted that although the Republic of Korea and Philippines showed very similar conditions in terms of population, levels of human resources, and industrial structure in the 1960s, the Philippines showed an average annual economic growth rate of only 1.8 % from 1960 to 1988, while the corresponding rate of the Republic of Korea had increased by 6.2 % per annum. To explain the differences between the two countries, Lucas (1988) suggested the learning-by-doing model and noted that economic growth should be dependent on how well the economy leads to learning effectiveness.

According to the Lucas model, when the know-hows which could be used to produce new commodities are accumulated to a critical level, new commodities could emerge. And employees could gain new learning effectiveness through new commodities. This process leads the enhancement of productivity and economic growth. In other words, for rapid economic growth, improvement of labor productivity through learning effectiveness is very important. This means that the society should be gradually changed from one with an industrial structure with low added value of learning effectiveness to one with a higher added value of learning effectiveness.

For example, in the 1960s, the Republic of Korea showed faster economic growth than the Philippines. The main exporting goods were from low added-value industries, such as wigs and plywood. However, it changed to textile and fabrics in the 1970s and it changed further to higher added-value goods such as home appliances and light industry goods in the 1980s. Thereafter, the Republic of Korea started to deal with much higher added-value goods, such as steel, vehicles, and semiconductors, which have contributed to extending labor learning effectiveness as well as the creation of many new commodities. In other words, the industrial society continued to develop and produce new commodities in high added-value sectors. It can be presented through naturally effective learning process. We believe that the Lucas model explains the continuous development and divergence of countries the industrial society.

In 1988, Lucas suggested three maxims about economic development. First, accumulation of human capital and technology changes over time. Second, human capital is accumulated through schooling. Third, human capital is accumulated through learning by doing. Under his study, each system converges to a specific growth rate according to the initial conditions, and poor countries could not overcome poverty.

Lucas's maxims of the learning-by-doing model, which are all related to the technological development and improvement in technicians' abilities, share similarities with the characterization of an accelerating society. That is, according to the initial condition of individual countries, the degree of the production function movement is determined in accordance with time.

According to Lucas (1988), the convergence of the growth rate is separate from the convergence of the national income per capita. Thus, although the existing growth rate is converged among countries, the gap of national income per capita among countries can be increased rather than converged. If this hypothesis is adopted widely, some believe that the accelerating societies once considered to have converged growth may experience an increased gap in national income per capita.

Xie (1994) saw the Lucas model from the viewpoint of transitional dynamics and examined the dynamic model through the lens of investing times on learning. According to Xie, if initial conditions in advanced and developing countries differ, growth of advanced countries can converge in three ways and the growth can converge in developing countries in five ways. Depending on each combination of conditions, catch-up, different equilibrium points, and divergence could be seen.

Xie's simulation results show that an advanced country's feasible-development path can be divided into three phases: the development slows down, remains the same, and speeds up. In addition to these cases, two more feasible-development paths are available to underdeveloped countries: it speeds up and slows down.

The underdeveloped country can catch up with the advanced country, attain the same equilibrium point as it, or the divergence could grow larger. The outcome depends on the paths that the advanced and underdeveloped countries choose to follow. For example, the gap between two countries gradually grows if the advanced country is following the present level growth path and the underdeveloped country is following the slowed down path. Xie (1994) interpreted the Lucas model as a dynamic equilibrium path and so showed the possibility of divergence and convergence in the inter-country growth gap. The Xie model includes the case of a gradual increase of inter-country divergence.

Xie's simulation of Country 1 with Country 2, where Country 1 is richer (Country 1 stands for the United States), shows that the equilibrium is subject to changes due to the length of learning in the two countries. This simulation shows that Country 1 can possess three kinds of equilibrium points, which means that the increasing gap may be the result of a different development path among advanced countries. Also, Country 2 can converge or more gaps can be seen around the equilibrium point of Country 1.

In addition to the prior conclusion that there might be increasing gaps between decelerating and accelerating societies, this small section showed there might be a gradually increasing gap among accelerating societies. Therefore, divergence, which means the increasing international gap within the accelerating industrial society, may be seen.

4.2.3 Divergence in the Technological Gap and Imitations

The technological gap approach explains economic growth through the positive correlation between the technological gap and economic growth. This approach is also used to examine the increase or decrease of the gap while identifying the technological gap with economic growth. On one hand, the innovation of advanced countries increases the technological gap between leader and follower countries; on the other hand, the imitation by developing countries is the main factor that decreases the technological gap between them. From this perspective, the inter-country economic gap is determined by the technological gap between countries. This situation looks similar to that of divergence discussed in this study.

Fagerberg (1987) proposed four hypotheses for the technological gap model: (1) There is a close relationship between a country's economic and technological levels of development; (2) the economic growth rate of a country is positively influenced by the growth rate in the technological level of the country; (3) it is possible for a frontier country facing a technological gap to increase its economic growth rate through imitation; (4) the rate at which a country exploits the possibilities offered by the technological gap depends on its ability to mobilize resources for transforming its social, institutional, and economic structures. To test these hypotheses, two models (based on supply-side and Keynesian) were estimated. The growth of GDP is estimated as a function of GDP per capita, growth rate of patent applications, gross fixed investment, and growth of world trade. The countries are classified into tree types: all, Organisation of Economic Co-operation and Development (OECD), and small and medium OECD countries. The full period of study, 1960–1983, is also divided into two sub-periods: 1960–1973 and 1974–1983. The Durbin-Watson test was used for verification, the results of which are presented in Table 4.4.

Table 4.4 The technology gap—test results

All countries, 1960–1983 (*N* = 99)	
GDP = 2.04−0.19 TG + 0.18 PAT + 0.13 INV,	R^2 = 0.61
(1.99)** (−3.90)* (7.79)* (3.21)*	SER = 1.56, DW(g) = 1.56
GDP = 0.29−0.19 TGa + 0.13 PATa + 0.14 INVa + 0.55 W,	R^2 = 0.75
(0.97) (−4.64)* (5.47)* (3.70)* (12.62)*	SER = 1.35, DW(g) = 1.56
OECD countries, 1960–1983 (*N* = 16)	
GDP = 1.02−0.14 TG + 0.18 PAT + 0.16 INV,	R^2 = 0.68
(1.03) (−2.46)* (6.62)* (4.07)*	SER = 1.21, DW(g) = 1.81
GDP = 0.51–0.13 TGa+0.09 PATa+0.16 INVa+0.51 W,	R^2 = 0.79
(2.20)** (–2.72)* (2.86)* (4.87)* (14.35)*	SER = 0.98, DW(g) = 2.36
Small and medium-sized OECD countries, 1960–1983 (*N* = 68)	
GDP = 0.44−0.17 TG + 0.16 PAT + 0.19 INV,	R^2 = 0.60
(0.38) (−2.74)* (5.26)* (3.82)*	SER = 1.22, DW(g) = 1.81
GDP = 0.46−0.14 TGa + 0.03 PATa + 0.15 INVa + 0.50 W,	R^2 = 0.78
(2.04)** (−3.04) (1.02)* (3.76)* (14.55)*	SER = 0.90, DW(g) = 2.26
All countries, 1960–1973 (*N* = 49)	
GDP = 3.02−0.32 TG + 0.10 PAT + 0.17 INV,	R^2 = 0.54
(2.26)** (−4.00)* (2.41)* (2.80)*	SER = 1.47
GDP = 5.78 -0.31 TGa + 0.13 PATa+0.14 INVa-0.09 W,	R^2 = 0.60
(2.10)** (−4.11)* (3.09)* (2.43)* (−0.30)	SER = 1.39
OECD countries, 1960–1973 (*N* = 38)	
GDP = 1.91−0.18 TG + 0.09 PAT + 0.17 INV,	R^2 = 0.50
(1.54) ***(−2.17) ** (2.06)** (3.16)*	SER = 1.10
GDP = 5.10−0.21 TGa + 0.12 PATa + 0.15 INVa−0.02 W,	R^2 = 0.59
(2.26)* (−2.62)* (2.95)* (2.91)* (−0.07)	SER = 1.02
Small and medium-sized OECD countries, 1960–1973 (*N* = 34)	
GDP = 4.01−0.14 TG + 0.02 PAT + 0.01 INV,	R^2 = 0.12
(2.72)* (−1.61)*** (0.46) (1.07)****	SER = 1.00
GDP = 3.01−0.18 TGa + 0.05 PATa + 0.08 INVa + 0.21 W,	R^2 = 0.26
(1.33)***(−2.13)**(1.16)****(1.25)**** (0.80)	SER = 0.94
All countries, 1974–1983 (*N* = 50)	
GDP = −1.82−0.10 TG + 0.12 PAT + 0.24 INV,	R^2 = 0.70
(−1.27)**** (−2.01)** (4.13)* (4.48)*	SER = 1.29
GDP = 0.32−0.11 Tga + 0.11 PATa + 0.22 INVa + 0.59 W,	R^2 = 0.75
(0.81) (−2.22)** (4.26)* (4.43)* (4.63)*	SER = 1.19
OECD countries, 1974–1983 (*N* = 38)	
GDP = −1.74−0.08 TG + 0.03 PAT + 0.21 INV,	R^2 = 0.51
(−1.51)*** (−1.43)*** (0.65) (5.01)*	SER = 0.91
GDP = 0.72−0.07 TGa + 0.03 PATa + 0.19 INVa + 0.43 W,	R^2 = 0.59
(2.35)** (−1.29)**** (0.62) (4.76)* (4.18)*	SER = 0.84
Small and medium-sized OECD countries, 1974–1983 (*N* = 34)	
GDP = −2.34−0.10TG + 0.03PAT + 0.24INV,	R^2 = 0.51
(−1.90)** (−1.72)** (0.71) (4.93)*	SER = 0.89
GDP = 0.64−0.09TGa + 0.02PATa + 0.21INVa + 0.44W,	R^2 = 0.58
(1.94)** (−1.60)*** (0.55) (4.44)* (4.07)*	SER = 0.84

Source: Fagerberg (1987), Table 4, p. 98

Note 1: Method of estimation = ordinary least squares; *, **, *** = significant at 1 %, 5 %, and 10 % levels respectively

Note 2: All one-tailed tests

Note 3: *SER* standard error of regression; *DW(g)* Durbin-Watson statistics adjusted for gaps

Fagerberg (1987) drew conclusions from the above verification method as follow: (1) the economic development level of one country (GDP per capita) is closely correlated with the country's technological development level (research and development or patent statistic) and (2) the technological gap model is explained when the combination of all industrial nations are used as a standard. However, due to increased expenses since 1973, imitation became less effective as a method to reduce the technological gap.

The above conclusions show that the technology gap explains the economic growth by technological development in an industrial society. The economic growth rate is dependent on technological development such as innovation and imitation. According to Fagerberg (1987), the advanced countries can promote the gap from the developing countries by innovation. And the developing countries can lessen the gap to the advanced countries by imitation. However, for the catch-up, they must be able to convert different social, systematic, and economic structures to effective resource. In addition, since 1973, innovation by imitation became less effective in reducing the technological gap, which means it has become harder to reduce the technological gap between the advanced and developing countries. The conditions under which the technology gap is increasing or maintained represent the country's divergence by level of technology.

In a similar context, Emeagwali (2007)[6] suggested that intellectual capital and technology should cause a gap between rich and poor countries. Particularly, he insisted that the natural resources (petroleum, gold, diamonds, etc.), which had been sources of wealth in the past would no longer be main factors for wealth. As representative examples, he referred to Japan, Korea, and Taiwan, which take precedent in terms of technology over oil-producing countries such as Saudi Arabia, Nigeria, and Venezuela.

4.2.4 Catch-Up Strategy and Economic Divergence

Unlike the empirical result previously reviewed, economic divergence with respect to institutional change could also be used as an argument that shows the relationship between the convergence hypothesis and divergence. Economic divergence is the counterargument of convergence.

A number of researchers investigated the issues of convergence of advanced and developing countries according to nation leading theory and its counterargument. Abramovitz (1994) explained the characteristics of developing countries in terms of "technological congruence" and "social capability." Technological congruence

[6] Philip Emeagwali (born in 1954) is a Nigerian-born computer scientist/geologist who was one of two winners of the 1989 Gordon Bell Prize, given from the IEEE (Institute of Electrical and Electronics Engineers), for the use of the Connection Machine Supercomputer, featuring over 65,000 parallel processors, to help analyze petroleum fields.

means the compatibility of the market size of advanced and developing countries and their factor supply. Social capability means the education needed by developing countries to catch up with advanced countries and various efforts (general education, technological capability level, financial management power, personal compensation regarding related commercials or banks, economic behaviors) to equip the development infrastructure. To achieve expanding social capability, government policy plays an important role. According to Abramovitz (1994), government takes the lead in industrialization (e.g., Germany and Japan after the Industrial Revolution as well as Korea and Taiwan after World War II). These developing countries in the late twentieth century achieved economic growth and reduced the economic gap with the advanced countries through government-leading industrialization.

However, the American economist, Williamson (1994), suggested that ideas such that government-leading policies could lead developing countries to catch up advanced countries were wrong. Williamson insisted that most East Asian countries could not catch up to the advanced countries. Williamson does not directly mention the divergence but does show the difficulty in generalizing the convergence phenomenon in empirical international cases. The limitations that Williams exposes suggest that developing countries taking a government-leading approach may not be able to close the economic gap between them and advanced nations.

4.2.5 Divergence Due to ICT Diffusion and Expansion of the International Growth Gap

Seo and Chung (2002) reported that the growth gaps among the advanced countries, especially between the United States and other advanced countries, have expanded since the 1990s. Their view is slightly different than those who espouse conditional convergence or learning by doing perspectives. While convergence among the advanced countries is acknowledged, Seo and Chung suggest that the advanced countries once perceived to part of the same club (i.e., they had succeeded in industrialization comparable to the United States) have started to show divergence among themselves.

In the study of Seo and Chung (2002), to prove the presence and to quantify the magnitude of the growth gap, the development of GDP per capita of several nations is compared. In the 1990s, the United States experienced an Internet technology (IT) boom that led to more rapid economic growth than other leading economies were experiencing. Figure 4.4 shows the trend of GDP per capita in the United States, OECD nations, and Japan between 1990 and 2001. It shows that the GDP per capita in the United States increased from US$23,200 to US$29,000 and that of both OECD nations and Japan increased from US$17,000 and US$18,600 respectively to US$21,000 in the same period. That is, in 1990, the gap of GDP per capita between the United States and the OECD nations and Japan was US$6,200 and US $4,600, respectively, and the gaps had both increased to US$8,000 by 2001.

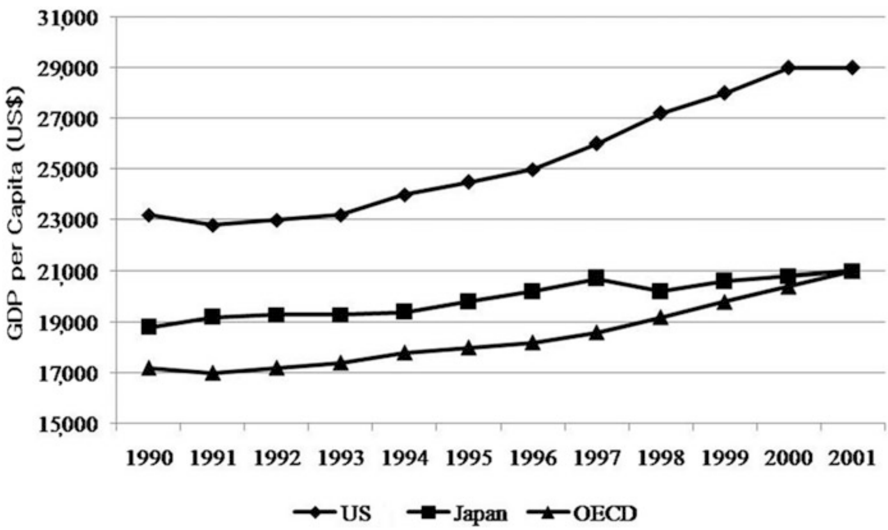

Fig. 4.4 Development of GDP per capita among groups of countries, 1990–2001 (Sources: Seo and Chung 2002, Fig. 1, p. 7. Data are from the Groningen growth and development centre Total Economy Database, University of Groningen, http://www.ggdc.net/). Note 1: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, the Netherlands, New Zealand, Norway, Switzerland, Sweden, and the United Kingdom were included in the OECD country category. Note 2: The currency (US$) is based on unchangeable standard in 1996)

Since the late 1970s or early 1980s, the growth gap between the United States and other countries has mostly increased; however, a few advanced countries succeeded in reducing the growth gap due to various development trends. As a result, the countries are now grouped differently and classified into new country groups. The new groups include the (1) growth-gap increasing group, (2) the convergence group, and (3) the catch-up developing country group. The grouping of countries is based on an index in which U.S. GDP per capita serves as a reference; it is computed as

1. $Index = \frac{1}{n}\sum_{t=1}^{n}\frac{x_{i,t}}{x_{usa,t}}$

where $x_{i,t}$ indicates the t phase of GDP per capita of country i, and n is the number of countries in the group. When the index comes to close to 1, convergence is taking place; that is, the growth gap is reduced. If the index is close to 0, the divergence tendency is seen; that is, the growth gap increases. The index results suggest the following grouping: (1) growth-gap increasing group (divergence) consists of Austria, Belgium, Canada, Denmark, France, Italy, Japan, the Netherlands, New Zealand, Sweden, Switzerland, and the United Kingdom; (2) the convergence group is comprised of Australia, Finland, Ireland, and Norway; (3) the catch-up developing countries are Greece, Korea, Portugal, and Spain.

The growth gap between the expanding (diverging) group and the United States includes many advanced countries such as the France, Japan, and the United Kingdom among others. To investigate the factors that cause the growth gap among advanced countries, the correlation between ICT investment intensity (ICT investment/GDP), the international gap of ICT divergence, and the growth gap is determined by regression analysis. The results are reported in Table 4.5.

The estimation results show that in model A, if OECD and EU nations increase (or decrease) the ICT-intensive investment gap with the United States by 1 %, the growth gap with the United States decreases (or increases) by 4.6 % and 4.3 % respectively. In model B the lag effect of ICT investment is shown, and if OECD and EU nations increase (decrease) the ICT-intensive investment gap with the United States by 1 %, the growth gap decreases (increases) by 5.1 % and 4.2 %. According to these presumptive results, there should be a positive correlation between the growth and information gaps in the 1990s. In other words, those countries that undertook ICT investment as rapidly as the United States could reduce the growth gap with the United States, while countries that could not undergo ICT investment could have experienced an increased growth gap with the United States.

For model F, in which outdoor effects are considered, the results show that if intensive investment of domestic ICT is increased by 1 %, then the growth gap with the United States decreases by 4.4 %. However, if other country members increase their ICT-intensive investment by 1 %, the growth gap with the United States decreases by 22 % due to network effects. Model E, which included ICT-intensive investment, was used to examine whether the inner ICT expansion promotes closing of the growth gap. It shows that if OECD and EU nations increase the ICT intensive investment of by 1 %, the growth gap with the United States decreases by 5.4 %.

In conclusion, advanced countries, which are considered as one group, also show the tendencies of convergence, divergence, and catch-up processes in their group inside. The development of the ICT field may play an important role in the catch-up process of the investor countries. However, as was seen from the examples and empirical data, 12 countries are located in the growth gap: 4 countries have enlarged the growth gap, 4 countries are in the convergence group, and the remaining 4 countries are classified in the catching-up group. That is to say, as a result, the expansion of a polarized growth gap is observed both empirically and in reality.

4.2.6 Summary of Reviewed Theories for Explaining Economic Divergence

Divergence is a dynamic phenomenon describing development of the output per capita or the gap in gross output between two countries over time. This phenomenon has not only an empirical explanation that can be illustrated with case presentations, but theories of it have been demonstrated in a variety of economic research studies. In this study, we have reviewed the viewpoints of researchers with

Table 4.5 Verification results of the relationship between information and communication technology-intensive investment and the growth gap

		Dependent variables	Explanatory variable							
		Growth Gap (G)	ICT Intensity Gap (GICT)		ICT Intensity (ICT)		ICT Externality Effect (EXT)			
Classification	Model	G	lag 0	lag1	lag 0	lag1	lag 0	lag1	R^2	Adj R^2
OECD	A		0.04526 (2.53)**						0.56	0.45
EU			0.043273 (2.35)**						0.60	0.50
OECD	B			0.05113 (3.15)**					0.58	0.47
EU				0.04198 (2.49)**					0.61	0.51
OECD	C		0.04564 (2.46)**				0.00317 (0.08)		0.56	0.45
EU			0.04012 (1.96)***				−0.1634 (−1.46)		0.55	0.42
OECD	D			0.03492 (2.22)**				−0.00075 (−0.02)	0.50	0.40
EU				0.06227 (3.22)*				0.27200 (3.71)***	0.66	0.57
OECD	E				0.05402 (3.05)**		−0.0329 (−0.090)		0.58	0.47
EU					0.05300 (2.65)*		−0.1602 (−1.48)		0.57	0.45
OECD	F					0.03844 (2.57)**		−0.03213 (−0.89)	0.51	0.41
EU						0.04472 (2.83)*		0.21991 (2.82)***	0.65	0.55

Source: Seo and Chung (2002), Table 1, p. 18

Note 1: Numbers in parentheses represent t-values of estimated coefficients

Note 2: *, **, *** represent statistically significance levels at 1 %, 5 %, and 10 % respectively

Note 3: The variables are defined as follows: yi : GDP per capita of country i, $G_i = \text{In}(y_i/y_{usa})$, $\dot{y}_i/y_i - \dot{y}_{usa}/y_{usa} = A_0 + A_1 GICT_i$, ICTi : ICT investment/GDP of country i $EXT_{i,t} = \text{In}\left\{\left(\sum investment^{ict} - investment^{ict}_{usa} - investment^{ict}_{i}\right)/\left(\sum GDP - GDP_{usa} - GDP_i\right)\right\}$

different perspectives on economic growth and its development between countries at different development levels and over time. We reviewed the perspectives on absolute and conditional convergence, endogenous economic growth, technological gap, and ICT diffusion theories.

A number of researchers reject absolute and conditional convergence hypotheses, which state that the economic levels of every country would converge on one single point. De Long (1988) and several others contradicted the absolute convergence hypothesis. Barro and Sala-i-Martin (1992), Mankiw et al. (1992), and others offered a conditional convergence hypothesis. In their view, convergence occurs among countries of similar economic development levels. This conditional convergence can be regarded as a presentation of a partial divergence phenomenon.

In regard to the endogenous economic growth theory, Lucas (1988) showed and explained divergence between country groups. Xie (1994) advanced Lucas's view further and showed that divergence may occur within a group of countries.

The technological gap approach and the catch-up strategy are among other theories found in the related literature. In this regard, Fagerberg (1987) and several others insisted that advanced countries can accelerate the divergence process by ceaseless technology development, which spreads the technology gap wider. Fagerberg and several others also verified that the developing countries, which need to imitate the advanced countries in the short-term to reduce the gap, have difficulties in imitating due to the lack of social capabilities. Subsequently, the divergence worsens. Williamson (1994) have also shown that developing countries have limitations for catch-up of advanced countries. Lastly, based on recent ICT development, Seo and Chung (2002) showed that diffusion of ICT induces divergence between countries and country groups.

4.3 The Inter-country Income Divergence Model

According to Solow's absolute convergence theory, the velocity of economic growth of each country converges in the long run. However, when considered technological development, in the economic growth model, economic growth gaps would emerge among countries. In previous section, it is proved by the various literature reviews. Such divergence between countries has been a widely spread phenomenon since the emergence of the industrial society era.

The decelerating agricultural society (Kim et al. 2009a) is growing over time but its development speed is decreasing. In the case of the pure agricultural society, which is not industrialized, very low technological innovation rates limit the shifts in the long-run production function. Therefore, output from agricultural society shows a decelerating Aggregate Production Function (APF) production expansion path, which represents economic development in the long run and the decelerating meta-production function. Due to its production structure, the decelerating agricultural society that has reached the growth limit, even the countries entering at an early stage, are forced to a growth standstill. So, eventually the economic development of a number of countries is converged to a similar level, but the time in which they reach that point differs.

In the accelerating industrial society (Kim and Kim 2009a) the development speed of the economy is growing in an accelerative form. Therefore, in the accelerating society structure, countries that entered early into the industrial society are in an advantageous position over latecomers. The following countries could not reach the level of former countries even if they had the same economic development speed, and the growth gap between them widens over time. Furthermore, developing countries have difficulty achieving the same economic development speed as developed countries because many of the developing countries are in a disadvantageous position when it comes to acquiring necessary development resources such as energy and access to markets for their goods.

The faster accelerating knowledge-based society has greater accelerating economic development speed than former industrial societies. In the knowledge-based society, which has faster technological improvement over time due to ICT development, the production function is characterized by increasing returns. The degree of shift of APF gets bigger, and the shift also gets faster. Therefore, output according to time in the knowledge-based society, that is, economic growth in the long run, appears to be an accelerative form with much steeper slope than the output of the societies that preceded it.

The much deeper divergence between the advantaged and disadvantaged countries is shown in the faster accelerating-society structure. Moreover, the gap between the two groups of countries in the industrial society continues to be seen in the faster accelerating knowledge-based society. The gap width gets bigger because countries that entered the industrial society at an early stage of their development are also more likely to enter early into the faster accelerating society.

In this study, three models are provided that together explain the process of divergence among countries through both decelerating and accelerating societies. We offer these examples to illustrate empirical cases.

4.3.1 Income Divergence Between Accelerating and Decelerating Societies

The discussion of inter-country income divergence is investigated with respect to different societies and the systematic differences linked to their development levels. In Fig. 4.5, the economic development path by time in an accelerating country is described as line A, while the economic development path by time in a decelerating country is described by line C. The figure shows that the gap between accelerating and decelerating countries is increased over time (t1 → t2 → t3). Also the gap between t2 → t3 shows exponential growth that exceeds that of t1 → t2.

In Table 4.6 we report a comparison of the GDP per capita for both rich and poor country groups in three time periods: 1820, 1900, and 1992. The table shows that

Fig. 4.5 Income divergence model between accelerating and decelerating countries

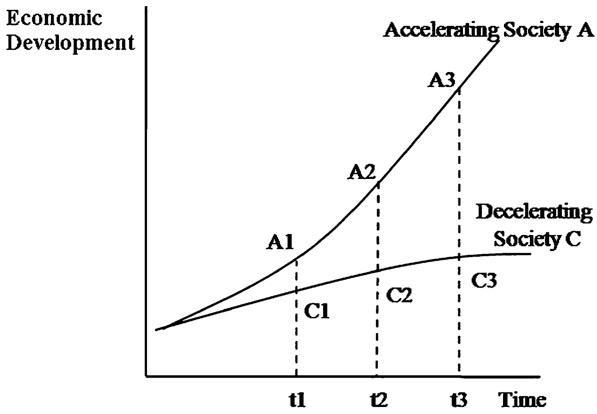

Table 4.6 Comparison of gross domestic product per capita between rich and poor countries

Classification	1820	1900	1992
Rich countries	United Kingdom 1,756	United Kingdom 4,593	United States 21,558
	Netherlands 1,561	New Zealand 4,320	Switzerland 21,036
	Australia 1,528	Australia 4,299	Japan 19,425
	Austria 1,296	United States 4,096	Germany 19,361
	Belgium 1,291	Belgium 3,652	Denmark 18,293
Poor countries	Indonesia 614	Myanmar 647	Myanmar 720
	India 531	India 625	Bangladesh 720
	Bangladesh 531	Bangladesh 581	Tanzania 601
	Pakistan 531	Egypt 509	Congo 353
	China 523	Ghana 462	Ethiopia 300

Source: UNDP (1999), p. 38

since the appearance of the industrial society, the income gap between rich and poor countries has been gradually increased even into the knowledge-based society[7] (United Nations Development Programme 1999).

The period required for the income gap to double is gradually shortened (UNDP 1999). In Table 4.7, the rich/poor income ratio is reported at six time points from 1820 to 1997. Although the groups of countries being compared differ, the ratio increases from 3:1 in 1820 to 14:1 in 1913, and from 30:1 in 1960 to 74:1 in 1997. The fast increasing ratio is indicating a widening inter-country income divergence or economic growth pattern.

Also according to Huntington and Harrison (2000), the economic gap between Western Europe and the poorest countries in the world was approximately threefold in 1820, which increased to 20-fold in 1990. He showed the increasing income gap

[7] Knowledge-based society, which is also called “the information society,” “the new economy,” and “the digital society,” was first introduced by Machlup (1962). In this society, the creation, distribution, diffusion, use, and manipulation of information is important to economic growth.

Table 4.7 Comparison of rich and poor country incomes

Year	1820	1870	1913	1960	1990	1997
Rich/poor ratio	3:1	7:1	14:1	30:1	60:1	74:1

Source: UNDP (1999), p. 3

Note: Ratios of year 1820, 1870 and 1913 are obtained from comparing income of upper 50 % countries and lower 50 % countries. Ratios of year 1960, 1990 and 1997 are from upper 20 % and lower 20 %

between rich and poor at the global level. Two groups of unweighted rich and poor countries are shown.

The average GDP per capita of the 20 poorest countries increased by 26.4 % from US$212 in 1960 to US$268 in 2000 (Oh 2005; United Nations Economics and Social Council 2005). However, in the same period, the 20 advanced countries increased their average GDP per capita from US$11,417 in 1960 to US$32,339 in 2000. Therefore, the difference in GDP per capita between the two country groups was remarkably increased from 53.85-fold in 1960 to 120.67-fold in 2000.

The United Nations Conference on Trade and Development (UNCTAD) conducted a simulation of trade and development. Based on the results, it produced a report in 1996 (UNCTAD 1996).[8] Developing countries show a gradually decreasing income level that causes an imbalance in development between advanced and developing countries. Table 4.8 shows that although developing countries are likely to expand their exports, real wages or per capita income is decreased.

Assuming that the population or employment is increased by 20 % in the developing countries,[9] labor-intensive exports by developing countries are increased. This in turn increases export amounts in developing countries as well as reduces manufacturers' employment in advanced countries. This outcome is based on Ricardo's comparative theory. While income level per capita of the advanced countries is increased, that of the developing countries is decreased so the income gap between advanced and developing countries grows.

Recent data indicate that the income gap between rich and poor countries persists and increases. The gaps between advanced countries and developing countries in 2 years are reported in Table 4.9.

[8] The model is used to simulate the effects of increased exports of labor-intensive manufactured goods by the South on the terms of trade and incomes. It is assumed that North and South are completely specialized in the skill- and labor- intensive manufacturing sectors respectively, so that Southern exporters do not compete with the Northern producers, and wages are fully flexible in the North and full employment always prevails. The simulations are carried out by increasing the size (population and employment) of the South by 20 % compared to the baseline while keeping the size of the North unchanged. This is equivalent to increasing the supply of labor-intensive exports faster than demand. For more details, see the Trade and Development Report (1995) Annex 1 to part Three.

[9] This figure is based on a 20 % increase in population and employment.

Table 4.8 Trade and income effects of labor-intensive exports by the South

Advanced countries (North)		Developing countries (South)	
Real wage (unskilled)	8.1	Real wage (unskilled)	−2.9
Real wage (skilled)	7.2	Real wage (skilled)	−8.9
Export volume (good 1)	−31.5	Export volume (good 2)	86.7
Per capita income	4.2	Per capita income	−7.8
Manufacturing employment	−6.9	Terms of trade	−63.2

Source: UNCTAD (1996), Table 41, p. 152

Table 4.9 The changes of gross national income per capita of each country group

Group	2002(US$)	2003(US$)	Changes (%)
Low income country group	430	440	2.3 increase
High income country group	26,490	28,600	7.9 increase
Average	5,120	5,510	7.6 increase

Source: The Bank of Korea (2005), Table 2, p. 3

Table 4.9 shows the gross national income (GNI) of the high-income country group compared with the low-income country group in 2002 and 2003 as well as the GNI per capita changes of each country group in 2003 (with 2002 as a base). In the case of the low-income country group, the GNI increased by 2.3 % from US$430 in 2002 to US$440 in 2003. However, in the high-income country group, it increased by 7.9 % from US$26,490 to US$28,600. Also it shows that the income gap between the advanced countries and developing countries increased from 62-fold in 2002 to 65-fold in 2003.

4.3.2 Income Divergence Among Accelerating Societies

The discussion of inter-country income divergence is investigated here but the focus is on divergence among accelerating societies. In Fig. 4.6, the economic development path by time in advanced industrial societies is described as A, while the economic development path by time in developing industrial societies is described as B. For comparison, the development path for a decelerating society is shown as the dashed line C. The figure shows that the gap between advanced and developing industrial societies is increased by time (t1 → t2 → t3). Also the gap between the last two time periods, t2 → t3, is exponentially increased and is greater than that of the first two time periods, t1 → t2.

A number of factors cause economic divergence between advanced and developing countries. These include, among others, differences in acceleration of economic development, of differences in securing capital and technology, the technology gap, discrepancies in securing raw materials and energy, and the differences in production, sales, and securing markets among the two groups of countries.

The decelerating income for an agricultural society (dashed line) is diverging from those of the initial industrial society (solid lower line) and the sold-growth

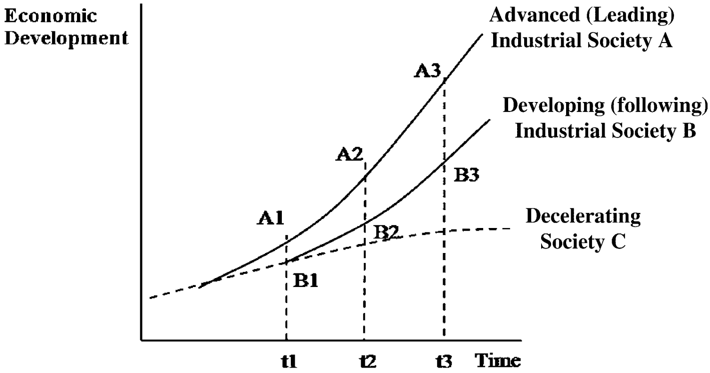

Fig. 4.6 Income divergence model among accelerating societies

industrial society (solid upper line). It illustrates the pattern of divergence of income among the different societies and their diverging economic growth. The pattern is further explained in Fig. 4.7 by the APF production expansion path.

Figure 4.7 shows the APF production expansion paths of the advanced industrial society and the developing industrial society. As the technological level of each society grows, growth function shifts from APF1 to APF2, APF3, APF4, and movement width of APF is assumed to increase according to the accelerating society theory. It is also assumed that the developing industrial society is catching up the technological level of the advanced industrial society. In this case, k1, k2, k3, and k4 represent the input level of each society and each society production (q1, -), (q2, q2'), (q3, q3'), (q4, q4') of output level, respectively.

When comparing the input levels of k2, k3, and k4, one can see that the gap is continuously increasing from (q2-q2') < (q3-q3') < (q4-q4'). Likewise, it is verified that the advanced industrial society and the developing industrial society are polarized according to technological level gap even when they have the same input level. The divergence of two societies according to time could be clearly defined if one assumes that each input level k2, k3, and k4 is attributed to time t1, t2, and t3 respectively.

In Table 4.10, the development of income, measured as GDP per capita in six points of time between 1820 and 1990, is reported for samples of West European, Asian, and African countries. The divergence among advanced industrial societies (10 West European countries), developing industrial societies (6 Asian countries), and decelerating societies (57 African countries) according to the GDP per capita trend shows evidence of significant gap and heterogeneous development patterns among the different societies and over time.

The trend in income gap among and between the different societies is shown in Fig. 4.8. When drawing the GDP per capita trend of each country group, one sees that the gap according to time is increasing.

The divergence phenomenon of the industrial society for the period from 1820 to 1913, based on data that show the production and consumption of coal in advanced

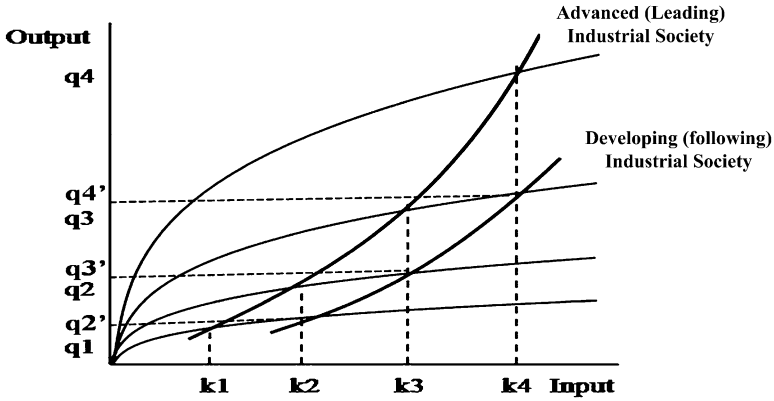

Fig. 4.7 Income divergence model among accelerating societies

Table 4.10 GDP per capita according to country group (1990 international dollars)

	1820	1870	1913	1950	1973	1990
10 Western European countries	1,322.2	2,156.9	3,762.6	5,747.2	12,988.3	17,585.7
6 Asian countries	–	–	887.7	1,153.3	3,037.0	7,326.2
57 African countries	418.0	444.0	585.0	852.0	1,365.0	1,385.0

Source: Maddison (2001)

Note: The 10 Western European countries are Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Sweden, Switzerland, and United Kingdom. The 6 Asian countries are India, Malaysia, Singapore, South Korea, Taiwan, and Thailand

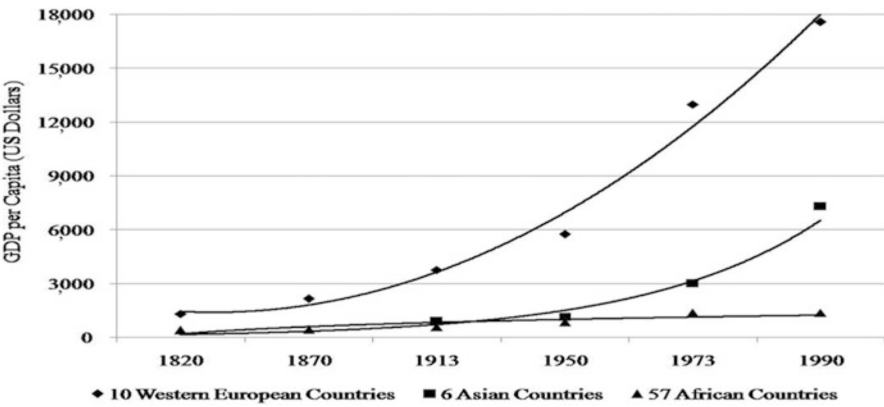

Fig. 4.8 GDP per capita trend of each country group; the line is fitting curve (1990 USA dollars standard)

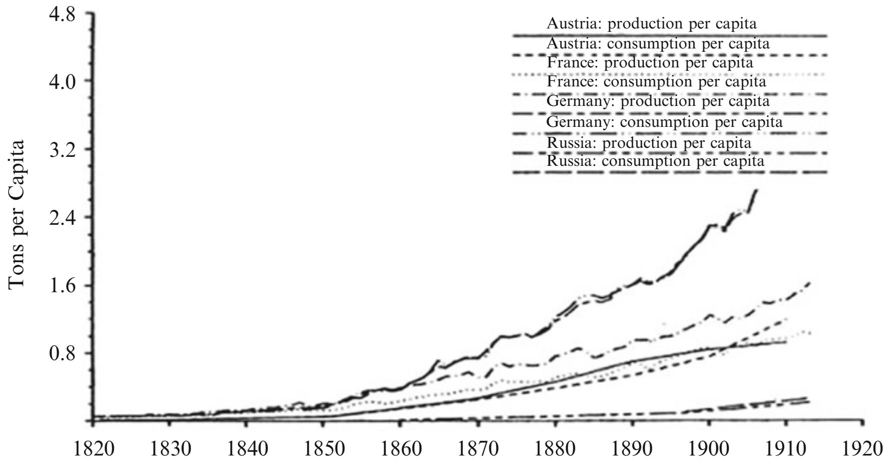

Fig. 4.9 Production and consumption of coal, 1820–1913 (Sources: Cameron (1985), Fig. 2, p. 12. Belgium statistics are from L'Annuaire Statistique de la Belgique, i87i and I9I4, France statistics are from Annuaire Statistique de la France, i965, Germany statistics are from Walter G. Hoffman and Das Wachstum der deutschen Wirtschaft seit der mitte des i9. Jahrhunderts (New York, i96i), United Kingdom statistics are from B. R. Mitchell and Phyllis Deane and Abstract of British Historical Statistics (Cambridge, i962))

European industrial countries, is reported in Fig. 4.9. During the industrial era, coal was an indicator of economic development because it was a major necessity for industrial development.

The divergence phenomenon between the advanced and developing countries, based on the GDP trend of three advanced countries (Germany, Japan, and the United States) and two developing countries (Argentina and the Republic of Korea), is reported in Fig. 4.10. A focus on the data prior to 1990, the period when all five countries can be considered industrial economies, shows evidence of a clear pattern of income divergence. In our opinion, the data subsequent to 1990 involve disparate development of knowledge-based industries and societies.

The UNCTAD report introduced 20 items from the top-ranked dynamic market products with annual average export-growth values over 8.4 %, which is the average of world exports (UNCTAD 2004). Among these 20 selected products, over 50 % are from developing countries and consist of only three items: silk (6th, 87 %), knitted undergarments (7th, 57 %), and knitted fabrics (18th, 54 %), while all other 17 items originated from the advanced countries. (See the Table 4.11.)

High added value or expensive exports are of great advantage in terms of amount of exports and purchasing power. Between 1980 and 2003, the export-amount index increased by 10.1 % and purchasing power increased by 8.7 % annually in the developing countries. However, for those developing countries that had the core of high added-value manufacturers, the export-amount index increased by 13.7 % and the purchasing power increased by 13.5 % annually. This suggests that the advanced countries, which mainly export high added-value products, have an advantage over developing countries in trade relations (see Table 4.12).

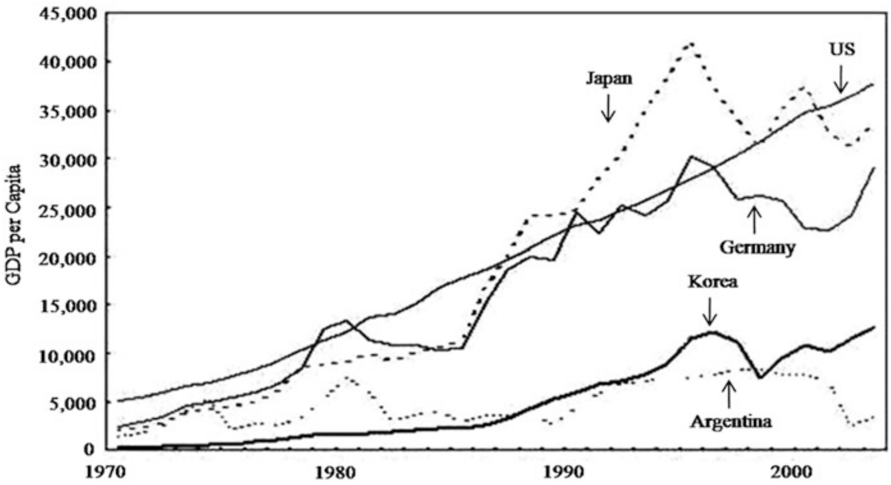

Fig. 4.10 Trend of GDP per capita of sample countries (US$) (Source: International Monetary Fund 2007)

Figure 4.11 shows another model of divergence that the income divergence between countries could increase much more when intervention occurs. As shown in Fig. 4.11, the degree of divergence process when it is assumed that, without intervention, a developing industrial society could accomplish economic development under the same conditions as an advanced industrial society. However, as divergence progresses, overlapping economic activity between the two countries increases as a result of efforts to secure raw material and energy, market competition, and so forth. Both countries try to export their products in the same market and try to import raw materials from the same sources. As the trade relationships among countries expand globally, the countries compete for limited sources. Under such circumstances, countries that have developed a high level of technology and have differentiated their products from rival products from other countries can achieve fast economic growth. Advanced industrial societies, which are likely to have higher technology levels, have an advantage over developing industrial societies.

The developing industrial society could have been positively influenced by advanced industrial societies as their economic activities overlapped. In our opinion, developing industrial societies are at a disadvantage due to their low levels of capital accumulation and technological capacity and are therefore unable to compete effectively with advanced industrial societies. Furthermore, when advanced industrial societies feel threatened by expanding economic activity of developing industrial societies, they protect their domestic market with policies that may result in trade wars.[10]

[10] The United States adopted Section 301 in 1974. With this procedure, U.S. companies can claim foreign that some trade barriers create a unfair trade disadvantage for them.

Table 4.11 Shares of main exporters and of developing economies in world exports of the most market-dynamic products, 1980 (%)

Rank	SITC code	Product group	Share of developing countries	Main exporting countries (Share)	
1	*776*	Transistors and semiconductors	46	United States (17)	Republic of Korea (10)
				Japan(15)	Malaysia (7)
				Singapore (10)	
2	*752*	Computers	36	United States (13)	Japan (10)
				Singapore (13)	Netherlands (9)
3	*759*	Parts of computers and office machines	38	United States (17)	Taiwan Province of China (7)
				Japan (14)	Malaysia (6)
				Singapore (9)	
4	*871*	Optical instruments	30	Japan(22)	Germany (10)
				United States (17)	China (5)
				Republic of Korea (12)	Hong Kong (China) (5)
5	*553*	Perfumery and cosmetics	10	France (28)	United Kingdom (12)
				United States (12)	Germany (11)
6	*261*	Silk	87	China (70)	India (3)
				Germany (9)	
7	*846*	Knitted undergarments	57	China (16)	Italy (6)
				United States (8)	Mexico (5)
				Turkey (6)	
8	*893*	Plastic articles	23	United States (14)	China (7)
				Germany(13)	Italy (7)
9	*771*	Electric power machinery	37	United States (11)	China (9)
				Germany (10)	Japan(9)
10	*898*	Musical instruments and records	18	United States (20)	Germany (8)
				Japan (12)	United Kingdom (7)
				Ireland (12)	
11	*612*	Leather manufactures	45	Italy (16)	United States (7)
				Taiwan Province of China (11)	India (6)
				China (7)	Republic of Korea (6)
12	*111*	Non-alcoholic beverages	22	France (19)	Belgium/ Luxembourg (7)
				Canada (7)	China (7)
				United States (7)	
13	*872*	Medical instruments	12	United States (27)	Japan(6)
				Germany (12)	Ireland (6)
				United Kingdom (7)	
14	*773*	Electricity distribution equipment	34	Mexico (16)	Japan(6)
				United States (14)	France (4)
				Germany (9)	

(continued)

Table 4.11 (continued)

Rank	SITC code	Product group	Share of developing countries	Main exporting countries (Share)	
15	*764*	Telecommunications equipment, and parts	24	United States (15)	Japan(9)
				United Kingdom (9)	Sweden (7)
16	*844*	Textile undergarments	4	United States (30)	Germany (9)
				United Kingdom (23)	Canada (5)
				France (11)	
17	*048*	Cereal preparations	14	Italy (11)	France (10)
				Germany (10)	United Kingdom (8)
18	*655*	Knitted fabrics	54	Taiwan Province of China (20)	Italy (8)
				Republic of Korea (16)	China (8)
				Germany (8)	
19	*541*	Pharmaceutical products	8	Germany (15)	United Kingdom (10)
				Switzerland (11)	United States (10)
20	*778*	Electrical machinery	23	Japan (17)	United Kingdom (7)
				United States (13)	Mexico (6)
				Germany (13)	

Source: UNCTAD (2002), p. 57

Table 4.12 Export volume, purchasing power of exports, and terms of trade in developing countries, 1980–2003 (average annual percentage change)

Section	1980–2003	1980–1985	1986–1990	1991–1995	1996–2003
All developing countries					
Volume indices of exports	10.1	2.1	16.6	14.7	5.3
Terms of trade	–1.3	–3.9	–0.7	0.3	0.5
Purchasing power of exports	8.7	–2.2	15.9	15.2	5.9
Major exporters of manufactured goods					
Volume indices of exports	13.7	10.3	21.1	18.6	7.3
Ter terms of trade	–0.2	–1.5	0.6	0.5	–1.2
Purchasing power of exports	13.5	9.8	22.0	19.3	6.1

Source: UNCTAD (2004), p. 54

Figure 4.11 shows that the intervention of advanced industrial societies in trade relations has affected the shift in the economic development path from B to B'. In other words, the gap between line A and B is increasing as the slope of B decreases.

The speed of development in industrial society B is getting slower and is gradually approaching that of decelerating society C. Figure 4.11 shows that the

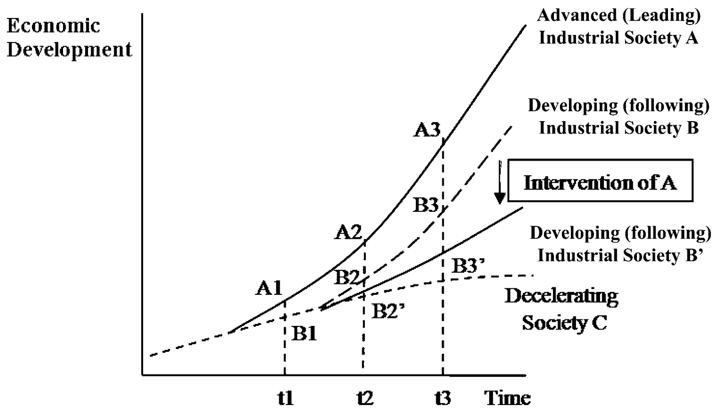

Fig. 4.11 Model of accelerating societies

developing industrial society is becoming the raw material supplier as well as a commodity market place for the sale of goods from advanced countries. Quoting Prebisch (1950), Nurkse (1953), and Kuznets (1980), Climoli and Correa (2004) stated that trade liberalization could be harmful to the growth of less developed countries that have domestic markets and endogenous technological capabilities that are not sufficiently developed.

4.3.3 Income Divergence Among Faster Accelerating Knowledge-Based Societies

The analysis of inter-country income divergence is investigated with respect to different societies and the systematic differences linked to their levels of development. We analyze the income divergence among the faster accelerating knowledge-based societies. The development in the form of income divergence is shown in Fig. 4.12.

In the faster accelerating knowledge-based society, the increased divergence could further the gap among nations over time. As the path of economic development in an advanced industrial society leads to a knowledge-based society, the path accelerates, A1 → A2 → A3' → A4', and in the case of the developing industrial society, the path changes from B1 → B2 → B3 → B4 to B1 → B2 → B3 → B4' (Fig. 4.12).

As time elapses, the faster advanced industrial society starts to become the knowledge-based society. As in an industrial society, in a knowledge based society, the gap between lines A and B gets bigger as time elapses:

A2-B2 < A3'-B3

A3'-B3 < A4'-B4'

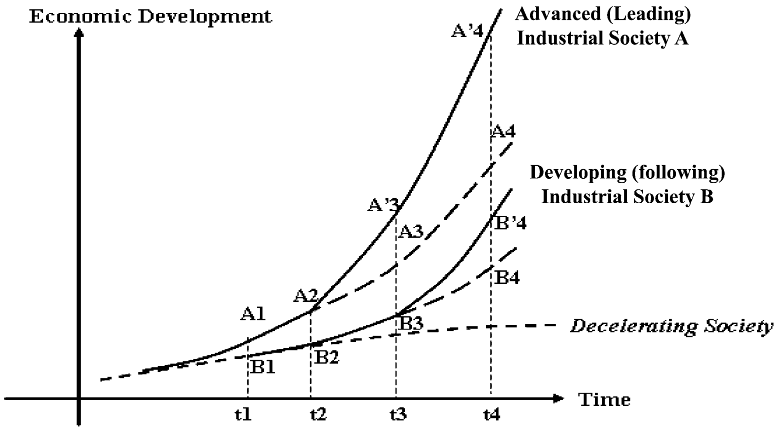

Fig. 4.12 The effect of competition on income divergence of the accelerating knowledge-based society

Moreover, a much bigger gap appears than the ones seen in the previous industrial society.

A3-B3 < < A3'-B3

A4-B4 < < A4'-B4'

4.4 Conclusion

There are a number of factors that cause economic divergence between advanced and developing countries. Causal factors include differences in acceleration of economic development, differences in securing capital and technology, the technology gap, discrepancies in securing raw materials and energy, as well as differences in production, sales, and securing markets among the two groups of countries.

Divergence appears because the industrial society is accelerating such that output is increased geometrically over time. Through the previous discussion and models, we have seen that developing countries, even those characterized by industrialized accelerating societies, cannot catch up to advanced countries because the growth gap between them is increasing. In this regard, we hardly need to mention the case of decelerating developing countries and accelerating advanced countries.

Differences in securing capital and technology between advanced and developing countries play an important role in divergence. Developed countries formed commercial capital through mercantilism and transformed it to industrial capital by securing technologies. They have accumulated enormous capital and technology by expansive reproduction. Developing countries have belatedly attempted technology development and have generated policies aimed at importing or imitating advanced countries' technology. The capital of developing countries has been accumulated too late to allow them to reach the levels of fast economic acceleration experienced by advanced societies.

According to the capital and technology gaps, developing countries have slower speeds of expansive reproduction than advanced countries enjoy. These gaps induce increasingly large disparities in economic output between accelerating industrial societies and those struggling to catch up.

Discrepancies in securing raw materials and energy between advanced countries and developing countries affect the economic-development growth gap. Advanced countries such as the United Kingdom faced the Industrial Revolution with infrastructures for industrialization in place and they procured raw materials and energy from colonies. Late-starting advanced countries such as Germany supplemented their shortages through government-leading industrial policies and technology development (Zweynert 2006). Output increases according to expansive reproduction accompany geometrical demand increases for raw materials and energy. Hence latecomer developing countries have disadvantages in securing raw materials and energy while advanced countries already have massive capital and vested interests.

Difference in securing markets between advanced countries and latecomer developing countries also affects divergence. Historically, developing countries have been disadvantaged because they depended on domestic demand or needed to enter advanced countries' markets whereas advanced countries had secured worldwide markets such as colonies. Today, developing countries also face disadvantages because they must try to expand their small domestic markets to compete in the world market where advanced countries have placed their products.

Production and sales guide expansive reproduction in industrial societies. However, latecomer developing countries have difficulties in securing production factors and access to overseas markets. Even those that overcome these disadvantageous and sustain expansive reproduction under the same conditions as advanced countries see the economic gap grow between themselves and leading countries as the latter experience accelerating development speed.

In conclusion, we contend that divergence exists between advanced and developing countries, and it has significant impact on the development of countries that belatedly enter the accelerating society. To overcome divergence, the latecomers need to adopt different development theories and policies than those of advanced countries.

If convergence theory were adequate, then late-starting developing countries could approach the economic level of advanced countries over time by following policies and development processes of advanced countries. In the polarizing industrial society, however, late-starting developing countries cannot narrow the gap by using the same economic growth strategies of advanced countries.

To catch up with advanced countries, a well-organized alternative development theory of late-starting developing countries needs to be established. This should be done by in-depth discussions and research of accelerating society's economic phenomena. We will leave this development prospect for further research.

Appendix 1 UK & USA Versus Germany & Japan Case

A1.1 Comparing the LN and the FN

The pattern of the economic growth of England and USA, the Leading Nations (LN), will be compared with Japan and Germany, the Following Nations (FN). The period under examination will be partitioned as there had been many considerable events which radically changed the international and economic circumstances during the long period of the episode. Each of the three partitioned phases reflects the circumstances it's under. That is, the Burgeoning Period consists of the period from the first industrial revolution in England to the beginning of the First World War. While the Chaotic Period consists of the two world wars, the Mature Period consists of the economically thriving period after the war. For each period, the pattern of economic growth for respective nations will be compared.

The Fig. 4.13 demonstrates the change in GDP over time, and will be used to empirically analyze whether the aforementioned features of accelerating society and the divergence between societies are valid.

Figure 4.13 shows the GDP per capita of the LNs and the FNs from 1820s to 1980s.[11] As discussed in the above sections, the economic developments of the LN and the FNs have been broken down into three periods—the burgeoning, the chaotic, and the mature. The analysis on the development trends in each period are provided in the rest of the section.

England and USA were the first to enter the industrial era following the LN type of industrialization. Being the first nation to succeed in the Industrial Revolution, England was able to transform into industrialized society and attain fast economic growth. Although USA lagged behind in terms of the period, USA was classified as the LN due to its spontaneity[12] rather than the competition that Germany and Japan had faced during the industrialization process. These nations, classified as the FNs, were under competition against the LNs. Although they had entered the accelerating society through industrialization, Germany and Japan were never able to attain the same level of GDP per capita as the LNs. This is a typical example of the divergence between the LNs and FNs where both blocs have entered the accelerating industrial society.

The vast efforts by the FNs to gain on the LNs during the chaotic period are shortly followed by sharp economic conflict, leading to the War. The intense focus on the munitions industry in order to prevail in the war leads to rapid increase in GDP in rather short period. Although the subsequent two wars ended in the Alliance's victory, the defeated nations were able to retain its accelerating economic growth pattern in the long run perspective. Although many of their production plants were

[11] Each nation's GDP graph provided henceforth are simple average of the international Geary-Khamis dollars. Data has been extracted from Angus Maddison (2006).

[12] Refer to "the Burgenoning period: industrialization and globalization of the market" from this chapter.

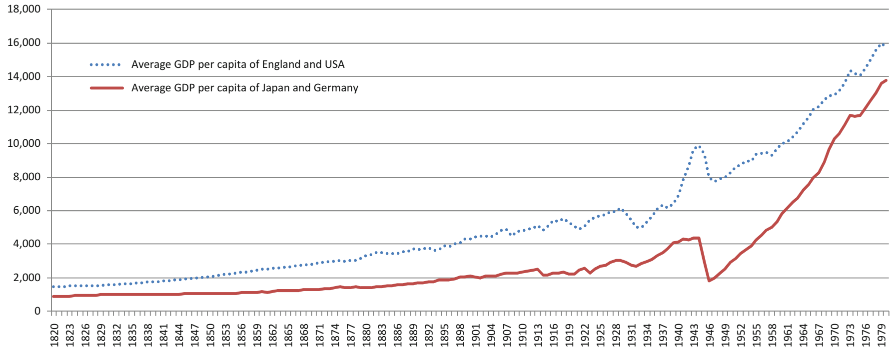

Fig. 4.13 Comparison of GDP per capita between England/USA and Japan/Germany

destroyed and the GDP decrease after the wars were greater, the Axis powers were able to vie with the LNs after the wars and join the advanced nations based on their military and industrial technologies that had been cumulated throughout the wars.

The accelerating industrial society can be observed in the mature period. The increasing economic growth rate of the LNs is sustained and the FNs have joined the advanced nations by reaping the existing advanced technologies. However these FNs display more rapid increase in the economic growth rate; this accounts for the recovered economy that had been destroyed during the war. In this period, a simple comparison of the economic growths among England, US, Germany, and Japan may be misleading as they display seemingly converging growth. But the actual mechanism underneath this phenomenon is that Germany and Japan had already become one of the advanced nation through the technology accumulation and are showing similar accelerating economic growth.

So far we have examined the economic growth pattern of the FNs and the LNs through GDP data of each nations. In this graph, we have confirmed the divergence between the FNs and the LNs in the accelerating economic growth. From now on, we will provide a more detailed explanation and clear reasoning on the divergence for the divergence. In particular, empirical evidence following social phenomenon and industrial policy of each nations will be used to establish policies to overtake the gap between the LNs and the second generation LNs.

A1.2 The Burgeoning Period: Industrialization and the Globalization of the Markets

A1.2.1 The Industrialization of England and USA

It is by no chance any coincidence that England became the first industrialized state. The mercantile city states such as Venice or Genova of Italia have accumulated its

Table 4.13 England's actual increase in the production and factors of economic growth (annual growth, %) (Crafts 1985)

Year	Agricultural production	Industrial production	Total domestic production
1700–1760	0.6	0.7	0.7
1760–1780	0.1	1.5	0.7
1780–1801	0.8	2.1	1.3
1801–1831	1.2	3.0	2.0

Period	Capital	Labor	Total domestic production	The productivity of total factors
1700–1760	0.7	0.3	0.7	0.3
1760–1800	1.0	0.8	1.0	0.2
1801–1831	1.5	1.4	2.0	0.7
1831–1860	2.0	1.4	2.5	1

wealth during the agricultural era by securing commercial trade routes of the Mediterranean Sea, the once the center of the trade. However, the center of the trade has shifted from the Mediterranean Sea to the Atlantic Ocean, and the Dutch succeeded in leading the Atlantic Ocean trade, becoming one of the most well-known marine commercial states.

At the time, England had been fairly engaged in commerce through overseas trade based on its geological advantage. England had already defeated the Spanish Invincible Armada by the time the center of the trade shifted to the Atlantic Ocean, challenging the trade dominance of the Dutch. England was able to evolve into a genuine commercial state through the English Revolution (or the Glorious Revolution) and the naturalization of the Huguenot. By the end of the Anglo-the Dutch Wars (1652–1674), England was able to replace the Dutch as the trade dominant state, securing vast overseas trade routes and colonies.

The commercial state of the two nations had different characteristic. While the Dutch had established an expansive reproduction system through simple intermediate trade on peppers and spices, England had established an expansive reproduction system based on its domestic production on the wool. The importance of this difference lies in that England was able to transform the commercial society into industrial society by means of expansive reinvestment on manufacturing of the wool, thus enabling manufacturing based expansive reproduction system. In addition, gentry who had secured state power through English Parliament had promoted national policies that advocate commercial benefits. Such policies in turn enlarged and facilitated expansive reinvestment. In summary, coupled with accumulated capital and rich resources, the development of expansive reproduction system based on manufacturing had instigated the Industrial Revolution, transforming the decelerating agriculture society into the accelerating industrial society.

Table 4.13 show the actual increase in production principal index of England in 1700–1860. The data confirms that the slow and gradual growth had lasted for over 100 years. Despite the slow growth rate in the initial stage of England's Industrial Revolution, it clearly shows the acceleration in the growth.

Table 4.14 The composition of trade in England (%) (Crafts 1985)

	Export			Import		
Year	Manufactured goods	Raw material	Food	Manufactured goods	Raw material	Food
1700	80.8	8.2	11.0	28.4	45.0	26.6
1750	75.4	16.8	7.8	14.4	54.5	31.1
1801	88.1	5.0	6.9	4.9	56.2	38.6
1831	91.1	5.5	3.4	2.2	70.4	27.4
1851	81.1	13.3	5.6	4.9	58.2	36.9

Table 4.15 Change in the economic structure of Europe and England (%) (Crafts 1985)

	Male labor				Income			
	Manufacturing		Farming and mining		Manufacturing		Farming and mining	
Year	England	European average	England	European average	England	European average	England	European average
1700	18.5	12.6	61.2	72.0	20.0	19.3	37.4	51.4
1760	23.8	16.9	52.8	66.2	20.0	21.3	37.5	46.6
1800	29.5	18.6	40.8	64.0	19.8	22.0	36.1	44.8
1840	47.3	25.3	28.6	54.9	31.5	25.2	24.9	37.2

The data in Table 4.14 shows the composition of trade in England. The data displays the typical industrial society characteristics where food and raw materials are imported and manufactured goods are exported. And such pattern is observed to grow more evident, implying that England had successfully industrialized.

The Table 4.15 shows the course of reformation in economic structure of England and Europe. The male labor is observed to be holding a increasingly greater proportion in England than in European average, while lesser in the agriculture. Also, larger proportion of income from manufacturing in Europe and lesser in agriculture and mining can be confirmed. It can be elicited that the economic structure of England has changed due to the industrialization.

Table 4.16 shows the distribution of England's full time labor in each of the industries. There is a sharp increase in the mining and manufacturing while decrease in agriculture and fisheries. Since the total size of the labor is increasing, the absolute increase in the number of labors working in mining and manufacturing must be larger than the given distribution in the table.

As for USA, the young nation had freed its capital from the influence of England's capital since the independence in 1776. This change may be thought of as the first step necessary to begin its own industrialization and depart from the colonial market that had consumed the finished goods while providing raw materials. Since the independence, agriculture was the main industry in the South, while the manufacturing in the North. The emancipation of slaves following the end of the Civil War allowed black slaves in the farms of the South to flow into factories in the North. This was one of the key momentums that had turned USA

Table 4.16 The change in the size, distribution, and the participation rate of the full time labor in England (%) (N. C. Tranter, The Labor Supply 1780–1860, In R. Floud and D. McCloskey (Eds.), The Economic History of Britain since 1700, Vol. 1, 1700–1860. Cambridge University Press, pp. 204–226 (recitation : Looking back on England's Industrial Revolution, Kim, 2006))

		Distribution of the labor (%)				
Year	Size of the labor (in millions)	Agricultural and fisheries	Mining and manufacturing	Commerce and transports	House work	Public services and others
1780	4.0	–	–	–	–	–
1801	4.8	35.9	29.7	11.1	11.5	11.8
1811	5.5	33.0	30.2	11.6	11.8	13.3
1821	6.2	28.4	38.4	12.1	12.7	8.5
1831	7.2	24.6	40.8	12.4	12.6	9.5
1841	8.4	22.2	40.5	14.2	14.5	8.5
1851	9.7	21.7	42.9	15.8	13.0	6.7

Table 4.17 The percentage of added value by each industry in USA (%) (U.S. Department of Commerce, Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1957, Government Printing Office, 1960)

Year	Agriculture	Mining	Manufacturing	Construction
1839	72	1	17	10
1849	60	1	30	10
1859	56	1	32	11
1869	53	2	33	12
1879	49	3	37	11

into industrial nation. Since then, USA began to grow into a literally industrial nation, in particular, an independent one. Through internal colonialization of the enormous Northern America, the Northeastern part of USA that had begun industrialization could keep up the positive feedback in the expansive reproduction system. The high transporting cost arising from geological accounts and the high tariff rates from the protective trade policies all contributed to the substitution of the imported goods to the domestically manufactured goods, establishing the basis for industrial technologies to accumulate. In short, USA has developed a comparatively spontaneous and unaffected LN type of industrialization through its enormous continent.

The above Table 4.17 shows the percentage of added value by each of the industries from 1839 to 1879. Before the Civil War in 1839, the percentage of the value added by agriculture was 72 % while only 17 % was added by the manufacturing industry. However the percentage by the agriculture decreased to 49 % while the percentage increased up to 37 % in manufacturing industry by 1879. That is, the portion of the total added value by the manufacturing industry had doubled during the 30 years.

Table 4.18 Increase in the labor forces and output (%, figures from 1910 based on 1860) (Walton and Rockoff 1990, pp. 374–375)

Increase in labor forces		Increase in output	
Farming	2.0	Food production	3.7
Cotton spinning	3.0	Textile goods	6.2
Construction	3.7		
Education	5.2		
Manufacturing in total	5.4	Manufacturing in total	10.8
Commerce	6.0		
Mining	6.7	Black coal	46.1
Steel industry	7.1	Steel manufactures	25.2
		Cement	70.7
Railroad	23.2	Length of transportation (passenger)	17.1
		Length of transportation (freight)	98.1

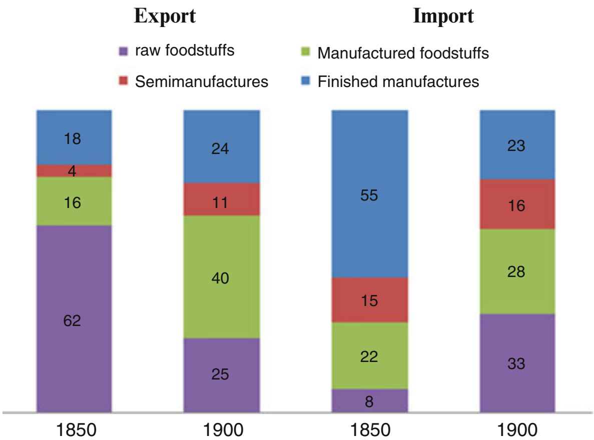

Fig. 4.14 The composition of USA trade in 1850 and 1900 (%) (Walton and Rockoff 1998)

The above Table 4.18 compares the percentage of the manufactured goods output for each unit of labor in 1860 and 1910. All items increased by nearly twice, indicating that the industrialization resulted in increasing the efficiency of manufacture industries.

The Fig. 4.14 shows the composition of USA import and export trade in 1850 and 1900. From the export composition, increase in the proportion of manufactured goods can be observed in 1900 in contrast to the large proportion of raw materials in the early periods. In the import composition, the finished manufacturers that have occupied nearly half of the total import has decreased to the quarter of the total import by 1914. All these changes reflect that the trade structures have reformed to the industrialized LN structure (Table 4.19).

The above table is the proportion of labor forces and national income in each of the industries. The labor forces in the agricultural industries have decreased approximately 15 % over 60 years while the portion in the national income has decreased by 10 %. On the other hand, the labor forces in the mining and manufacturing have increased by around 7 % but the proportion in the national

Table 4.19 Distribution of income and labor forces in each of the industries (%) (Gallman and Howle 1971)

Period	Labor force			National income		
	Farming	Manufacturing and mining	Others (third industries)	Farming	Manufacturing and mining	Others (third industries)
1839–1859	56.9	14.1	29	25.8	14	60.2
1869–1879	51.9	20.7	27.4	21.6	17.5	60.9
1889–1899	41.5	21.8	36.7	15.2	24.7	60.1

income has increased by about 50 %. This reflects the change of value addition in USA to a more highly complex industrial structure.

So far we have examined the process of USA industrialization with principal economic indicators. We have confirmed that the industrialization began spontaneously and uninfluenced by others under the fulfillment of several prerequisite conditions. Therefore the industrialization in USA can be classified as an LN type.

A1.2.2 Industrialization of Germany and Japan

Germany was practically 200 years behind England and 150 behind France in terms of economic development as the putting-out-system (Verlag) of hand made goods were prevalent in the early nineteenth century. However, Germany has managed to industrialize by focusing on consumer products in 1830, and then on capital goods industries such as steel industries, electronics industries, mechanical industries, and chemical engineering industries from 1850s. Compared to the economic growth during the industrial revolution of England, Germany displayed impressive growth during the initial phase as a FN. The initial growth of England could only be slow due to the market driven industrialization, a property commonly held among LNs. However, Germany could catch up effectively through government driven development, as most of the FNs do. Subsequently, Germany attains astonishing growth from 1890 to 1914, before the First World War.[13]

The Table 4.20 shows the average annual economic growth from 1850 to 1913, which can also be referred to as Germany's Industrialization Period. This is a result of the astonishing growth rate that Germany had displayed during the industrialization.

Figure 4.15 shows the annual output from each industry during Germany's Industrialization Period. Growth can be observed in all industries—in particular, the second industries shows that the output has increased by nearly 1,000 % during the 60 years. Such data elicits that Germany's manufacturing industries have attained astonishing development.

[13] Bowen (1950).

Table 4.20 1850–1913 average annual economic growth of Germany (%) (Mathias and Postan 1978)

Period	Net product	Net product per capita	Industrial employment
1850–1874	2.5	1.7	1.6
1875–1891	1.9	1.0	2.3
1892–1913	3.2	1.7	2.1

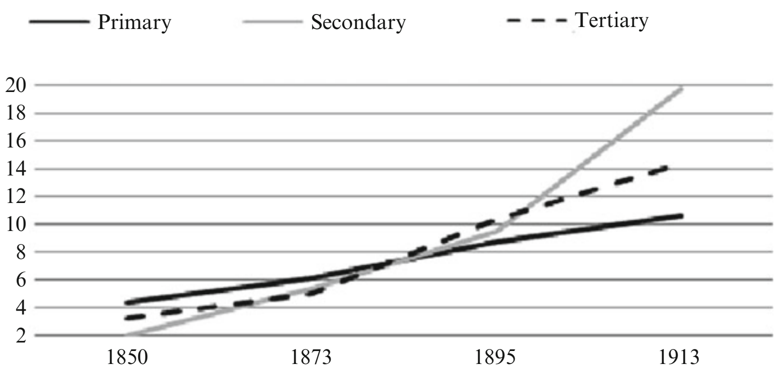

Fig. 4.15 The output of each industries in Germany (in 100 million Marks) (Frank and Tipton 2003, p. 140)

The data in Table 4.21 displays the distribution of German male in the industries. Although the total labor forces constantly increased, the proportion of German male engaged in farming and fisheries decreased constantly. However, in industries that are essential to the development of industrialization, such as mining, manufacturing, and construction industries, the working population is constantly increasing. Based on the structure of employment, Germany is seen to be switching over to industrialized society.

The threshold for Japanese industrialization is Meiji Restoration. With the increasing conflict between social classes and the pressure from the Western Powers, Meiji Restoration sprung with the expulsion of the Japanese feudal government by the antiestablishment. Afterwards, Japan had started to reform itself into a modern nation through interaction with the foreign nations and the adoption of the Western science and technologies.

Table 4.22 displays the change in the total domestic output and the percentage contributed by each industry. The total domestic production has increased by nearly twice in 35 years, with the agriculture's production decreasing by 12 % while the manufacturing industries increasing by over 8 %.

Tables 4.23 and 4.24 show the proportion of import and export for each item from 1874 to 1811 in Japan. In 1870, Japan had mainly imported manufactured goods and exported raw materials. However, since the beginning of the twentieth century, a change can be seen—the shift to the import of the raw material and export of the

Table 4.21 The distribution of German male occupation from 1882 to 1907 (in thousands) (Mitchell 1980)

Year	Farming and fisheries	Mining	Manufacturing	Construction	Commerce	Transportation and communication	Services	Others	Total
1882	5,702	569	3,721	940	678	423	1,173	168	13,374
1895	5,540	789	4,565	1,340	930	598	1,596	150	15,508
1907	5,284	1,197	5,959	1,887	1,251	983	1,907	114	18,582

Table 4.22 Change in Japanese economic structure (Francks 1999, p. 39)

Year	Total domestic production	Output proportion	
		Agriculture	Manufacturing
1885	3,774	42.1	7.0
1890	4,639	39.8	7.9
1895	5,375	37.0	8.9
1900	5,966	34.7	11.2
1905	6,214	31.6	12.6
1910	7,424	30.9	15.6

Table 4.23 The proportion of import by item (import and export rated by the average 10 year market price, %) (Ohkawa et al. 1979)

	Import							
	First industries				Second industries			
Period	Food	Fuel	Others	Total	Fabrics	Light industries	Heavy industries	Total
1874–1883	0.7	5.0	3.1	8.8	54.0	17.8	19.4	91.2
1877–1886	0.8	6.1	3.4	10.3	49.6	18.7	21.4	89.7
1882–1891	5.0	6.4	7.3	18.7	37.4	17.4	26.5	81.3
1887–1896	7.1	5.0	16.1	28.3	28.2	14.6	29.0	71.8
1892–1901	9.9	4.4	22.1	36.4	16.8	14.2	32.6	63.6
1897–1906	13.8	4.7	24.6	43.2	11.8	12.3	32.8	56.9
1902–1911	12.5	4.0	28.8	45.2	9.6	10.8	34.4	54.8

Table 4.24 The proportion of export by item (import and export rated by the average 10 year market price, %) (Ohkawa et al. 1979)

	Export				
	First industries	Second industries			
Period	Total	Fabrics	Light industries	Heavy industries	Total
1874–1883	42.5	42.4	6.9	8.2	57.5
1877–1886	39.5	43.0	7.8	9.7	60.5
1882–1891	33.0	45.6	9.0	12.4	67.0
1887–1896	26.3	48.9	11.3	13.5	73.7
1892–1901	21.0	52.6	13.2	13.2	79.0
1897–1906	16.6	53.6	15.9	13.9	83.4
1902–1911	14.1	53.8	17.2	14.9	85.9

Table 4.25 Capital for each industries in Japan (in 1,000 yen) (Japan Statistical Association 1998)

Year	Agriculture	Manufacturing	Others	Total	Percentage of manufacturing (%)
1885	1,450	7,771	41,439	50,660	15.3
1890	8,230	77,530	139,717	225,477	34.4
1895	1,522	58,729	113,796	174,047	33.7
1900	2,750	176,550	599,951	779,251	22.7
1905	3,773	235,041	737,023	975,837	24.1
1910	17,746	655,983	807,672	1,481,401	44.3

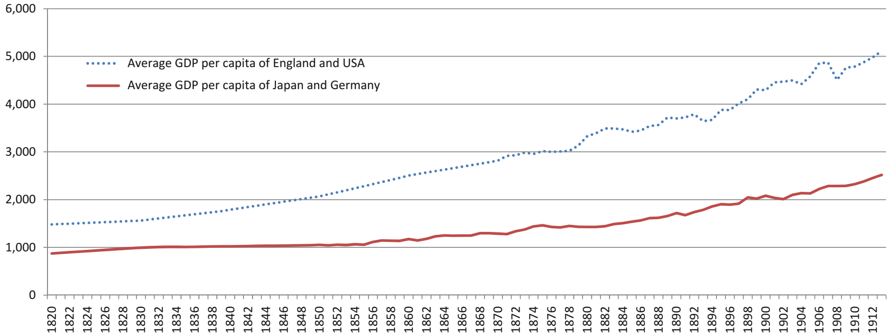

Fig. 4.16 Comparison of GDP per capita between England/USA and Japan/Germany—burgeoning

manufactured goods. In particular, the amount of imported wool fell rapidly, implying that Japan had reached the stage where domestic production of the item sufficed.

Table 4.25 shows the composition of capital in each industry in Japan. As the total capital increases, so do the capital of all industries. However, a rapid increase in the proportion of manufacturing can be observed—from 15.3 % in 1885 to 44.3 % in 1910. Due to the industrialization, the weight on domestic manufacturing increased gradually.

Up until now, we have examined the success of Japanese and German industrialization through principal economic index. However, given the clear difference from the USA or England's industrialization, we would like to refer to the process as a FN type industrialization. That is, a FN type industrialization is an industrialization revolution process that is stimulated by the success of LN's industrialization and led by government's aggressive policies in a rather short period without sufficiently satisfying the prerequisites.

The Fig. 4.16 represents the average GDP per capita of USA-England and Japan-Germany. It can be seen that both the LNs and the FNs have entered accelerating society with stable growth, although FNs were a little behind the FNs in its entry time to the accelerating society. The gap between the two groups is enlarging despite the fact that they have both entered the accelerating society due to the difference in the economic and market power. The graph shows a typical example of the divergence between FN and LN.

A1.3 The Second Period: The Chaotic Period

A1.3.1 Conflict Between the FNs and the LNs

As previously examined, England was the first to go through Industrial Revolution and hence led the industrial society. With its world top class technological and industrial competency, England promoted free trade. By importing raw materials and expanding overseas export markets, England enabled its product to spread out to a greater extent than ever. The once-protective nation as evidenced by its Navigation Act, England's aggressive promotion on free trade policies has enabled it to exploit the fruits of industrialization, contributing much to development of its economy and industries. USA, as well, adopts protectionism in the early stage of industrialization, but after securing sufficient industrial competency, it promotes free trade.

On the other hand, Japan and Germany attempted to establish expanded productive system by through protecting its infant industries and internalizing modern industrial technologies. To complement its competency against the LNs, the FN governments have provided subsidy and encouraged the formation of large conglomerates and capitals, as well as obtaining the insufficient production factors. Subsequently conflicts between the LNs and the FNs vying for larger markets and raw materials led to the outbreak of the First World War.

In 1929, the world witnessed the Great Depression following the First World War. The economic recess that resulted as the repercussion from the Great Depression impeded the economic growth of the FNs. In order to overcome this difficulty, the two FNs—Japan and Germany—initiated military expansion as a means to reinforce its military force while expanding domestic industrial demand. The military expansion driven by nationwide ideological movements, militarism and Nazism, enabled enlargement of domestic demand, protection of the export markets, and attainment of the production factors that were necessary for sustainable growth. Such attainments of the production factors from overseas markets were included in the expansionist policies.

Military conflicts and arms races followed consequently from the military expansionism between the FNs and the LNs, leading to the outburst of the Second World War.

Table 4.26 The increase in GDP per capita and GDP per labor unit (annual average growth, %) (Feinstein et al. 1997)

	GDP per capita		GDP per labor unit	
	1890–1913	1913–1929	1890–1913	1913–1929
England	0.9	0.3	1.0	1.5
US	2.0	1.7	2.2	2.4
Germany	1.8	0.8	1.9	1.4
Japan	1.4	2.4	1.7	3.5

Table 4.27 England's domestic production and expenditures during the wars (real domestic production in 1939 has been set to 100) (Harrison 1988)

		Percent of national income (%)	
Year	Net domestic production	(1)	(2)
1938	100	7	2
1939	103	16	8
1940	120	48	31
1941	127	55	41
1942	128	54	43
1943	131	57	47

A1.3.2 The Effect of War and Conflict on the Economy

The conflict between the two blocs led to the War, which in turn influenced the economies of each nation. In this section, economic indices of the FNs and the LNs will be examined to see how the war had affected the economy.

The Table 4.26 shows the increase in the GDP per capita and productivity (GDP per labor unit) from 1890 to 1929. No disparity between the two indices can be found before the First World War. However, since the First World War, the change in productivity increases at a faster rate than the GDP per capita. This is because the labor input by individuals decreased while the output has increased by greater ratio. As a matter of fact, the labor hour per week in most of the nations has decreased from 54 to 48 h. This reflects the accumulation of capital since the First World War. At the same time, this is an affirmation that they knew knowledge has been applied to production and improvements in the education have been made that contributed to the build-up of the human capital.

Table 4.27 shows the ratio of net domestic production and expenditure of governmental finances and resources during the Second World War. Domestic production has increased steadily with the threshold of the war, and the expenditure ratio on the war section has taken roughly up to half of the national income after 1940. Therefore, England has grown in terms of production during the Second World War, and cause being can be thought of as the concentration of investment and resources on the war.

Table 4.28 Economic indices of USA during and after the war (One billion dollar) (Economic Report of the President, Washington, DC: US Government Printing Office, 1969)

Year	GNP	Private expenditure	Gross domestic private investment	Federal government expenditure		Consumer's price index (1957–1959 basis)	Unemployment rate (%)
				Military expenditure	Others		
1940	99.7	70.8	13.1	2.2	3.8	48.8	14.6
1941	124.5	80.6	17.9	13.8	3.1	51.3	9.9
1942	157.9	88.5	9.8	49.4	2.5	56.8	4.7
1943	191.6	99.3	5.7	79.7	1.4	60.6	1.9
1944	210.1	108.3	7.1	87.4	1.6	61.6	1.2
1945	211.9	119.7	10.6	73.5	0.7	62.7	1.9
1946	208.5	143.4	30.6	14.7	2.5	68.0	3.9
1947	231.3	160.7	34.0	9.1	3.5	77.8	3.9
1948	257.6	173.6	46.0	10.7	5.8	83.8	3.8
1949	256.5	176.8	35.7	13.3	6.8	83.0	5.9

Table 4.29 Germany's expenditure breakdown and national income (One million Mark, current price) (Overy 1982)

Year	Military expenditure	State expenditure	National income
1938–1939	17.2	39.4	98
1939–1940	38	58	109
1940–1941	55.9	80	120
1941–1942	72.3	100.5	125
1942–1943	86.9	124	134
1943–1944	99.4	130	130

Table 4.28 displays some of the principal economic indices during and after war, five years each. A comparison of 1940 with 1945 shows that, the gross national product has increased by 200 % while expenditure increased only by 50 %. On the other hand, while domestic private investment has decreased by 50 %, military expenditure has increased by 3,600 %. Also, consumer's price has increased by 45 % and the unemployment rate decreased. This is due to the unemployment rate of 15 % from the Great Depression since 1929 that facilitated mobilization of the labors. Also, the output had doubled by operating the idle facilities which were half of the existing facilities. All these achievements were possible only through the participation in the war. Following the end of the war, private invest increased and military expenditure decreased greatly.

Table 4.29 shows the expenditure and national income of Germany during the Second World War. Comparatively constant increase is observed annually in the military expenditure, and the rate of increase is greater than the total expenditure.

Table 4.30 shows the proportion of each industry's in the total industry during the Second World War. We can observe that Germany has focused on the military industry, with the industry taking up to 40 % of the total industry size in 1994. It can

Table 4.30 The portion of each industry in Germany (%) (Harrison 1998)

Year	Basic industries	Armaments	Construction	Investment goods	Consumption goods
1938	21	7	25	16	31
1939	21	9	23	18	29
1940	22	16	15	18	29
1941	25	16	13	18	28
1942	25	22	9	19	25
1943	24	31	6	16	23
1944	21	40	6	11	22

Table 4.31 Expenditure by Japanese Government (%) (Pauer 1999)

Year	National defense	Allocation on the local government	Resource development	Industry	Education and culture	Welfare	Liability	Others	Total
1930	28.6	0.1	5.9	15.7	9.0	1.1	17.7	21.9	100
1935	46.3	0.0	5.8	2.4	6.8	1.4	17.6	19.7	100
1940	50.3	5.2	3.1	9.0	3.5	1.6	15.5	11.8	100
1960	7.8	19.1	16.9	9.4	12.1	13.3	1.5	19.9	100

Table 4.32 Annual Japanese military supply index (setting 1941 as 100) (U.S.S.B.S, Military Supplies Division, Japanese War Production Industries, Washington, DC, 1946)

	Aircraft	Military armament	Naval armament	Commercial fleet	Warship	Motor vehicle
1941	100	100	100	100	100	100
1942	171	133	151	135	110	62
1943	341	167	286	351	145	45
1944	465	221	512	414	207	39
1945	338	143	242	111	120	16

be seen from the above two tables that Germany has focused on the war and concentrated its investments on the military industries.

Table 4.31 shows the composition of expenditure by the central Japanese government from 1930 to 1960. Just before its involvement in the World War II, its expenditure on national defense took nearly half of the whole expense in 1940. Such expenditures indicate that Japan had been devoted in preparation for war.

Table 4.32 shows the military supply index during the Second World War. Increases in the indices of aircraft or armaments are observed while civilian goods such as motor vehicles have decreased. This also suggests that Japan had been committed to war rather than civilian industries. The decrease of the production index in 1945 is thought to be caused by the destruction of many production facilities and the recess in consumption and production following defeat.

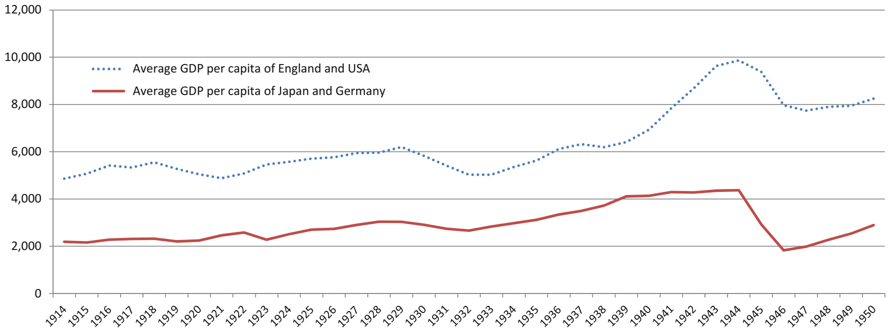

Fig. 4.17 Comparison of GDP per capita between England/USA and Japan/Germany—chaotic

Thus far we have examined the economic circumstances during the wars and the Great Depression, from 1914 to 1950. The Fig. 4.17 displays relatively irregular economic growth pattern. The great depression caused recession all over the world for nearly 4 years. The economic growth from 1940 to 1945 is mainly owed to the special circumstances, namely, the War. Also, the abrupt crash after 1945 reflects the bubble in the economic growth caused by the War. Relatively Germany and Japan fell more rapidly than USA and England. The disparity arises from the result of the war, but in addition, it can also be thought of as a special form of divergence between FN and the LNs. It is undeniable that the LNs with more accumulated capital and technology are advantageous over the FNs in the modern warfare as the warfare itself requires the mobilization of tanks and aircraft.

A1.4 The Mature Period: Postwar Prosperity: The Prosperity of the Victorious Nations

Victorious USA and England retained its accelerating growth after the war. In particular, USA was able to establish dominance in the international relations and politics through the Paris Peace Conference and the San Francisco Conference. It should be noted that through Marshall Plan and economical assistance to the developing nations, USA was able to establish a new order, shifting the center of the world economy from Europe to EU.

Table 4.33 shows the proportion of each nation's postwar industrial production and export. After the war ended in 1947, USA occupied over half of the total world production up to 53.4 % production level, and the export has increased from 13 % in 1938 to 22 % in 1948. The implication is that USA has grown to fit the term "PAX Americana[14]" with its vast influence over the world economics.

[14] The term is used to indicate the circumstances in which the world order is retained by US.

Table 4.33 Postwar economic index of nations (proportion in the world economy, %) (Lee 2004, p. 161. The industrial production is converted to 1948 US current price, and the export is FOB price converted to US dollars)

	Industrial Production				Export			
	1938	1948	1953	1958	1938	1948	1953	1958
US	36.3	53.4	51.5	43.7	13.0	21.9	18.9	16.4
England	13.8	11.4	10.4	10.2	10.3	11.5	9.0	8.8
Germany	11.5	3.7	7.4	9.8	–	1.4	5.7	8.5
Japan	3.6	0.9	2.1	3.4	4.7	0.5	1.5	2.7

Table 4.34 The expenditure by the government of the England and the real output amount (One million pound, 1938 base year for the real output) (Mills and Rockoff 1993)

Year	Government income	Government expenditure	Loss	Real output amount
1938	958	1,110	152	5,177
1939	1,065	1,538	473	5,348
1940	1,471	3,378	1,097	6,150
1941	2,238	4,637	2,399	6,502
1942	2,714	5,228	2,514	6,548
1943	3,215	5,729	2,514	6,661
1944	3,393	5,878	2,483	6,326
1945	3,337	5,194	1,857	5,880
1946	3,236	3,669	433	5,830

In contrast to the shift in the center to USA, England displays relatively slow economic growth. Because the wars were staged in Europe, it was inevitable for the England to focus on exhaustive wars rather than technological and industrial development, suffering greater aftereffect than the USA. Kindleberger (1964)[15] mentioned the limited technological capacity, loss of assets and increase in liability during the war, distribution trouble, and conflicts between classes as the cause of the slow recovery of England, with the loss of leadership through the war being the primary reason.

Table 4.34 displays the governmental income and expenditure, and the real output amount in England. It must not have been easy to compensate the cumulated loss even after the war. In addition, decrease in the real output amount can be observed after 1944. This reflects England's reliance on American supply in order to dedicate all its forces onto the battles against Germany. The gap between England and FNs has narrowed additionally as the defeated nations recovered faster than the victorious nations, a phenomenon explained as the Phoenix Factor.[16]

[15] Kindleberger (1964).

[16] Organski and Jacek (1977).

Table 4.35 Growth of GDP, factor inputs, total factor productivity from 1950 to 1973 (annual %)

	England	Germany	Japan
GDP[a]	2.42	5.02	8.06
Factor inputs[b]	1.75	2.27	3.70
Total factor productivity	1.27	3.50	5.58

[a]Craft and Toniolo 1996
[b]Chen 1977

Although England was the first to attain accelerating economic growth, it hands its Super Power position to USA after the Second World War. However, the GDP growth rate per capita from 1950 to 1973 reaches nearly 2.5 %, a figure higher than that during the industrial revolution. England still firmly holds its position as the leading nation today and is capable of influencing world economy through its financial industry.

A1.4.1 The Defeated Nations: Through the Economic Recovery and Leaping Ahead

The aftermath of the war left defeated Germany and Japan with heavy compensation duty and destroyed production facilities. Both limped in social and economic chaos with its GDP per capital dropping to late nineteenth century level. But it should be noted that both technology and engineers had been acquired from military industry during the war. With such potentials and the threat of the spread of Communism combined, it was compelling for the Western powers to economically support the once enemy states, Germany and Japan, through Marshall plan and others. The defeated nations managed to develop into economically advanced nation with cutting edge industry technology, and its GDPs nearing England and USA by the end of twentieth century.

Table 4.35 compares the growth rate of GDP, factor inputs, and total factor productivity between England, Japan, and Germany. The GDP growth rate of Germany and Japan are over 200 % and 300 % of England's growth rate, respectively. In 1950, the growth rate of factor inputs reached nearly 400 % of that of 1913, while the growth rate of total factor productivity increased by nearly 1,200 %. Such growth is quite impressive as England was able to increase by 200 % and 300 % respectively during the same period. The growth rate of Japanese is even higher. Although the two nations were defeated, they were able to achieve such miraculous economic developments based on the technological capacity that was accumulated during the war.

It has been pointed out that the Korean War in 1950 provided the basis for economic development to Japan in particular (Hamada and Kasuya (1993),[17] Tsuru (1993),[18] Kindleberger (1996)[19]). However, our focus is on the technology that had

[17] Hamada and Munehisa (1993).
[18] Tsuru (1993).
[19] Kindleberger (1996).

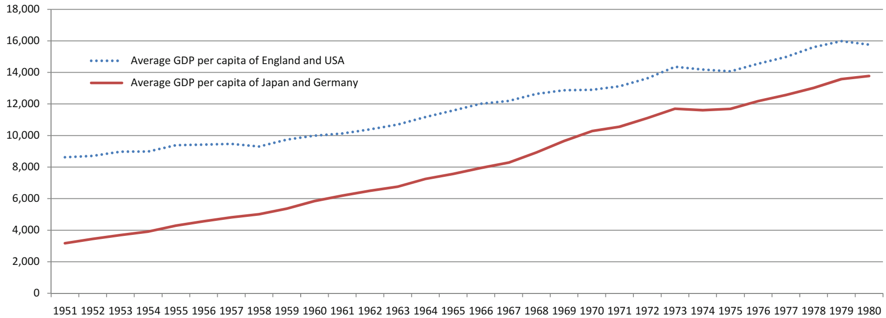

Fig. 4.18 Comparison of GDP per capita between England/USA and Japan/Germany—mature

been accumulated through the Second World War. Because of this technology, USA had no other option than to use Japan as the supply base for the Korean War.

As discussed above, the economic development of the defeated nations were in fact faster than USA and England. It would be misleading to regard this rapid development as an evidence for the convergence between the FNs and the LNs, when in fact it is a process of economic recovery to its normal level by nations that have already accumulated high level of technology.

Thus far we have examined the pattern of economic growth of the first generation FNs and LNs. They all display accelerating economic growth up until 1970s (see Fig. 4.18). The recovery effect from the repercussions of the war and its original economic growth is combined to produce rapid growth. This is often misinterpreted as the convergence between the FNs and the LNs, but it fails to take the accumulated technology into account. This is evidently shown through the equal relationship shown between the civil sectors of the German and American companies after the war. Also, the high productivity shown by Japanese companies even after adopting technologies from USA is another sufficient evidence.[20]

A1.5 Closing

In this chapter we have cross-examined the growth pattern of England and US, the LNs, with Germany and Japan, the FNs, for each period. Despite the rapid change in the circumstances, the acceleration of the economic growth along with the divergence between the FNs and the LNs were confirmed. We were able to identify and explain the causes of the seemingly converging economies during the Mature

[20] Tessa Morris-Suzuki (1994).

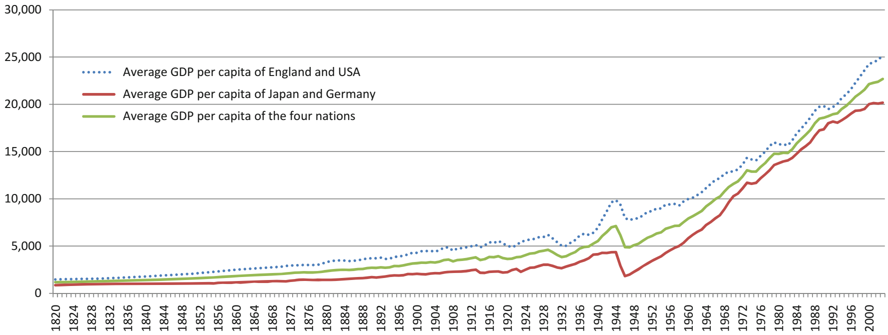

Fig. 4.19 Comparison of GDP per capita between England/USA, Japan/Germany and all four nations

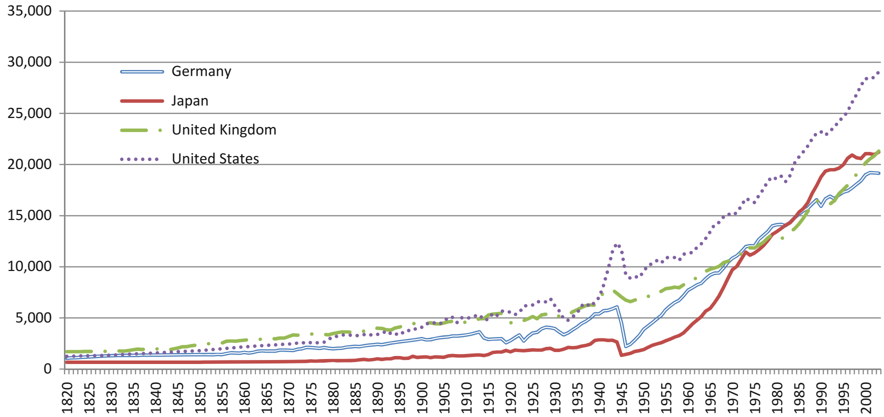

Fig. 4.20 GDP per capita of four nations

Period of the economic development. Most of all, we have confirmed all these facts through empirical data.

Figure 4.19 shows the average GDP per capita of LNs and FNs each, along with the average of GDP per capita of all four nations. We can summarize the above discussion through Fig. 4.20.

– The economic divergence between the two blocs is easily observed up until 1930s during the burgeoning period. In England and US, spontaneous industrial revolution stemmed from rich resources and favorable conditions, giving a head start over other nations. The gap between the FNs and the LNs enlarged despite various efforts by Germany and Japan to catch up with the LNs.
– During the chaotic period, economic growth show unstable pattern due to the economic crisis and wars resulting from the conflict between the LNs and the FNs. However, both the increasing pattern and the diverging pattern are observed as the technological capacity is enhanced during the war time.

– With their accumulated technological experience and capacity, Germany and Japan managed to rank with the advanced nations in the mature period, showing acceleration in its development rate. The defeated nations show rapid development stemming from the recovery effect and the growth effect. However it would be misleading to interpret this as the convergence of the economic growth.

Appendix 2 UK & USA Versus Latin America & East Asia Case

A2.1 Industrialization of the Second Generation FNs

We have examined how the first generation FNs, Germany and Japan, were able to catch-up with the LN type industrialized nations such as England and USA in the Appendix 1. Now, we'll be examining the economic development process of the second generation FNs, namely, the Latin America and East Asia nations that were bent on industrialization.

We have chosen Argentina, Brazil, and Chile as the representative nations from Latin America. The three nations take up to 68 % of the whole area and 65–70 % of the Latin American GDP (PPP) from 1930 to 1980. Even today, they hold nearly 70 % of the 2007 Latin American GDP. Also, the average GDP per capita of these nations is higher than other Latin American nations in comparison to the advanced nations, approaching nearly 70 % of the advanced nation's GDP in 1948 when the economic growth was at its peak. Although their average GDP (PPP) has dropped to 34 % of that of the G7 nations in the recent years (2007) following the economic policy failure, the number is still quite high compared to the rest of the Latin American nations' 20 % GDP ratio. Therefore, the three nations—Argentina, Brazil, and Chile will be considered as the representative FNs of the Latin America nations.

Also, only Republic of Korea and Taiwan are selected as the representative nations of the East Asia. Before the economic crisis, the Four Dragons—Republic of Korea, Taiwan, Singapore and Hong Kong—have occupied nearly quarter of the Asia GDP (PPP), excluding China, India, Japan, and the Middle East. The four nations still occupy nearly 30 % even in 2007 and are thus referred to as the NIE[21] (Newly Industrializing Economies) by many scholars. The economically advanced Japan and the third generation FNs, China and India, are all excluded from the discussion along with the Middle East nations that are based on different economic development structure. Among the Four Dragons mentioned above, Singapore and Hong Kong are city states, focusing on service industries such as intermediate

[21] Refers to the nations that have not yet attained worldly economic capacity but shows rapid economic growth compared to the developing nations.

trade[22] rather than manufacturing industries. Consequently, the two city states are inappropriate subjects in discussing the accelerating economic development through expansive reproduction of the industrialized society, and only the Republic of Korea and Taiwan are selected as the second generation FNs of the East Asia.

As in Episode 1, this chapter will discuss the economic growth according to each period. However the time in the analysis on each period will be adjusted in order to contrast the developmental process of the Latin America and the East Asia. The decelerating agricultural society after the independence in the Latin America and the East Asia will be regarded as the pre-industrialization. And since the Episode 2 has not yet ended, we will analyze the period by dividing it into only two phases, the burgeoning phase and the chaotic phase. The second generation FNs have not yet entered the mature phase even today (2009) and are still in the chaotic phase.

The threshold for the burgeoning phase—during which the second generation FNs enter the accelerating industrialized society—can be thought of as the initiation of the import substitution industrialization[23] (ISI), an aggressive attempt by the governments to industrialize. Baer (1972)[24] provided detailed review on the ISI and the development process. According to his study, the ISI of the Latin America became substantial through the two World Wars and the Great Depression. Sharing similar view, Diaz-Alejandro (1984)[25] stressed on the Great Depression in discussing the turning point of the modern Latin American economy history. Taylor (1998)[26] referred to 1940s as the Golden Age of the ISI following the increase in domestic demand and boost in export of the agricultural product. Bulmer-Thomas (2003)[27] showed that change in the Latin American economic structure was brought about by the ISI. All these literatures suggest that ISI is the turning point of the Latin American economy. That is, Latin America has entered the accelerating industrialized society since the Great Depression in 1929 when manufacturing industries expanded following the ISI.

Alam (1989)[28] pointed out that the miraculous economic growth in Taiwan is a result of its economic policies since the import substitution strategies in 1950s. Although the strategies themselves do not differ from that of the other developing nations, Taiwan was able to attain comparably greater economic growth through factors such as agricultural policies, large influx of foreign aids, nurturing of manufacturing industries and human capital, and efficient autonomous regime. Dent (2002)[29] asserted that the ISI of Republic of Korea has started during the Seung Man Lee administration at the end of 1950s in food and fiber industries.

[22] Young (1992).

[23] Baer (1972).

[24] Baer (1972)

[25] Alejandro (1982).

[26] Taylor (1998).

[27] Bulmer-Thomas (2003).

[28] Alam (1989).

[29] Dent (2002).

Gereffi (1989)[30] classified the industrialization process of East Asia in to two phases, the first ISI and the first Export Oriented Industrialization (EOI). As in the Latin American case, 1950s can be viewed as the threshold of the economic growth in East Asia with the ISI. Correspondingly, the East Asia has entered the accelerating industrialized society at this point of time.

On the other hand, the beginning of the chaotic phase can be discerned by the national economic crisis. Both the Latin America and the East Asia has suffered financial crisis, but followed different economic development path afterwards. There have been two financial crises in Latin America. We will refer to the first one in distinguishing the periods.

Cardoso et al. (1992)[31] attributed the Latin America's financial crisis in 1980s to the Oil Shock in 1974. The compound effect of the fluctuating inflation and increase in interest rate by 5 % point by USA and 4 % point by UK in 1981 has led the indebted Latin America to financial crisis in 1982. Since then, Latin American economy has suffered 8.5 % decrease in its export amount and 7.6 % decrease in its export sum. Edwards (1995)[32] explained that the Latin American economic crisis started as its foreign debt increased from 45.2 billion dollars in 1975 to 176.4 billion dollars in 1982. The study also provided detailed discussions on the economic crisis by showing that the debt ratio to GDP has increased from 66 % in 1975 to 91 % in 1983 in Chile, while that of Argentina and Brazil increased from 15 % and 19 % to 44 % and 48 % respectively. On the other hand, Dent (2002)[33] called for attention to the financial crisis in 1997 and 1998 as the critical point in the modern economy history of the East Asia. Past research have regarded economic crises as the turning point in the economic development as such were often followed by discernible changes, either mitigation or intensification of the divergence.

In the Latin America and East Asia cases that we have examined, the years that distinguish each of the phases do not coincide. This is owed to the difference in the economic development progress attributed by various factors from political and economical circumstances along with international relations. However both the ISI (the outset of the accelerating society) and financial crises (the critical turning point in the economy) are of common economic experiences that both regions go through. Therefore it would be very meaningful to compare each phases that show similarity in the development process despite three differences in the chronicles.

[30] Gereffi (1989).

[31] Cardoso and Helwege (1992).

[32] Edwards (1995).

[33] Dent (2002).

A2.2 Comparison of the Second Generation FNs and the Advanced Nations

As previously discussed, Argentina, Brazil, and Chile are selected as the representative nations of Latin America, while Republic of Korea and Taiwan are selected for East Asia. These nations have attained high economic growth rate, gaining on the advanced nations in terms of GDP during the mid and late twentieth century. The Fig. 4.21 supports the previously suggested theories by comparing the GDPs between the advanced nation and the second generation FNs.

The above graph shows the GDP per capita of USA and UK in comparison to the Latin American FNs from 1820 to 2000. As in the previous chapters, the economic progress since the industrialization has been classified into the burgeoning period and the chaotic period.[34] Apart from the classification from Episode 1, the comparison of the development progress between the LNs and the FNs in Episode 2 will be based on the second generation's chronicle.

A typical decelerating society with low increase in the FN's GDP can be observed before the industrialization. The economic growth of Latin American nations have mainly depended on the primary industry in this period. Also, the noticeable rapid economic growth from 1890s to 1930s in the early twentieth century can be attributed to the industrialization of the advanced nations, followed by increase in the primary industry export in Latin America. Detailed discussions will be provided in the next chapter.

During the beginning of the industrialization in the Latin America in the burgeoning period, dynamic acceleration of development progress can be observed in the advanced nations. At this point, divergence of the economic growth rate between the FNs and the Latin America is observed through the enlarging disparity in the GDP. In particular, the USA has enjoyed economic prosperity over a decade since the 1990s called the new economy.[35] This reflects the entrance into a more accelerating society. On the other hand, further recession in the GDP growth rate is observed in the Latin America. The intensification of divergence is observed.

Figure 4.22 shows the GDP per capita of the USA and the UK in comparison with the Republic of Korea and Taiwan, the FNs. As in the case of the Latin America, the economic development progress has been classified into the burgeoning period and the chaotic period.

Before the industrialization, recession in the GDP growth rate can be observed. That is, East Asia displays typical decelerating agricultural society similar to Latin America.

During the burgeoning period when the industrialization sparks, acceleration in the growth can be observed similar to the advanced nation. However, unlike the

[34] To avoid confusion, the GDP graph of the advanced nations is provided for mere comparison with the FNs, irrelevant of the period classifications.

[35] First mentioned in Newsweek, US, in 1995. Refers to the 1990s when US saw increase in productivity comparable to that of the past 60 years without depression.

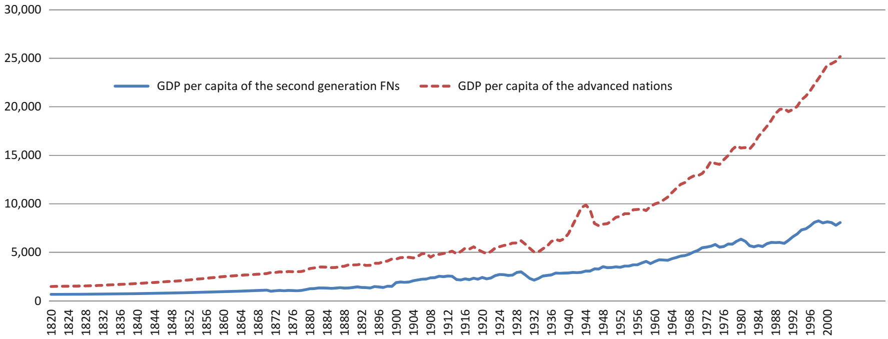

Fig. 4.21 Comparison of GDP per capita between the advanced nations (USA and UK) (Japan and Germany have not been considered here as they have yet to attain) and the second generation FNs (Argentina, Brazil, and Chile)

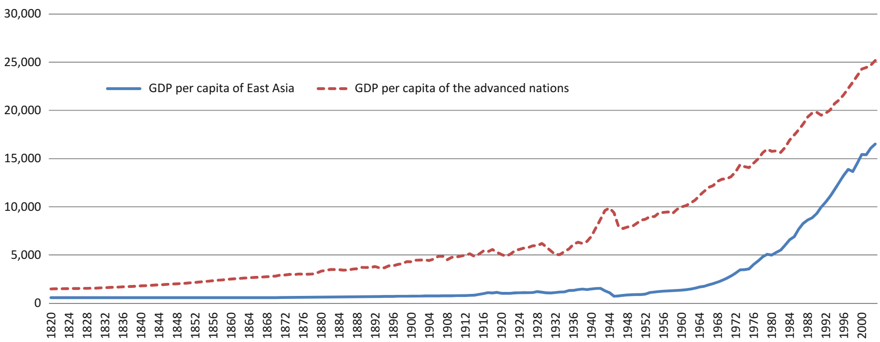

Fig. 4.22 The comparison of the GDP per capita between the advanced nation (USA and UK) and representative nations of East Asia (Republic of Korea and Taiwan)

Latin America, the disparity is reduced. This is attributed to the effective catch-up by the East Asian FNs resulting from concentration of its resources on to the economic growth rate and the comparative decentralization of the advanced nation’s resources to distribution and welfare rather than growth, resulting in the slowdown of the economic growth. The East Asia managed to catch-up with the advanced nations. However, consider such circumstances, it can be said that the divergence was still an ongoing process theoretically if the effects of the national policies were to be excluded.

The initiation of the chaotic period starts with the East Asia’s financial crisis in the mid 1990s. Unlike the Latin American case, the disparity with the advanced nations is not enlarging. This can be attributed to the previous catch-up effect and the information based economy effect, which allows more accelerating society based on the ICT industry. Also, the difference in the political inclinations between the advanced nations and the FNs may have rendered the similar effects as in the burgeoning period.

Thus far we have examined the economic growth trend of the FNs and the LNs through GDP data. The previously discussed decelerating society, accelerating society, and divergence between the FNs and the LNs have been confirmed in the trend. We will provide detailed explanations for each period and more specific bases for the divergence issue. In particular, industrial policies and social phenomena in each nation on every period will be examined in detail with the corresponding empirical evidence.

A2.3 Before the Industrialization: Decelerating Society

The decelerating agricultural societies in both Latin America and the East Asia can be confirmed. The decelerating society is a society in which the rate of economic growth and the increase in output decrease gradually. The production technology can be characterized by diminishing marginal return as the rate of output increase and the economic growth gradually fall due to technical limitation and simple reproduction structure. Such phenomena can be confirmed through change in technologies and induced innovations. At this point, USA and UK had already entered the industrialized society, and hence, divergence with from the decelerating society can be observed. The economic circumstances of Latin America and East Asia before the industrialization are described below (Fig. 4.23).

The above graph compares the GDP per capita of principal Latin America nations and the advanced nations since the independence in 1800s[36] to 1929, the Great Depression. The advanced nations are displaying accelerating economic growth as they have already industrialized. Latin American nations display typical agricultural society in which the economic growth declines.

However, from this point, the economic growth rate increases by a step and shows increasing pattern until the Great Depression. The increase is attributed to the increase in the exports of the first industries such as agriculture and mining following the increase in demand on raw materials for the production of manufactured goods in the advanced nations.

Figure 4.24 shows that the main export items of Argentina, Brazil and Chile were corn and wheat, coffee and rubber, nitrate and copper, respectively, in 1913. That is, the Latin FNs had exported agricultural and mined goods mainly during the pre-industrialization period.

As previously mentioned, the economic development of Latin American economy from 1900 to 1930 is owed to the export of primary industry goods. Figure 4.25 shows the change in the export amount from Latin America to advanced nations.

[36] Argentina and Spain became independent from Spain in 1816 and 1818, respectively. Brazil gained its independence from Portugal in 1822.

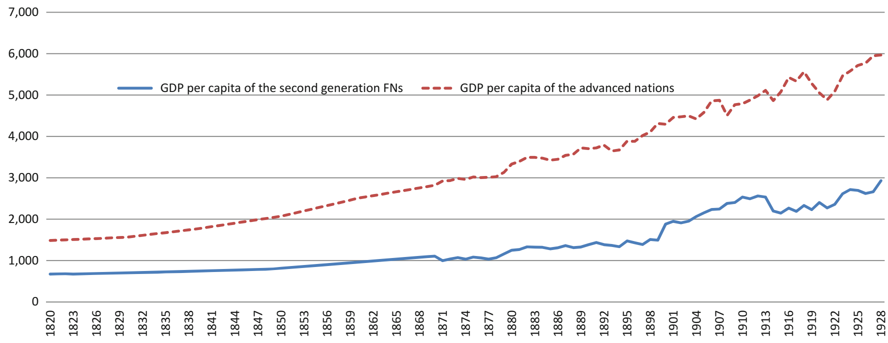

Fig. 4.23 Before the industrialization of Latin America (Maddison 2006)

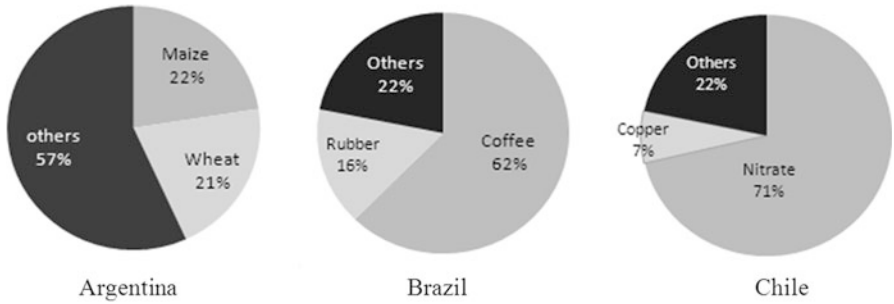

Fig. 4.24 The concentration of the primary industry goods in 1913 (Mitchell 1993)

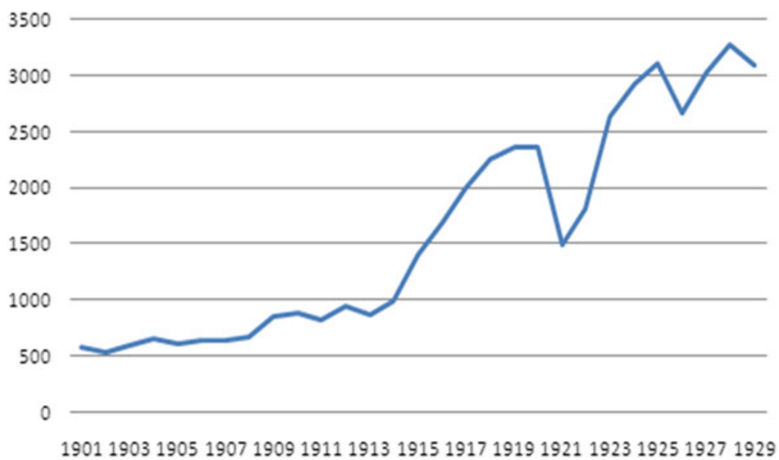

Fig. 4.25 Total export amount from principal Latin American nations to advanced nations (UK, USA) in million peso (Mitchell 1993, The rapid increase in the export growth during the 1910s is reflects the rapid increase in demand by the advanced nations as a result of the First World War)

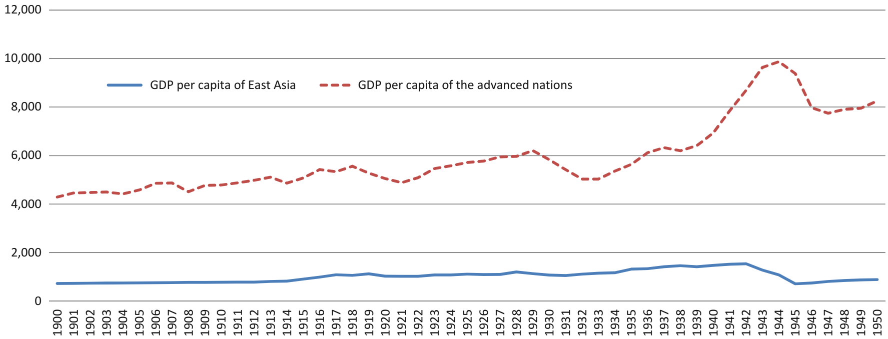

Fig. 4.26 Pre-industrialized period in East Asia

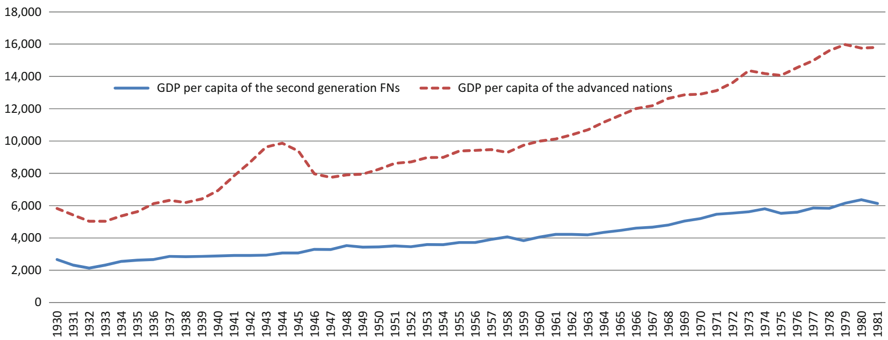

Fig. 4.27 The Burgeoning period in Latin America

The Fig. 4.26 resembles the increasing trend of Latin American GDP increase. That is, the increase in GDP was the result of increase in export amount following the economic boom of the advanced nations. This effect is irrelevant to the economic growth of the accelerating industrial society.

Figure 4.27 contrasts the GDP per capita of Republic of Korea and Taiwan against that of the advanced nations from early 1990s to 1950s, that is, until the independence shortly after the Second World War. The graph shows the increasing rate of growth in advanced nation, but the economic development growth of Taiwan and Korea is recessed, a typical feature of agriculture society. Following the social/ political turmoil and the imperialistic aggression by Japan, rigorous industrialization had not yet started with its primary product from the primary industry. The period is best characterized by the decelerating agriculture society. In particular, serious fall back of economy is evidenced since the beginning of 1940s following the World War II and its after-effects.

Table 4.36 Primary export items of Won bloc (Won bloc is the region created under Imperial Japan, ranging from Japan island, Chosun, Taiwan, Sakhalin, Kwantung, and Nanyang) (unit: Choun) (100-Year Korean Economy Reviewed by Journalists, Journalist Club of Korea, 2005)

Items	Year 1937		Year 1938		Year 1939	
Rice	1,381	1.42(%)	11,013	6.76(%)	25,272	9.66(%)
Flour	1,020	1.05	4,283	2.62	4,245	1.62
Fisheries	5,062	5.22	7,214	4.43	17,911	6.84
Sugar	4,476	4.61	3,810	2.34	2,060	0.79
Mineral oil	2,016	2.08	4,107	2.52	4,716	1.80
Textiles	16,543	17.06	27,045	16.60	527	0.20
Rayon	7,858	8.10	4,249	2.61	11,382	4.35
Cement	886	0.91	3,282	2.01	4,497	1.72
Mechanics	6,417	6.62	9,799	6.02	19,346	7.39
Lumber	7,228	7.45	3,418	2.10	923,282	3.55
Synthetic fiber	–	–	–	–	15,053	5.75
Others	44,099	45.47	84,679	51.98	147,377	56.32
Sum	96,986	100.00	162,899	100.00	261,668	100.00

Table 4.36 represents the primary export items just before the outbreak of the Second World War. The primary export items are composed mainly of the primary industry products.

Also Table 4.37 shows the primary industry products of Korea and Taiwan in the 1920s. Although specific percentage the items occupy in the total export amount is unknown, based on the percentage that the items occupy in the total Asian production, the economic structures of these nations can be judged to have been based on agriculture.

A2.4 The Burgeoning Period: Industrialization (Entry into Accelerating Society)

The representative nations from Latin American and East Asia have been witnessed to enter into accelerating society during the burgeoning period. The accelerating society indicates that the rate increase in the output or the economic growth is accelerating with time. The production function displays diminishing marginal return just as in the decelerating society even in the industrialized societies. However, the rate of the increase in the total output accelerates with time when technological advance is taken into account. Industrialized societies can attain accelerating economic development through increase in demand, market expansion, and the accumulation of capital and technology. As in the case of decelerating society, such acceleration can be explained in terms of technological change and innovation induction. The accelerating feature will be confirmed in Latin American and East Asian cases, specifically, in their burgeoning period.

Graph below contrasts the GDP per capita of advanced nations against selected Latin American nations. The graph of the advanced nations can typically

Table 4.37 Output of the primary industry products in 1927 (in 100 t) (League of Nations, International Statistical Year Book 1928)

	Korea	Taiwan	Comment
Wheat, 1925	2,860	6	Excluding India, Korean product accounted for 11 % of Asian product
Barley, 1925	8,788	5	Excluding India, Korean product accounted for 11 % of Asian product
Rice	31,283	12,512	
Tobacco, 1925	102	10	
Sesame, 1923	38	13	
Ground nut, 1925	15	276	
Coal, 1925	624	1,705	
Gold, kg	5,910	280	Excluding India, Korean product accounted for 23 % of Asian product
Silver, kg	1,617	467	

characterized as accelerating. The constant increase in GDP indicates that Latin America have just entered the accelerating society, albeit minor. The minor acceleration of Latin America fails to catch-up with the rapidly developing advanced nations, resulting in diversification.

The Burgeoning period is considered to be the Great Depression of 1929, the turning point in Latin American economy. The leading economic powers suffered serious setbacks since the Great Depression in 1929 and the impacts were passed onto the Latin Americans owing to their foreign dependent economic structure (Table 4.38).

As shown in the table, USA and UK occupied from a range of nearly 30 % to 60 % of the export market of the selected nations from the Latin America, and over 40 % of the import market. This is the cause of the concurrent depression of the Latin American economy when the economy of advanced nations crashed during the Great Depression.

The economic crisis of the advanced nation was shortly followed by decrease in the export from the Latin America.[37] In order to overcome the depression, the Latin government initiated ISI in 1930s, an indication of the industrialization in the Latin FNs.[38]

Table 4.39 shows that increase in the export amount and GDP in 1945 can be observed since the industrialization in the 1930s. The low annual growth rate in the agriculture (the primary industry) implies little has been contributed by the primary industry to the economic growth. However, growth rate ranging from 3 % to 9 % in the secondary industry indicates that the economic growth was significantly affected by this industry.

[37] For example, the Argentine ratio of export to US rapidly decreased to 8.3 % in 1929 from 29.3 % in 1918, and that of Chile decreased from 56.8 % in 1918 to 33.1 %.

[38] Furtado (1976).

Table 4.38 The Export and Import market of the selected nations in 1913 (%) (Bulmer-Thomas 2003)

Country	USA	UK	Total
Argentina	4.7	24.9	29.6
Brazil	32.2	13.1	45.3
Chile	21.3	38.9	60.2
Country	USA	UK	Total
Argentina	14.7	31.0	45.7
Brazil	15.7	24.5	40.2
Chile	16.7	30.0	46.7

Table 4.39 The average annual growth from 1939 to 1945 (%) (Bulmer-Thomas 2003)

Country	Value of exports (dollar value at current prices)	GDP (constant (1963) price)	Agriculture	Industry
Argentina	8.0	2.1	0.2	3.6
Brazil	13.6	2.4	0	5.3
Chile	7.1	4.0	0	9.3

The GDP contribution by the secondary industries, namely, the manufacturing industries has increased to 35 %, 33 %, and 39 % in the selected nations, in 1975. Such ratio is beyond that of the USA or UK, 29 % and 33 % in 1975 respectively. Such figures draw out that by 1970s, industrialization has progressed much since 1950s. See Tables 4.40 and 4.41.

However, the primary industry products still occupy large portion of exports even in the 1970s. The implication is that the Latin American industrialization merely substitutes the import, and the export is still limited to the primary industry. Although the representative nations have displayed the some of the features of the second generation FNs through ISI, they failed to attain internationally competent manufactured goods.

The Table 4.42 shows that the exports by the Latin American nations are occupied by the primary products for the most part in 1965. Even by 1986, despite the slight decrease in its percentage, main export items are primary products. On the other hand, the proportion of the secondary products has not increased much since 1965. This reflects that these nations have failed to acquire international competence in manufacturing and thus failed to develop the secondary industries into export industries.

Table 4.43 displays the foreign share of selected industries around 1970. The foreign share is higher in chemical, electronic, and mechanical industries that require high technology than in food and textile industries. The inefficacy of technology transfer from the foreign firms is evident from the stagnant export in mechanical and transport industries even by 1986, despite the high foreign share. At the same time, it can be conjectured that the heavy dependence on foreign firms has led to the failure of domestic firms in adopting new technologies and internalizing them.

Table 4.40 The GDP contribution by industries (%) in each nations (Bulmer-Thomas 2003)

		Agriculture	Manufacturing[a]	Construction	Other service industries
Argentina	1930	24	21	4	51
	1935	24	23	4	49
	1940	24	25	4	47
	1945	19	26	4	51
	1950	16	25	5	54
	1955	16	28	5	51
	1960	15	30	4	51
	1965	14	33	4	49
	1970	12	36	5	47
	1975	13	35	6	46
Brazil	1930	24	13	–	–
	1935	23	14	-	-
	1940	21	18	8	53
	1945	18	21	9	52
	1950	16	23	10	51
	1955	15	26	10	49
	1960	13	29	8	50
	1965	12	28	6	54
	1970	9	33	6	52
	1975	8	33	7	52
Chile	1930	–	–	–	–
	1935	–	–	–	–
	1940	12	38	4	46
	1945	12	37	5	46
	1950	11	36	5	48
	1955	11	37	4	48
	1960	9	39	5	47
	1965	8	41	4	47
	1970	7	42	4	47
	1975	9	39	3	49

[a]The sum ratio of manufacturing, mining, and public utility industries

Also, further acceleration of Latin American economy is limited due to resource driven economy, political instability and other social troubles.

Figure 4.28 compares the GDP per capita of the advanced nations with that of Republic of Korea and Taiwan. The advanced nations show consistent acceleration in growth, and the East Asian nations likewise display accelerating industrialized society. According to the divergence theory, the GDP gap between the advanced nations and the East Asian nations should further widen. However, the social welfare policies to address aging society, population, education, and distribution problems have diverged the resources onto welfare, leading to slowdown in the economy. Detailed discussion on the welfare policies of the advanced nation will be provided collectively in the chaotic phase of East Asia.

During this period, the East Asian nations seemed to have conducted various and effective industrial policies. These nations did more than merely imitating or

Table 4.41 Exports shares of primary products in Latin America trade, 1973–1975 (%) (Junguito 1978)

Country	Primary share in merchandise exports	Primary share in total good and NFS export	GDP per capita (US dollars)
Argentina	44.6	38.1	1,550
Brazil	48.2	45.4	1,030
Chile	74.7	68.5	990

Table 4.42 The comparison of export between Latin America and East Asia based on industries (%) (Gereffi 1989)

Percentage share of exports	Primary commodities		Textiles and clothing		Machinery and transport equipment		Other manufactures	
Country	1965	1986	1965	1986	1965	1986	1965	1986
Taiwan	59	9	5	18	4	29	32	44
South Korea	40	9	43	25	3	33	29	33
Brazil	92	60	1	3	2	15	6	23
Argentina	94	77	0	2	1	6	5	14

Table 4.43 Foreign share of selected industries, circa 1970(%) (Franko 2003)

	Argentina	Brazil	Chile
Food	15.3	42.1	23.2
Textiles	14.2	34.2	22.9
Chemicals	34.9	49.0	61.9
Transport equipment	44.4	88.2	64.5
Electrical machinery	27.6	83.7	48.6
Paper	25.7	22.3	7.9
All manufacturing	23.8	50.1	29.9

adopting advanced nations' policies. They seemed to have applied the catch-up strategies of the successful first generation FNs, Germany and Japan, in accordance with its surrounding circumstances.

The industrial policies promoted by the East Asian nations can be characterized in three distinctive perspectives. The first is that they have qualitatively advanced its industrial structure by gradually progressing into technology intensive industries from labor intensive industries by the means of expansive reproduction. Another perspective is that although they have started out the industrialization to substitute the import from the advanced nations and meet the domestic demands, with the accumulation of technology and capital, they have altered their course to export driven policies by targeting the markets in the advanced nations.[39] And lastly, to facilitate the export driven industrialization strategy better, they have fostered

[39] McGuire (1994).

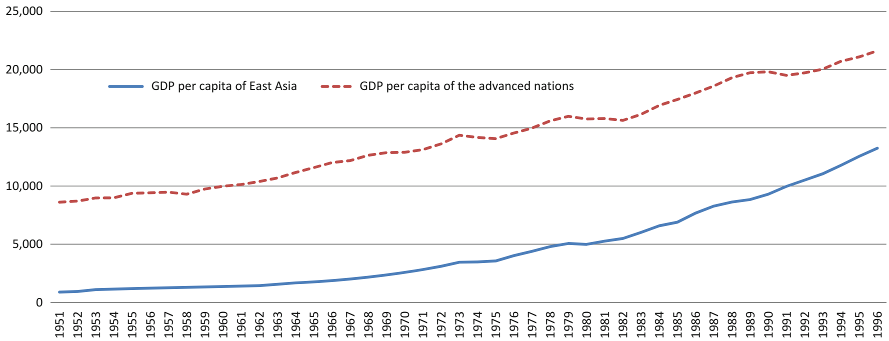

Fig. 4.28 The burgeoning period in East Asia

Table 4.44 The percentage of economically productive population in East Asia (%) (Mitchell 1995)

Korea(Year)	Primary industry	Secondary industry	Tertiary industry
1955	79.7	8.0	12.3
1960	64.9	9.4	25.7
1970	50.8	20.1	29.1
1980	37.8	28.3	33.9
Taiwan(Year)	**Primary industry**	**Secondary industry**	**Tertiary industry**
1930	69.5	9.8	20.7
1940	63.9	11.8	24.3
1956	55.5	16.7	27.8
1964	52.6	12.0	35.4
1970	44.2	15.8	40.0
1980	28.3	31.4	40.3

domestic firms and promoted their own industrial development under the guidance of the government.

Table 4.44 shows the proportion of economically productive population in East Asia. As in the case of Latin America, the labor force engaged in the primary industry have decreased while the labor forces engaged in the secondary industry increased. Such description elicits the progress of industrialization in these nations.

The GDP contribution by the secondary industry has increased to 29 % and 33 % (1975) in both Republic of Korea and Taiwan, respectively. This is beyond the corresponding level in manufacturing industries of USA and UK covered in 7.2. Such figures imply that since 1950s, significant progress in industrialization has been made in East Asia by 1980s. See Table 4.45.

Industries that have been previously developed in Japan is usually developed in Republic of Korea and Taiwan. In terms of industrial structure, growth pattern similar to that of Japan is shown in Taiwan and Republic of Korea with some time gap. Also, the industrial structure advanced qualitatively into more technology intensive industries as they neared the end of 1970s. See Table 4.46.

Table 4.45 The GDP contribution by each industries in Republic of Korea and Taiwan (%) (Mitchell 1995)

		Agriculture	Manufacture	Construction	Other service industries
Korea	1950	53	14	2	31
	1955	45	16	4	35
	1960	41	20	4	35
	1965	32	27	6	35
	1970	26	30	7	37
	1975	22	37	6	35
	1980	15	41	8	36
	1985	11	43	7	39
Taiwan	1952	32	16	4	48
	1955	29	18	5	48
	1960	29	23	4	45
	1965	24	26	4	46
	1970	16	33	4	48
	1975	13	35	5	47
	1980	8	40	6	47
	1985	6	42	4	48

Table 4.46 The order of introduction and growth of selected industries in Korea, Japan, and Taiwan (Ito 1997)

	Japan	Korea	Taiwan
Fiber	1900s–1930s	1960s–1970s	1960–1970s
Fabric	1950s	1960s–1970s	1960–1970s
Steel	1950s–1960s	Early 1960s—late1970s	
Chemistry	1960s–1970s	1960s late	1970s
Shipbuilding	1960s–1970s	Late 1970s	
Electronics	1970s	1980s	1970s
Automobiles	1970s–1980s	Late 1980s	

The Korean government has conducted several supportive policies such as the reduction and exemption of corporate tax, the export insurance, and reduction of tariff on imported raw materials. The government of Taiwan arranged similar policies including exemption of tariff on imported raw materials. See Table 4.47.

By fostering domestic firms, Republic of Korea and Taiwan were able to develop its domestic industries. An illustration of this point is the Korean automobiles industry. In 1962 "Senara", a Korean small-sized-Japanese-automobiles assembly plant, was established and automobiles industries burgeoned since; for example, Hyundai assembled Ford automobiles in 1967. Based on the government plans to localize in 1966, the government provided support on foreign exchange in accordance with the localization rate. As a result, the localization rose to over 60 % in 1972 from 21 % in 1966, extending to 92 % in 1984.[40] Korean mobile industry has

[40] Kim (2000).

Table 4.47 The export support policies in Republic of Korea and Taiwan (Institute for International Economy, The change in international economy circumstances and our correspondence, 1978)

	Korea	Taiwan
Finance	Financing up to 80 ~ 90 % of L/C amount	Financing 85 % of L/C amount
	Interest rate: 8 %	Interest rate: 6.5 %
Internal tax	Total exemption from business tax related to export	Exclusion of export loss, preliminary fund, and R&D expenditure to facilitate export from standard assessment
	Total exemption from corporation tax related to export	
	Extraordinary expenses income (over 30 % of ordinary expenses)	
Tariff	Refund of tariff on import of raw materials used for export, preliminary exemption, exemption of tax on important industrial facilities	Divided payments of tariff on imported equipment
	Reservation of tariff on bond factories	Exemption of import tariff on imported raw materials
Others	Export insurance system (payment of 90 % of the lost insurance)	Export insurance system
	Foreign exchange control	
	Foreign exchange insurance for branch offices of exporting firms	
	Field finance mortgage	
	External foreign currency mark payment guaranty	

managed to transform its manufacturing capacity from producing semi-products to whole products in merely 15 years. On the other hand, the domestic component ratio in terms of weight remained around 30 % in some Latin American automobile industries despite its ISI policies. Consequently, they depended on foreign firms such as GM, Ford, Volkswagens and were held back to simple assembly of the components.[41]

A2.5 The Chaotic Phase: The Financial Crisis

Latin America and East Asia developed through different courses during the chaotic phase. Both regions confronts a common economical turning point called financial crisis. While Latin America fell back against the financial crisis, the East Asia managed to retain its GDP gap with the advanced nations. While Latin America suffered further divergences that were evident since the burgeoning

[41] Furtado (1976).

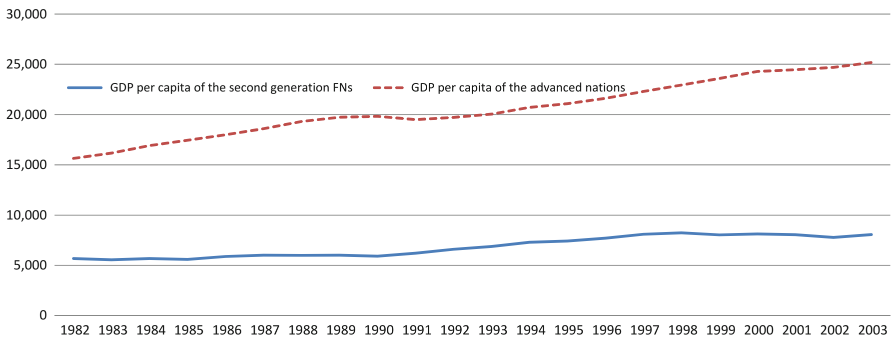

Fig. 4.29 The chaotic phase in Latin America

Table 4.48 World bank data on total external debt (Million, US$) (Wilkie 2002)

Country	Year	Long-term debt	Use of IMF credit	Short-term debt	Total external debt
Argentina	1970	5,171	0	639	5,810
	1980	16,774	0	10,383	27,157
	1990	47,676	3,083	10,473	62,232
	2000	111,887	4,478	31,515	147,881
Brazil	1970	5,020	0	714	5,735
	1980	57,981	0	13,540	71,520
	1990	94,340	1,821	23,716	119,877
	2000	206,326	8,827	29,521	244,673
Chile	1970	2,567	2	409	2,977
	1980	9,399	123	2,560	12,081
	1990	14,687	1,157	3,382	19,226
	2000	32,269	0	5,493	37,762

period, East Asia prevailed the divergence through qualitative advance in its industrial structure. Such advances include the development of further accelerating ICT industry. Detailed explanation and basis will be provided below.

Figure 4.29 compares the GDP per capita of selected nations from Latin America and advanced nations. The divergence that was evident since the burgeoning period intensifies during the chaotic phase. Latin America was unable to shake off the aftermath of the financial crisis in the early 1980s.

Krugman (1979)[42] construed the cause of the financial crisis to the discordance in domestic policies arising from excessive financial deficit and the fixed exchange rate. In particular, he pointed to the fixed exchange rate for the cause.

Table 4.48 shows the external debt of Latin American FNs from 1970 to 2000. The debt of all three nations are increasing both in short terms and long terms, ergo increasing total external debt. The increase in the debt is particularly large between

[42] Krugman (1979).

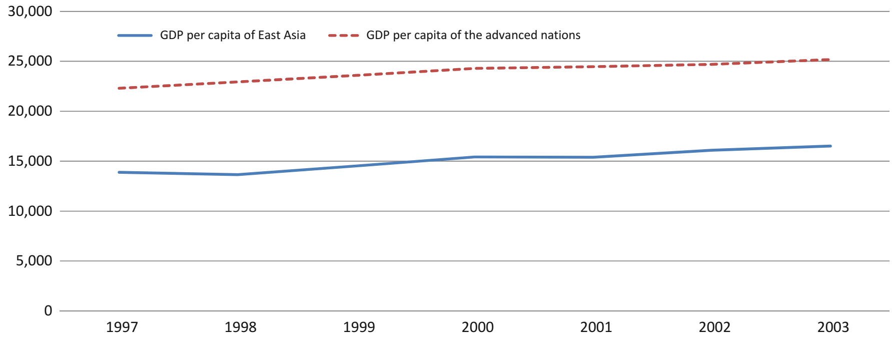

Fig. 4.30 The chaotic phase of East Asia

1980 and 1990, indicating that Latin American FNs have failed to overcome the economic crisis, intensifying the divergence.

Figure 4.30 compares the GDP per capita of selected nations from East Asia and advanced nations. The growth pattern of both advanced nations and East Asia nations is an extension of the acceleration, and diversification is not evident in this graph. Although the growth itself recedes shortly during the financial crisis, the growth trend continues based on its efficient developing process.

Several researches have been conducted to find the cause of the financial crisis in East Asia that broke out in 1997. Radelt and Sachs (1998)[43] held the sudden migration of the financial liquidity responsible. The study examines the case through fundamental factors including (i) the rapid volatility of interest rate, product prices, and trade conditions, and, (ii) the abrupt re-evaluation of the credit rating reflecting changes in political and economical policies. For the cause of the financial crisis outbreak, Corsetti et al. (1999)[44] pointed to the imbalances in macro economy such as the current account deficit, external debt, growth, inflation, ratio of savings to investment, financial deficit, real exchange rate, foreign currency reserves, civil investment, index of debt and profitability, excessive bank loan, indices of credit growth and financial instability, ratio of redemption of debt, dynamic aspect and the composition of capital flow, political instability.

However, the East Asian nations were able to overcome the financial crisis rather quickly. In particular, Korea was able to pay its redemption in advance by the means of acquiring foreign exchange liquidity, economy invigoration through lowering interest rate and expanding financial expenditure, aggressively promoting restructure, fostering and throwing in public funds, searching for new growth momentum, and others.

The above indices (see Table 4.49) represent 1997, the year the financial crisis broke out, and 2002, 5 years since then. The current account in 1997 was 8.2 billion

[43] Radelt and Sachs (1998).

[44] Corsetti et al. (1999).

Table 4.49 Economic indices of Korea during the 5 years of IMF era (The Ministry of Finance and Economy, promise of infinite potential. The achievements in 5 IMF years and the remaining challenge 2002)

Items	1997	2002
Economic growth (%)	−6.7 (1998)	6.1 (first half)
Consumer price (%)	7.5 (1998)	2.6 (Jan. ~ Oct.)
Unemployment rate (%)	6.8 (998)	2.5 (September)
Current account (in 100 million dollar)	−82	41 (Jan. ~ Sept.)
Reserved foreign exchange (year-end, 100 million dollar)	39	1170 (Jan. ~ Oct.)
Total external debt (year-end, 100 million dollar)	1807 (June)	1298 (end of Sept.)
Exchange rate (year end, Won)	1965	1225 (November)
Dishonored Bill ratio (%)	1.5	0.05 (September)

dollar deficit, while in year 2002, the current account surplus was 4.1 billion dollar. The reserved foreign exchange increased to nearly 30 time more, and the exchange rate decreased by nearly 60 %. All these indicate that Korea has tided over the financial crisis, at least so it appeared.

The Table 4.50 represents the investment on IT industry in the growth of Korean economy in the interval of 5 years since 1980. Before the crisis in the late 1990s, the GDP shows constant increase. Kim (2004)[45] has examined the GDP growth rate in terms of IT fixed capital, non-IT capital, employment, and conventional total factor productivity. The study found the shadow value of the fixed capital and derived revised GDP, revised TFP, and its contribution thereof. The rate of contribution of IT industry increased in each period. Also, the percentage occupied by the contribution in the revised GDP increased rapidly with each period. In summary, although the growth of Korean economy receded during the financial crisis in the late 1990s, it was able to continually grow through IT investment. That is, the growth of IT industry has driven the continual growth of Korean economy.

Unlike Korea, Taiwan did not go through direct financial crisis, but its economic growth still suffered from the Asian exchange crisis.

The above indices represent the economy of Taiwan before and after the outbreak of the crisis. Both the GDP per capita and average saving per household decreased while interest rate increased in year 1998. Although not shown in the Table 4.51, the increasing rate of export fell from 5.3 % in 1997 to −9.4 % in 1998 and the economic growth rate fell to 4.57 % in 1998. All these indicate that the economic growth of Taiwan had slowed down.

However, Taiwan was able to overcome the economic recession rather lightly by virtue of accumulation of constant surplus savings which was utilized by the domestic firms for market funds. Also, the limited nature of the ongoing opening of financial markets allowed it to evade speculative foreign aggressions. Other

[45] Kim (2004).

Table 4.50 The role of information technology investment in Korean economic growth (%) (Kim 2004, p. 340)

1981–1985	Average annual growth rate	Contribution
Conventional GDP	7.525	100
IT fixed capital	0.216	3
Non-IT capital	2.313	31
Employment	1.079	14
Conventional TFP	3.917	52
Revised GDP	7.968	100
Revised TFP	4.360	55
IT contribution	0.659	8
1986–1990	Average annual growth rate	Contribution
Conventional GDP	9.056	100
IT fixed capital	0.163	2
Non-IT capital	3.104	34
Employment	2.268	25
Conventional TFP	3.520	39
Revised GDP	10.365	100
Revised TFP	4.829	47
IT contribution	1.472	14
1991–1995	Average annual growth rate	Contribution
Conventional GDP	7.188	100
IT fixed capital	0.211	3
Non-IT capital	4.019	56
Employment	1.455	20
Conventional TFP	1.503	21
Revised GDP	8.701	100
Revised TFP	3.016	35
IT contribution	1.724	20
1996–2000	Average annual growth rate	Contribution
Conventional GDP	4.751	100
IT fixed capital	0.394	8
Non-IT capital	2.599	55
Employment	0.373	8
Conventional TFP	1.385	29
Revised GDP	12.760	100
Revised TFP	9.394	74
IT contribution	8.404	66

factors that have eased the recession was the stable industrial structure formed by SMEs that have occupied large portion of exports, the flexible exchange rate policies by the central bank, and sufficient foreign exchange reserve.[46]

[46] Kim (2007).

Table 4.51 The economic indices of Taiwan in 1997 and 1998 (Directorate-General of Budget, Accounting and Statistics Executive Yuan, Republic of China, Statistical Yearbook of the Republic of China 2006, The Chinese Statistical Association, 2007)

Item	1997	1998
GDP per capita (US$)	13,904	12,679
Private consumption per capita (US$)	8,148	7,461
Average saving per household (NT$)	228,951	226,831
Weighted average interest rate of domestic bank (%)	8.25	8.48
Weighted average interest rate of foreign bank (%)	9.69	10.37

Table 4.52 The ratio of total external debt to total domestic production in Korea and Taiwan (%) (Shin and Chang 2003)

	1976	1982	1985	1993	1996	1997
Korea	36.7	52.0	52.1	12.7	20.2	25.5
Taiwan	13.6	12.8	14.5	7.6	8.0	9.3

As Table 4.52 indicates, the dependence on foreign debt of Taiwan was comparatively lower than Korea. The stable economic structure sheltered Taiwan from direct crisis that Korea and other notable Southeast Asian countries have suffered.

The decrease in the gap with the advanced nation is not the retrogression of the divergence; rather, while the FNs focused and concentrated on growth through cutting-edge industries, the LNs strived to address the welfare issues such as the aging society, population, education, distribution and others.

Figure 4.31 shows that welfare related expenditure rate of the LNs have increased from 12 % of GDP in 1972 to 16 % of GDP in 1995. On the other hand, the FNs decreased from nearly over 3 % in 1972 to 2 % in 1995. Considering the accelerating GDP of LNs for two decades, the expenditure on welfare has increased quite extensively.

Figure 4.32 provides the average annual hours worked in US/UK and Korea. The average annual labor hour in USA and UK never exceeded 1,800 h. On the other hand, the Korean labor hour was 2,300 h in 2007, a decrease in 400 h since 1980 but still 500 h more than the advanced nations. While the average hours of labor per week is about 35 h in advanced nations, that of Korea is approximately 44 h. Staying low level in labor hours is a result of efforts on welfare policies by the advanced nation to increase the quality of life. Had the disparity in the policies not been present, our initial expectation of divergence would have appeared and continued to intensify.

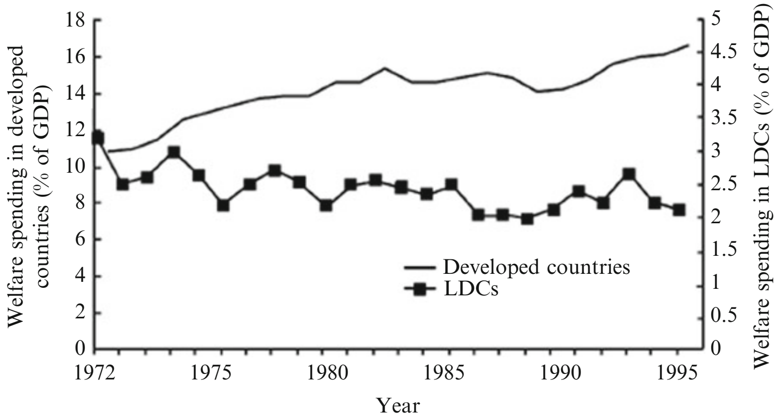

Fig. 4.31 The comparison of expenditure on welfare spending rate between the LNs and the FNs from 1972 to 1995 (Rudra 2002)

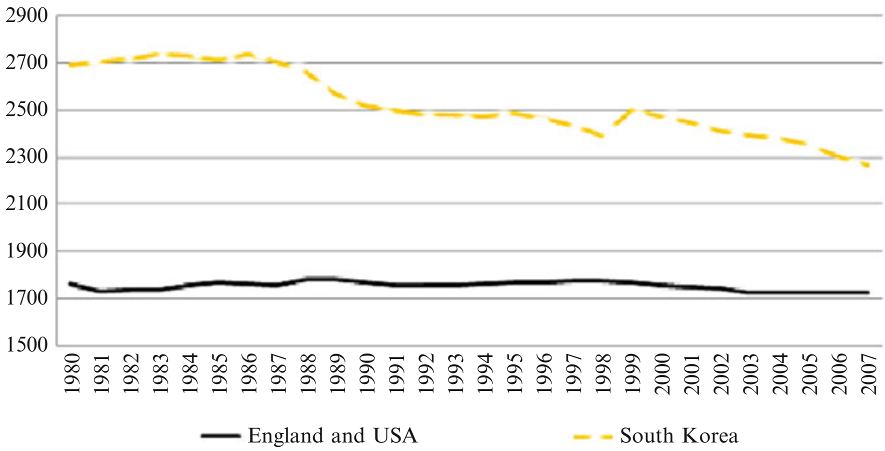

Fig. 4.32 Average annual hours actually worked per worker (OECD, http://stats.oecd.org)

A2.6 Conclusion

So far we have compared the development process of the second generation FNs with the advanced nations and examined the deceleration, acceleration, and divergence in each period. As in Episode 1 of the industrialized society, the divergence between FNs and LNs is present in Episode 2 and primary events and national policies that have influenced the economic growth have been confirmed through actual cases.

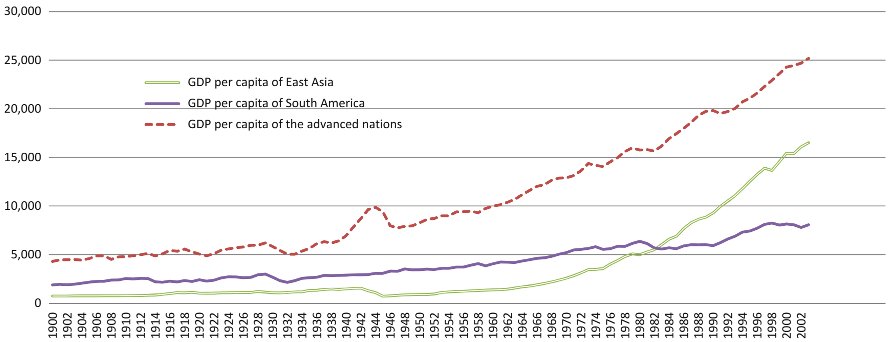

Fig. 4.33 Comparison of GDP per capita among the East Asia, South America and advanced nations

Figure 4.33 represents GDP per capita of LNs and the second generation FNs, namely, representative Latin American and East Asian nations. Through this graph, brief summary of the above discussion will be provided.

– The divergence is evident between Latin America and LNs. Failure in domestic policies intensified divergence since 1980s. Latin America has entered industrialized society since 1930s through ISI strategies from the primary goods export oriented growth in the early twentieth century. They show persistent growth, but fail to prevail in the face of financial crisis in the 1980s and the divergence intensifies.
– The divergence between East Asia and LNs is mitigated after 1980. The divergence was evident despite their various aggressive industrial policies to catch-up since the ISI strategies in the 1950s. After the financial crisis in the 1990s, they have tided over relatively quickly and reduced the gap with the advanced nations. However, had the advanced nations not diverged its resources on welfare and distribution rather than growth, the divergence would have intensified just as in 1980s.

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Chapter 5
The Faster-Accelerating Digital Economy

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Abstract The digital economy is one of the most important features of the knowledge-based society of the future. Based on information and communications technology (ICT), it grows faster than and eventually overtakes the traditional industrial economy. The fundamental driving forces of the digital economy's faster economic growth are as follows. First, ICT converges with and improves the efficiency of traditional industries. Second, the production function of the ICT industry shows increasing returns to scale. Third, the development of ICT stimulates not only demand and supply but the entire expansive reproduction system, resulting in faster-accelerating economic growth. This paper investigates the essentials, causes, and patterns of the faster economic growth of the digital

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economy, and forecasts its future on the basis of real-life examples from the US, Finland, and Ireland. Furthermore, the core of the IT paradox is revisited, so that the potential of the digital economy can be reaffirmed.

Keywords Knowledge-based society • Digital economy • New economy • Economic growth • Faster acceleration • Technological change • IT paradox • JEL Classification Numbers: L63; L68; L96; N10; O33; O47

5.1 Introduction

The term ‘digital economy’ was first used by the US Department of Commerce in its 1998 annual report to describe an economy that grew much faster than previous societies accelerated by ICT innovation. One important property of this economy is its inclusion of knowledge and information in main production factors, besides three major production factors - labour, capital, and land—of an industrial society. The digitalization of core economic activities including production, distribution, and consumption of goods and services is another main property of the digital economy (US Department of Commerce 1999).

Brynjolfsson and Kahin (2000) also defined the digital economy with digitalization of information. They emphasized that every part of the economy has experienced recently a transformation to digitalization and the digitalization of information was crucial in further growth of an economy.

Lyotard (1984) insisted that the development of IT technologies and the universal diffusion of knowledge make it possible to exchange knowledge as a good in the marketplace. The development of IT technologies is regarded as a critical factor for the establishment of the digital economy. Advanced IT technologies have led to the advent of new media, such as network based databases, and the development of computer networks and the Internet have made it easy to collect information and knowledge from all over the world. Information or knowledge intensity enabled by IT technologies has increased the importance of information and knowledge as production factors of an economy.

The digital economy is considered as a step toward the knowledge-based society. Drucker (1969) and Bell (1973) defined the knowledge-based society in concrete terms by stating that knowledge would be the basis of policy decision and knowledge workers who created and used information would become more important. They insisted that theoretical knowledge is necessary to innovate and manage technologies and policy systems that became more complex and changed comprehensively as time passed. Moreover, they asserted that the supply of knowledge workers would increase because of the growing population of well-educated personnel. Therefore, the entire society would move from a material-oriented to a knowledge-oriented economy as knowledge industries develop.

This paper is organized as follows: Sect. 5.2 describes the faster-accelerating characteristics of the digital economy—its role in improving traditional industries, the nature of its production function, and its influence on overall social change. Section 5.3 examines the structure and principles of the faster-accelerating distal economy. Section 5.4 demonstrates the faster-accelerating growth of the digital economy with three concrete examples. The IT paradox is revisited and the limitation and potential of the digital economy are examined in Sect. 5.5. Lastly, Sect. 5.6 concludes the paper, arguing that the digital economy is the driving force for the creation of a new economic paradigm.

5.2 Characteristics of the Digital Economy

5.2.1 Efficiency Improvement in Traditional Industries

The development and diffusion of ICT has increased the convergence between ICT and existing technologies in other industries. The technological advancement due to increasing ICT use in traditional industries has resulted in raising the added value and improving the productivity of traditional industries.

Computerization and digitalization of industries have influenced the entire production process, introducing faster and more efficient procedures. Solow (1987) provoked the productivity paradox dispute, but Brynjolfsson and Hitt (1998) refuted his statement by showing that ICT does lead to productivity improvement. They contend that computerization changes the industrial structure, leading eventually to productivity improvement. However, computerization by itself does not automatically bring about productivity improvement. As computerization matures, productivity improvement accelerates, and so does economic growth.

Many traditional industries, including the automobile, mechanical, and shipbuilding industries, attempt to improve their added values by developing new convergence technologies that graft state-of-the-art ICT into the existing systems. Table 5.1 shows some important examples of technology convergence between traditional industries and ICT.

5.2.2 Production Function of the Digital Economy

An economy driven by digital industries grows much faster than an economy based on traditional industries because of the increasing-returns-to-scale (IRS) production function of ICT industries. Whereas the traditional manufacturing industries of industrial societies show DRS, the production function of the digital economy has the IRS characteristic (Romer 1986; Ray et al. 2002). IRS refers to a certain trend in which the more the units of the input factor, the greater the output per unit of the input factor. Ray et al. (2002) insisted that IRS appears in the knowledge-based

Table 5.1 Examples of technology convergence between traditional industries and ICT

Industry	Major convergence technologies
Automobile industry	Web-based automobile, integrated modularization of components, intelligent safety system, engine control, gas emission control
Mechanical industry	MEMS[a], open PC-NC, industrial robots, IMS
Shipbuilding industry	Automatic sailing system, automatic ship identification system, integrated control system, super-luxury passenger ship (car ferry), special vessel-building technology
Textile industry	High-performance industrial textile (conductivity textile, smart textile, intelligent textile, etc.)
Construction industry	Intelligent construction system, construction robots, construction CALS/EC, contractor integrated technology and information system (CITIS)
Health-care industry	Next-generation intelligent medical equipments, sensory functions recovery devices for the disabled, speedy EMS, operating robots, micro autonomous endoscope

[a]*MEMS* micro-electronic-mechanical system, *IMS* intelligent manufacturing system

society due to the substitution of material capital for knowledge capital and its self-reinforcing nature in the process of knowledge accumulation as the driving force. Computer and software industries are representative examples that show the IRS production function. IRS reflects the continual increase of productivity due to the decrease of marginal cost to produce additional outputs. The marginal production cost of the software industry is considered to be close to zero (Ellison and Fudenberg 2000). Besides, Romer (1986) claimed that technology development can lead to continuous economic growth, and many economists believed that the phenomenal economic growth of the New Economy in the US had been built on ICT technologies (Gordon 1999; Stiroh 2002).

Arthur (1994) mentioned that the economic growth of the digital society accelerated faster than that of the traditional industrial society. Arthur (1994) explained the acceleration effect of the digital economy based on the IRS characteristic in production and the path-dependent economy. Shy (2001) theoretically proved the network effect observed in the computer hardware and software industries. His research on the distinctive feature of markets according to the different characteristics of software products (e.g. ease of reproduction and network effects) indicated that the software market, unlike the traditional product market, is not a competitive one but is dominated by a single technology. This kind of tipping effect in production is the basis of the technology-oriented accelerating growth of the digital economy. Harrington and Reed (1996) also mentioned the virtuous cycle of e-commerce growth, which represented the accelerating increase of e-commerce revenue well, when e-commerce was regarded as one of the production indicators of the digital economy. According to them, the faster-accelerating growth of the digital economy is significantly different from the economic growth trend of the traditional industrial societies, which have the DRS production function.

Section 5.3 further explains how the IRS production function influences the faster acceleration of economic growth.

5.2.3 Social Changes in the Digital Economy

Not only does the ICT-based digital economy affect the economic area, it also brings about all-round social change. The digital economy brings about economic and social transformation, which accelerates economic growth by stimulating the cycle of the expansive reproduction system (ERS).[1] In this section, we will look at five examples of such changes. The digital economy creates new demand for digital products, allows flexible economic structures, helps manage fluctuation in prices, restructures firms and employment types, and facilitates the emergence of the digital generation.

First, the digital economy creates new demand generated by new products, enabled by digital technology. The advances in computers and information technologies created tremendous opportunities for the production of new products (Balakrishnan et al. 1999). For example, as the Internet is widely used, the need for online identifiers has arisen and the market for identity management systems (IDMs) followed (Mueller et al. 2006). The development of a portable music player and MP3 (MPEG Audio Layer-3) created a market for online music stores. Apple's iPod and iTunes are symbols of the new market (Yoo 2008). As in these examples, the digital economy contributes to creating new demands that have not existed in traditional societies and expanding existing demands.

Second, the digital economy allows more flexible economic structures. With the development of ICT, the entry and exit of firms become easier, and consumers have a larger role. With the help of Internet-based e-commerce, entrepreneurs can start their businesses with a small amount of labour and capital. Small businesses in the digital economy have a potential for high growth due to the digital economy's IRS feature. Furthermore, as consumers can directly contact producers and send their messages via the Internet, they have a greater influence on producers. Producers, for their part, can obtain information about the consumers' needs and carry out efficient production based on the information. The development of ICT helps producers forecast the diffusion and demand of products more precisely so that producers can flexibly handle the fluctuation of demand as forecasted and reduce the amount of inventory. For example, Dell could make enormous profits by allowing customers to order PCs on the Web site. This initiative eliminated several factors that raised the product cost, and reduced the burden of inventory cost (US Department of Commerce 1998; Kraemer et al. 2000).

Third, the digital economy mitigates price fluctuation. In the US, ICT goods and services contributed to decrease the inflation rate. For example, without the ICT industries, the inflation rate would be 3.1 % in 1997. However, due to the continuous and remarkable price reduction by ICT industries, the overall inflation rate (i.e. with ICT industries included) dropped to 2 % (US Department of Commerce 1998). Kahn et al. (2001) concluded that the advances in information technology reduced the fluctuation of outputs and inflation. To derive the results, they compared real-world data with simulated data based on the general equilibrium model,

[1] The expansive reproduction system (ERS) is a unique growth structure of an industrial society that expands its economy through capital accumulation and technological innovation (Kim et al. 2010b).

which considers the production function and utility function along with inventory and includes the optimal fiscal policy.

Fourth, the digital economy transforms the structure of firms and employment type, and creates new employment. Large companies are reorganized to small companies or subsidiary companies, and outsourcing is used. E-commuting and flexible working schedules made fixed places and times of work unnecessary, which triggered the creation of various goods and small businesses. More flexible working conditions enabled by out-of-office businesses such as e-commerce contributes to the changes of employment structures. Besides, the development of ICT industries led to an increasing demand for skilled people in this area. In the US, the number of people employed in the ICT industries was estimated as follows: 557,000 in 1985, 1,200,000 in 1996, and 2,500,000 in 2006 (US Department of Commerce 1998). According to the 2009 statistics of the US Bureau of Labour Statistics, the number of persons employed in computer-related areas of the US in 2008 was estimated at about 3,200,000. If the entire ICT industries are considered, the impact of ICT industries on employment will be even larger.

Lastly, the digital economy prompted the emergence of the digital generation. Tapscott (1997, 2009) insisted that the digital generation was clearly distinguished from other generations in the matter of values and lifestyle, since it was the first generation that grew with the development of digital media. The digital generation actively participated in using digital media for communication, entertainment, learning, working, and thinking, and formed new values. The digital generation tended to maximize individual utility, and acted as prosumers, who affected the production process and were at the same time consumers of the products (Alch 2000; Leung 2004). Since the digital generation is actively involved in the production and consumption of new products, it contributes to stimulating the cycle of ERS.

5.3 Structure of the Digital Economy's Faster Growth

5.3.1 Time-Output Relationship in the Digital Economy

As already was mentioned, the production function of the digital economy shows evidence of IRS. Prior to describing the shift of IRS production function over time, we first see how the time-output relationship is observed for the DRS production function, which is generally considered as a production stereotype of previous industrial societies.

Figure 5.1a shows the positions of DRS aggregate production functions (APFs) at different time frames ($t = 1, 2, 3, 4$). Each APF reflects the technology level at the time. As time passes, technological innovation occurs and shifts the APF upward, though the range of technological change gets smaller. Figure 5.1b is a long-term time-output path, which follows the points of input–output intersection observed at each point of time. We define this path as an APF production expansion path, which means the production records of the APF observed at each point of time as an APF moves according to technological changes (Kim et al. 2010a). Figure 5.1b

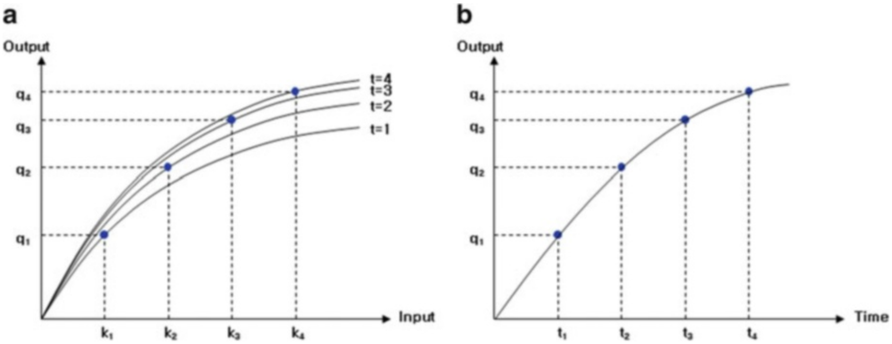

Fig. 5.1 Time-output relationships with DRS production function and slow technological change

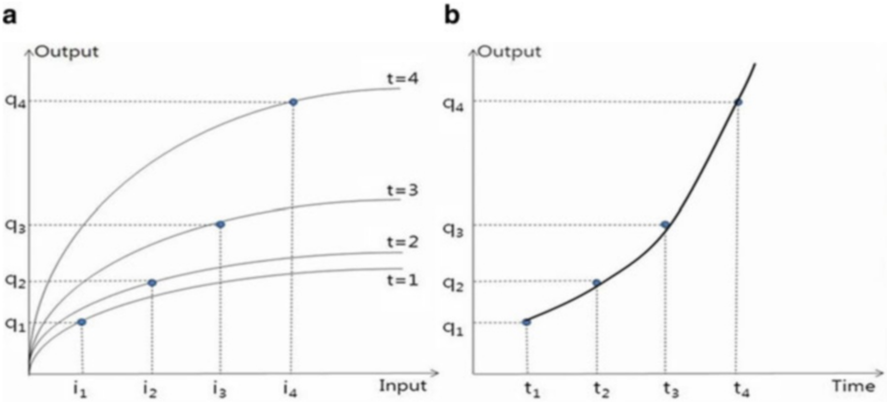

Fig. 5.2 Time-output relationships with DRS production function and fast technological change

indicates that the economic growth of the society which has this kind of an APF production expansion path tends to gradually decelerate in the long run. A pure agricultural society before the Industrial Revolution falls under this category, where the economy stagnates over time because of slow technological changes.

The next case is a situation in which the production function has the DRS characteristic, but technological changes are fast. As seen in Fig. 5.2, when we connect the input–output intersections, the curve shifts upward at each point in time when technological innovation happens; this case shows the accelerating growth pattern in the long run. Modern industrial societies after the Industrial Revolution achieved this pattern of economic growth (Kim et al. 2010b).

Lastly, we will examine how the output levels will change with time when the production function shows IRS, similar to the digital economy. First, we examine a test case that assumes the same technological progress as in Fig. 5.2; however, the production function changes from the DRS to the IRS type. Figure 5.3 shows the time-output relationship for this case.

In order to estimate the technological progress in Fig. 5.2, which measures how fast the production function shifts, the difference between the two time frames of a production function needs to be divided into two parts as in Fig. 5.3a: increase due

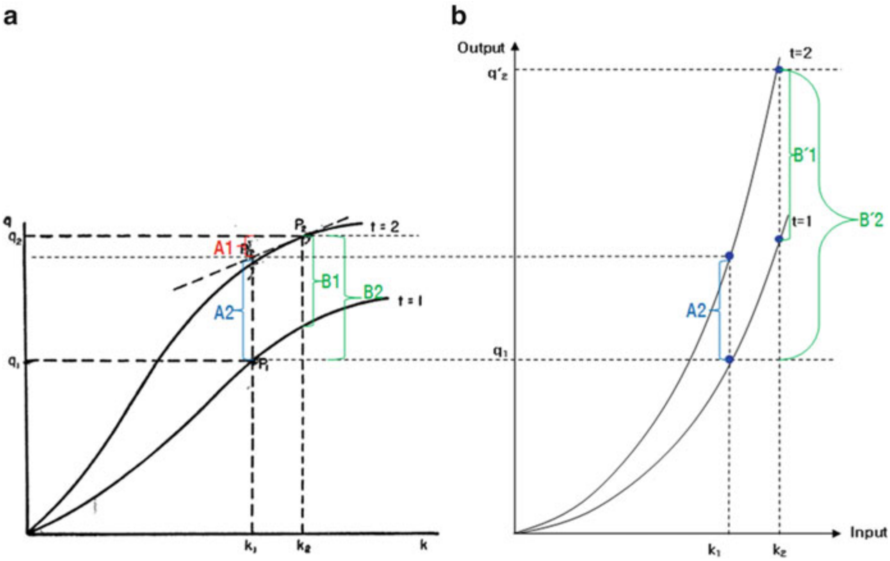

Fig. 5.3 Time-output relationships with IRS production function; the speed of technological change is the same as in Fig. 5.2 Source: (**a**) Solow 1957, p. 313, chart 1

to input changes and increase due to technological changes. Solow (1957) explained that because of the time lag between the two observed production points, the output movement along the production function and the shift of the production function itself are mixed in the shift of the production function estimated from the two sets of observations. Of the two movements, the shift of the production function itself is only related to the technical change between the two production points. In order to calculate the technical change, Solow (1957) drew a tangent line at P2, which was the input–output point at t = 2, and found P12, at which the tangent line met the input level of t = 1. Then, he calculated the technical change from the difference between P1 (the output level of t = 1) and P12 (the output at t = 2 adjusted to the input level of t = 1). Figure 5.3a illustrates this process. As regards the difference between the production functions at t = 1 and t = 2, the output increase due to an input increase at the same technology level, that is, along the same production function, is expressed as A1; the change of the production function itself from technological advancement is indicated as A2. B1 represents the difference between the outputs with and without technological innovation at t = 2. B2 measures the output difference between t = 1 and t = 2.

When the DRS production function of the industrial economy changes to the IRS production function of the digital economy, it is generally assumed that technical progress becomes faster. However, even if the technical progress is assumed to be the same as with A2, the output increase would be much bigger (see Fig. 5.3b). Even if the production function only changes to the IRS type, the difference between the outputs with and without technological innovation at t = 2 (B′1) is much wider than with the DRS type of production function (B1 < B′1). As a result, the difference between the total outputs q = 1 and q = 2, at t = 1 and t = 2, respectively, is also much larger with an IRS than a DRS (B2 < B′2) production function.

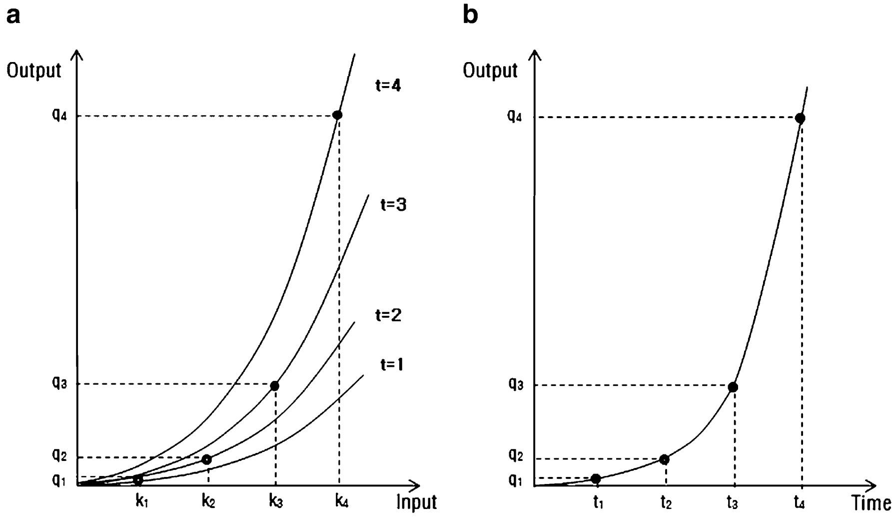

Fig. 5.4 Time-output relationships in the digital economy

Finally, the shift of the digital economy's APF with time appears to be similar to Fig. 5.4a. Looking at Fig. 5.4b, which traces the output according to the time frame of Fig. 5.4a, the long-run output curve of the digital economy accelerates faster than in Fig. 5.2b, which represents the industrial society.

In the digital economy, not only does the production function change from a DRS to an IRS type, but also the technological progress becomes faster than in industrial societies. Therefore, the output increase over time is much bigger than in industrial societies, and its acceleration rate of economic growth is also much faster.

Figure 5.5 compares the shifting patterns of APFs over time among the agricultural, industrial, and digital economies, as illustrated in Figs. 5.1, 5.2, 5.3, and 5.4. On the assumption that the shift in each APF starts at the same time (t_1), the pattern of each society's economic growth can be compared in one graph. In other words, we will compare the decelerating agricultural society with the industrial society and the digital economy that diverged from the agricultural society at t_1. Although the agricultural and industrial societies have a DRS-type production function in common, the range and pace of technological changes in the long run are different for the two societies. This causes the economic growth path of the two societies to diverge; the former becomes a decelerating and the latter an accelerating society. As for the digital society, its long-term growth trend is similar to that of the industrial society, but it accelerates much faster. Therefore, the economic growth of the digital economy is faster than that of the industrial society. This difference occurs because the acceleration mechanism and the pace of the digital economy's economic growth are based on the IRS production function, which is quite different from the DRS production function of the industrial society. For this reason, it is more appropriate to consider the faster acceleration system of the digital economy not as a continuation of the former industrial society's economic growth but as the emergence of a new economic system.

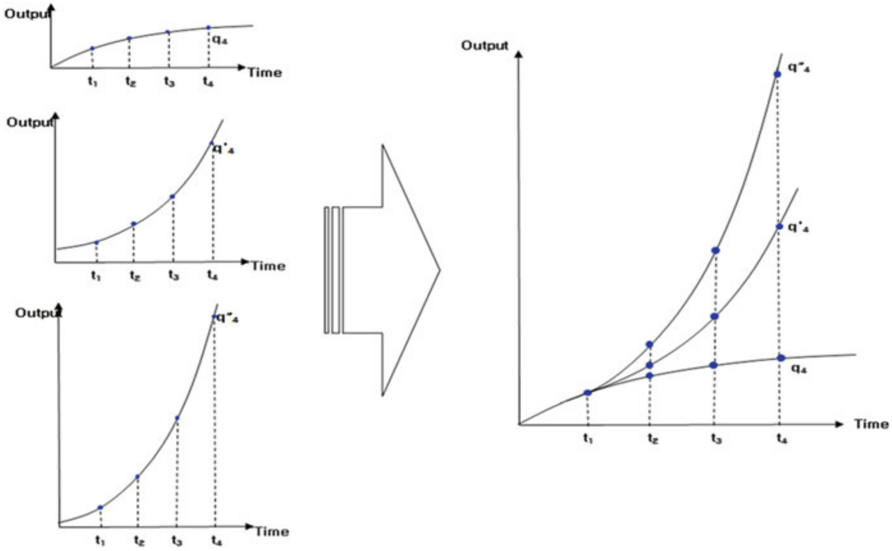

Fig. 5.5 Comparison of shifting APF patterns over time among agricultural, industrial, and digital economies

5.3.2 ERS of the Faster-Accelerating Digital Economy

Figure 5.6 illustrates three principles of the digital economy, represented by paths ①, ②, and ③, which help the virtuous cycle of the ERS of the industrial society to circulate more efficiently and faster with ICT developments.

The ERS of traditional industrial societies shows the virtuous cycle of economic growth, in which supply and demand increase by capital accumulation and technological innovation and then the increased supply and demand create expanded market equilibrium. It also explains the accelerating growth of an economy over time (Kim et al. 2010b).

ICT developments in the digital economy have similar effects as do technological innovation and accumulation in traditional industrial societies, but the spillover effects influence all types of industries and the entire cycle of the economy, in addition. Thus, as the driving force of the digital economy is based on the developments and utilization of ICT, we need to treat the effects of ICT developments not as part of industrial technologies in the ERS of the industrial society but as new independent technologies, in order to understand exactly the virtuous cycle of ERS in the digital economy.

The digital economy based on ICT has a different impact on economic growth compared to previous industrial societies in three respects. First, ICT contributes to efficient uses of traditional industries, which stimulate the development of new ICT convergence products. Furthermore, productivity improves, and the production

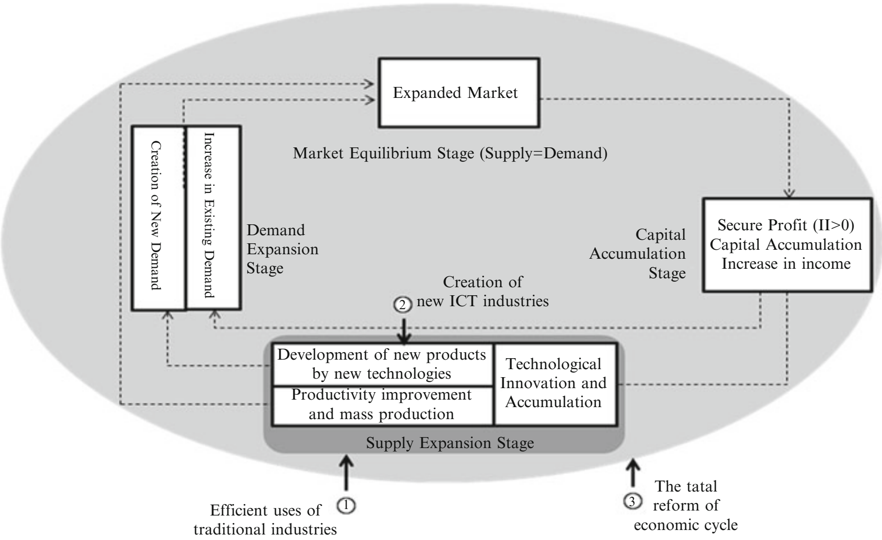

Fig. 5.6 Restructured ERS in the digital economy

cost reduces. As a result, technological innovation and accumulation in traditional industries are reinforced. Such effects are represented by arrow ① in Fig. 5.6.

Second, ICT industries themselves have a key role in supply. The development of ICT created new industries such as ICT manufacturing or ICT service that provide new goods and services that did not exist in previous industrial societies. This effect not only stimulates the expansion of supply in the ERS by experiencing the production expansion in IT industries at the industry level but also creates new demands as well as new industries. This kind of ripple effect is different from the previously mentioned ICT spillover effect for efficient uses of traditional industries. This involves the creation of new ICT products and the productivity improvement of ICT industries. This relationship is represented by path ② in Fig. 5.6.

Lastly, the impact of ICT developments on the virtuous cycle of ERS is not just confined to the production part. As we already saw in Sect. 5.2.3, ICT developments generate positive effects on the entire economy. Arrow ③ represents this relationship in Fig. 5.6. Overall social change that occurs in the digital economy causes the cycle of ERS to accelerate faster. Likewise, ICT developments exert mitigating influences on the management cycle of macroeconomics and improve its efficiency, leading to an overall market equilibrium.

The faster-accelerating production expansion curve of the digital economy is a result of the weighted average of the pure market creation effect by ICT industries and the productivity improvement effect by ICT-infused traditional industries. The weights used here can vary according to the proportion of digital industries and goods in the entire economy. The larger the proportion, the faster is the accelerating growth of the digital economy.

5.4 Case Studies

First, we present the New Economy of the US, the leader of industrial societies. Next, we consider Ireland and Finland, both early digital economies of Europe. Their economic growth surpassed that of other industrial countries in Europe, even though they lagged behind other countries during industrialization. Analyzing ICT-producing industries' labour-productivity and GDP data, we examine if these cases have digital economy attributes such as the traditional capital deepening and new-industry creation. We do not include the overall social changes generated by ICT to test if the cases are relevant examples of the digital economy, because this effect is difficult to be quantified and captured in the early stages of the digital economy, though it is possible to glimpse it through some macroeconomic indices like GDP. This investigation is left for future research.

5.4.1 The Digital Economy in Leading Industrialized Countries

The economic growth of the US, though a technology leader, is often predicted to be slower than other countries adopting its innovation. However, in the middle and late 1990s, the US enjoyed the highest GDP per capita and the fastest economic growth among major industrial countries. In the Economic Report of the President (White House 2001), this period of high economic growth of the US during this period was described as the 'New Economy'. The report mentioned that a notable feature of this period was the rapid growth of ICT industries.

During the New Economy period, the US grew faster than any other country, and ICT played a remarkable role in this rapid economic growth. Table 5.2 shows that in comparison with the EU total productivity recorded marked improvement in the US and the role of ICT increased rapidly between the early 1990s and the late 1990s, a period considered to be part of the New Economy phase. This means the US was one step ahead of the EU in its transition to a digital economy during this time.

Figure 5.7 depicts the change of GDP per capita for the US and OECD-Europe[2] from 1960 to 2006. The US economy grew rapidly from the middle of the 1990s. From 1995 to 2000, the GDP per capita increased annually by 3.87 % on average.[3] In the same time frame, the GDP per capita for OECD-Europe increased annually

[2] OECD-Europe covers, in addition to EU 15, the Czech Republic, Hungary, Iceland, Norway, Poland, the Slovak Republic, Switzerland, and Turkey. We assume there is no significant difference between EU15 and OECD-Europe, with regard to their representativeness.

[3] The US economy experienced a temporary recession in 2001. The adjustment process after the rapid economic growth, the decrease in bond price and increase in interest rate, the increase in energy price, the collapse of the high-technology sector, and the impact of Y2K and 9/11 are cited as the reasons (White House 2002).

Table 5.2 Rate of productivity increase and contributions from ICT: the US and the EU

	1990–1995		1995–2000	
	US	EU15[a]	US	EU15[a]
Total economy	1.08	1.88	2.52	1.41
ICT producing	0.51	0.33	0.75	0.47
ICT using	0.43	0.42	1.42	0.42
Non ICT	0.23	1.10	0.36	0.48

Source: Van Ark et al. 2002

[a]EU 15 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom

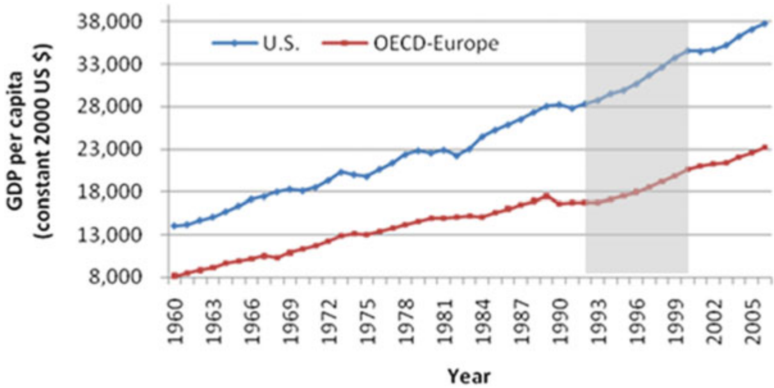

Fig. 5.7 GDP per capita for the US and OECD-Europe (constant 2000 US$) (Source: World Development Indicators Database 2008

by 3.13 % on average, which resulted in an expanding gap between the US and OECD-Europe. We can see that the New Economy left a large gap between the US and the EU in terms of economic growth.

Figure 5.8 describes the change of labour productivity in the US nonfarm business sector from 1977 to 2006. Whereas the rate of increase of labour productivity on annual average was 1.7 % for the whole period, it increased to 2.3 % for the period 1995 to 2000. These data confirm the remarkable increase of labour productivity during this period. Many studies pointed out in common that ICT is the main cause explaining the rapid increase of labour productivity in the New Economy after the mid-1990s (Stiroh 1998, 2002; Jorgenson and Stiroh 1999; Jorgenson et al. 2003).

In order to look into this phenomena in detail, we will review Oliner and Sichel's (2003) research, which estimated ICT contributions to labour productivity growth in the US from 1974 to 2001, categorized into ICT capital and ICT production (Table 5.3). Contributions from ICT capital was calculated by the capital deepening effect due to ICT assets, including computer hardware, software, and communication equipment. Contributions from ICT production was measured

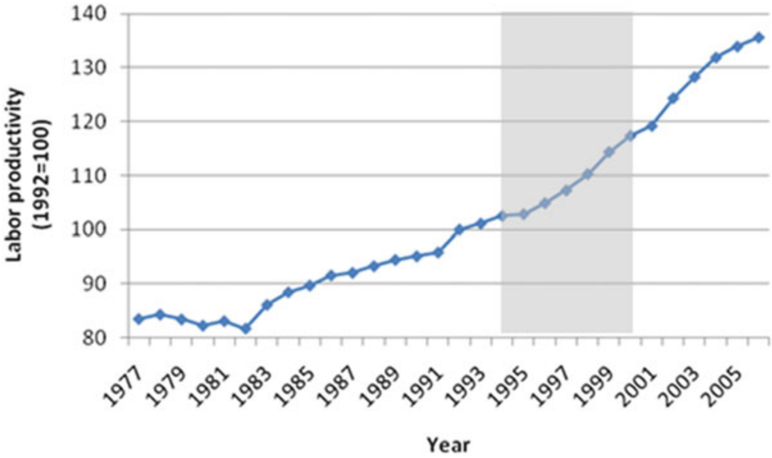

Fig. 5.8 Labour productivity of nonfarm business in the US (1992 = 100) (Source: The Bureau of Labor Statistics 2010)

Table 5.3 Contributions to the growth of labour productivity in the US

		1974–1990	1991–1995	1996–2001
Growth of labour productivity [a]		1.36	1.54	2.43
Contributions from	Capital deepening	0.77	0.52	1.19
	Labour quality	0.22	0.45	0.25
	MFP	0.37	0.58	0.99
Contribution from ICT	Total	0.68	0.87	1.79
	ICT capital	0.41	0.46	1.02
	ICT production	0.27	0.41	0.77

Source: Modified from Oliner and Sichel 2003, Table 1
[a]In the nonfarm business sector, measured as the average annual log difference for the years shown multiplied by 100

by multifactor productivity (MFP) from industries that produce ICT products, including semiconductors, computer hardware, software, and communication equipment. In other words, contributions from ICT capital are related to efficient uses of traditional industries by ICT, and contributions from ICT production are relevant to the creation of new industries by ICT. As the transition to the digital economy progresses, the proportion of its contribution to the improvement of labour productivity increases. ICT contributions to the growth of labour productivity for 1974–1990, 1991–1995, and 1996–2001 are estimated at 0.68, 0.87, and 1.79, respectively, which translates to 50.0 %, 56.5 %, and 73.6 % of the total growth of labour productivity resulting from ICT capital and production. On the basis of this analysis, Oliner and Sichel (2003) concluded that the accelerating growth trend of labour productivity in the New Economy after 1995 comes from ICT. In particular, the effect of ICT capital is noteworthy.

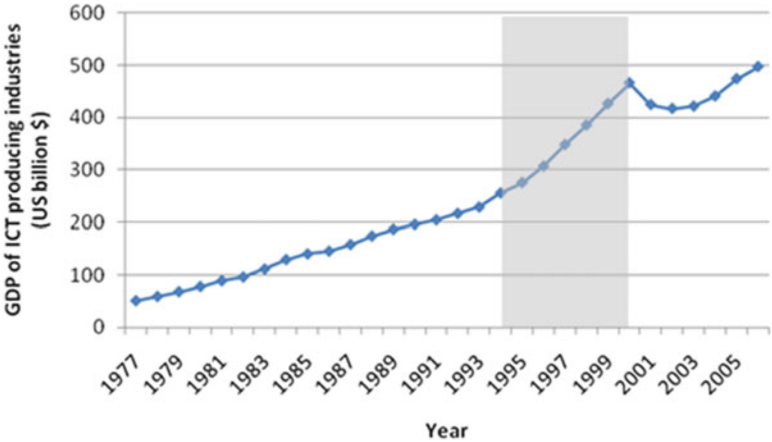

Fig. 5.9 GDP of ICT-producing industries in the US (in billion $) (Source: The Bureau of Economic Analysis 2010)

The GDP trend of ICT-producing industries[4] in the US that influence the creation of new industries is drawn in Fig. 5.9. The GDP of ICT-producing industries in the US grew rapidly after the mid-1990s and reached about 4.2 % during 1995–1999. During the same period, contributions from ICT to the economic growth of the US reached about 30 % (White House 2001). Although the size of ICT industries is relatively small, they play a key role in economic growth as its driving force.

Later, similar to the IT productivity paradox pointed out by Solow (1987), ICT contributions to economic growth were challenged since the GDP share of ICT-producing industries in the US dropped heavily in the early 2000s. Regarding this issue, the Economic Report of the President (White House 2002) explained that the ICT sector declined because the overheated stock market driven by the rapid growth of ICT calmed down and the demand for ICT capital decreased after the heavy investments by companies in 2000 to prepare for Y2K were no longer needed. Oliner and Sichel (2003) and Martinez et al. (2010) refuted the IT paradox and showed that ICT contributed to the growth of labour productivity even after 2000. The decline of ICT in the early 2000s was only temporary, and ICT is still the key growth engine for the US economy.

[4] The Bureau of Economic Analysis (BEA) grouped computer and electronic products, publishing industries (includes software), information and data processing services, and computer systems design and related services under the ICT-producing industry and estimates its GDP independently.

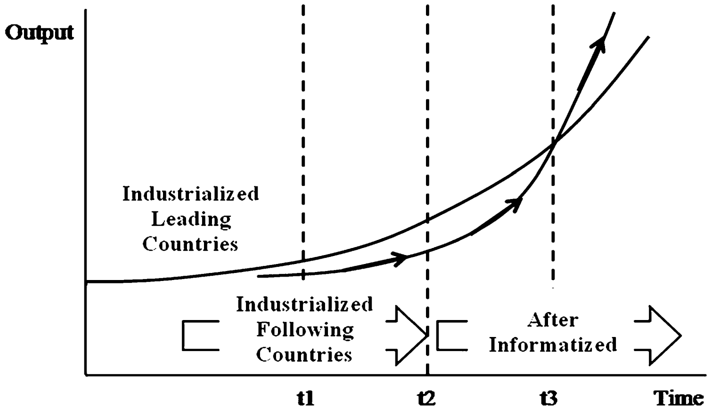

Fig. 5.10 Overtaking model of the digital economy

5.4.2 Digital Economy in Industrialized Following Countries

Despite the polarization in industrial societies, it is possible that following countries will overtake the leading countries if they adopt and develop a digital economy ahead of other countries. Figure 5.10 illustrates the process by which a faster-accelerating economy overtakes an accelerating industrial economy.

The speed of accelerating economic growth is measured by the slope of the time-output curve in Fig. 5.10. If the leading countries' economies are ahead in informatization, the gap between the leading and following countries will go on widening. However, if the following countries intensively invest in ICT to establish a faster-accelerating digital economy, the gap can be closed. In Fig. 5.10, the gap is broadening until t_2 in the process of industrialization. When the following countries enter the digital economy at t_2, the slope of economic growth becomes faster, and eventually the following countries overtake the leading countries at t_3. This paper presents two real-world examples among the following countries that show an outstripping economic growth curve: Ireland and Finland.

5.4.2.1 Ireland

Ireland experienced a serious financial crisis in the 1980s because of political instability and excessive government expenditure, and its GDP per capita dropped below 70 % of the European average. In the 1990s, however, Ireland intensively promoted ICT industries and, as a result, achieved a rapid 9 % annual growth, on average, in the mid- and late 1990s. This growth rate was the highest among OECD countries at that period of time. As shown in Fig. 5.11, Ireland grew remarkably faster than other economies, starting from the early 1990s. In the late 1990s, Ireland's GDP per capita surpassed the OECD and EU-15 (listed in Table 5.2)

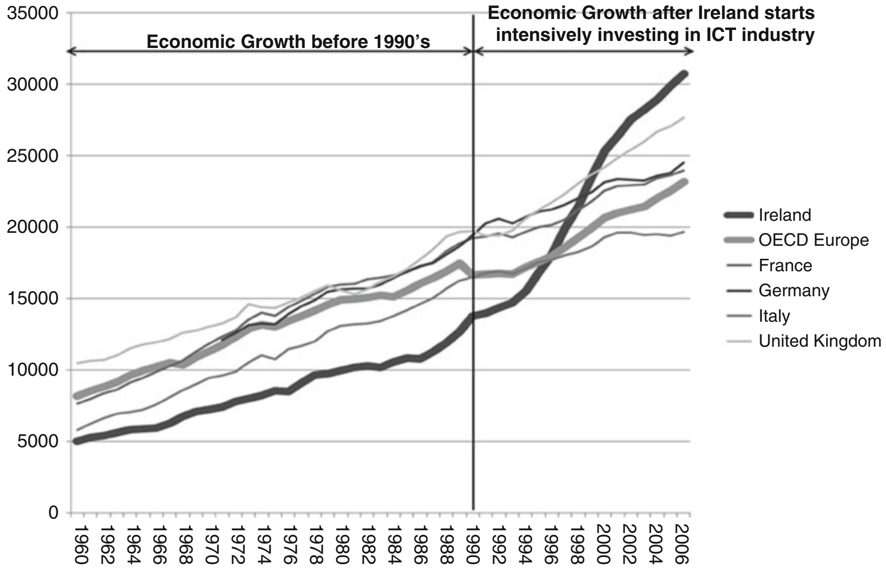

Fig. 5.11 GDP per capita of Ireland, OECD Europe (average), and other European countries (Source: World Development Indicators Database 2008)

averages, and the country emerged as one of the richest in Europe. In 2006, its GDP per capita, at $30,736, ranked ninth in the world.

Government policies that fostered software companies and focused on high-value-added ICT industries were the one factor that led Ireland into rapid economic growth. The country's domestic companies are technically inadequate, and the domestic market relatively small. From the 1990s, therefore, Ireland concentrated on policies that developed ICT industries by attracting competitive foreign companies. The Industrial Development Authority (IDA) offered various incentives such as tax benefits and financial support to attract foreign investments. As a result, many software companies, in particular, moved in and made considerable investments in Ireland. The development of ICT industries played an important role in the economic growth of Ireland, and the country achieved an annual average 4–5 % of economic growth, which was higher than the OECD average until the mid-2000s. However, Ireland began to experience economic downturn from the first half of 2008.[5] According to IMF (2009), though, the main causes of the economic bubble lie in the finance and construction sectors.

[5] Foreign direct investment (FDI) played an important role in the development of Ireland. However, before it could improve the productivity and efficiency of the domestic firms of Ireland, the inflow of FDI decreased, and finally the gross inflow of FDI turned to gross outflow in 2004. This lowered the potential growth rate of Ireland and expanded the GDP gap, which in turn intensified the economic bubble. In late 2007 when the bubble crashed, the banking industries suffered from a lack of funds as housing prices plummeted and bad loans increased. Finally, the aftermath of the global financial crisis in 2008 pushed Ireland into a period of economic recession.

Table 5.4 Contributions to gross-value-added growth in Ireland

	1990–1994	1995–1999
Gross-value-added growth	3.99	9.07
Contribution of capital input growth	1.37	3.51
(Contribution of ICT capital)	(0.25)	(0.71)
(Contribution of non-ICT capital)	(1.12)	(2.80)
Contribution of labour input growth	1.37	3.24
Contribution of multi-factor productivity growth	1.25	2.32

Source: EU KLEMS 2009

Table 5.5 ICT industries' contributions to labour productivity growth in Ireland

	1990–1995		1995–2000	
	Labour productivity growth	Contributions to productivity growth	Labour productivity growth	Contributions to productivity growth
Total economy	3.0		5.3	
ICT-producing industries	11.2	0.89	23.5	2.75
ICT-producing manufacturing	17.1	0.82	42.3	2.77
ICT-producing services	2.2	0.07	−0.2	−0.02
ICT-using industries	1.4	0.42	2.9	0.89
ICT-using manufacturing	6.1	0.37	8.7	0.56
ICT-using services	0.2	0.05	1.4	0.33
Non-ICT industries	2.6	1.48	2.7	1.65

Source: Van Ark et al. 2002

Table 5.4 shows the average contributions from each component to Ireland's GDP growth during 1990–1994 and 1995–1999. The total gross value added increased 2.27 times from the first to the second half of the 1990s. Moreover, contributions from ICT capital during this period increased 2.84 times, exceeding those from other components. The Table 5.4 confirms that the economic growth of Ireland accelerated as ICT industries matured, and the proportion of ICT capital's contribution to this growth continued to increase.

ICT also contributed substantially to the improvement of Ireland's labour productivity after the 1990s (see Table 5.5). Van Ark et al. (2002) estimated the ICT industries' contributions to the improvement of Ireland's labour productivity in the 1990s under three categories, following the international standard industrial classification of all economic activities (ISIC Rev. 3): ICT-producing, ICT-using (where the ratio of ICT capital is relatively high), and non-ICT industries. Contributions from ICT-producing industries represent the effects of ICT on the creation of new industries, and those from ICT-using are none other than ICT's effects on efficient uses of traditional industries. According to their analysis, the role of ICT industries, particularly the producers, was crucial to the improvement of Ireland's labour productivity.

The relatively high proportion of ICT industries in its economy helped Ireland achieve a faster-accelerating economic growth compared to the established industrial societies such as the UK, Germany, France, and Italy. Figure 5.12 shows the GDP trend of Ireland's ICT-producing industries.

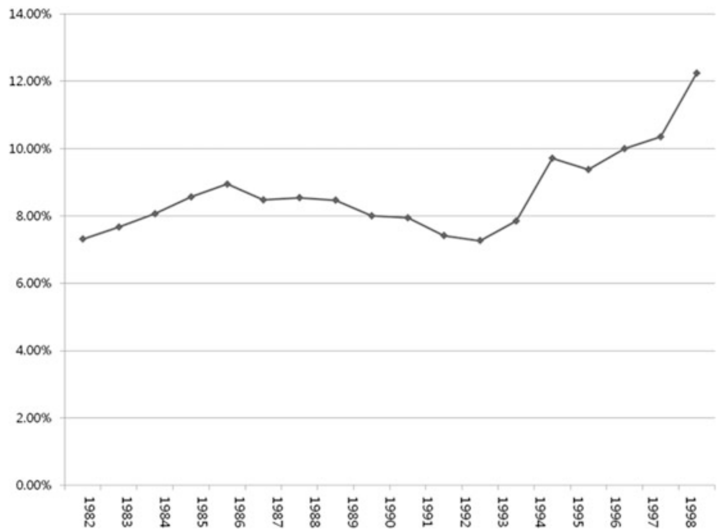

Fig. 5.12 GDP share of ICT-producing industries in Ireland (Source: The Groningen Growth and Development Centre 2005)

5.4.2.2 Finland

Figure 5.13 compares GDP per capita of Finland with the average GDP per capita of OECD Europe during 1950–2001. Finland experienced high economic growth compared to OECD Europe in the early 1980s, as financial institutions became free to raise and manage funds after financial and capital liberalization policies were applied. However, this period is also characterized by careless management of finances with financial institutions buying real estate and providing loans excessively (Fig. 5.13, A). In addition to this problem, the collapse of the Soviet Union, which was the most important export market, caused Finland to face a serious financial crisis after the late 1980s (Fig. 5.13, B). The foreign exchange shortage and the severance of trade with the Russian Federation forced the industrial structure of Finland to change. As a result, ICT industries, including the mobile phone and other hardware-manufacturing sectors, were developed as key industries. Fuelled by ICT, the economy of Finland has been growing faster than OECD-Europe ever since (Fig. 5.13, C).

Statistics reveal that the GDP growth from 1995 to 2001 was 5 %, on average, compared to 3.5 % from 1950 to 2001 (OECD 2002). In order to overcome the economic crisis, Finland announced an ICT promotion policy in 1994, before other countries did so. The government proposed a new policy aimed at 'education, training and research in the information society', and pursued the adoption and development of information technologies as the key national policy. As a result of these policies, Finland enjoyed a high economic growth and is now one of the most competitive countries among EU members.

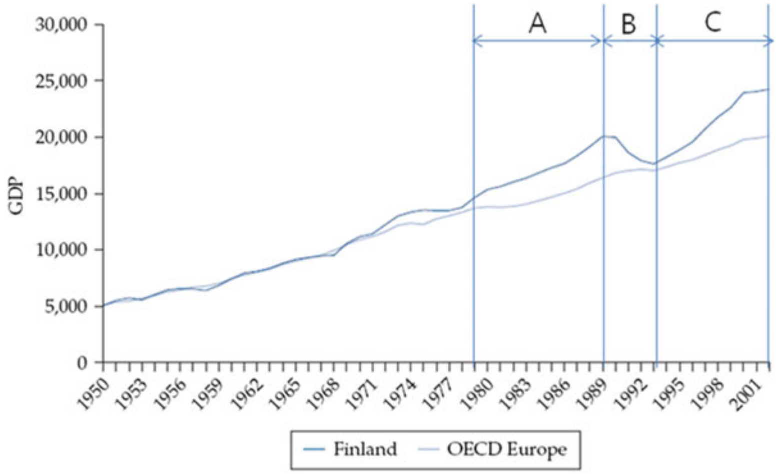

Fig. 5.13 GDP per capita in Finland and OECD Europe, at 1995 prices and purchasing power parity (PPP) exchange rates (Source: Carl et al. 2006)

Table 5.6 Factor contributions to the output growth of the Finnish non-residential market sector

		1980–1990		1990–2004	
		(a)	(b)	(a)	(b)
Growth of real gross value added at basic prices[a]		3.15	3.15	2.53	2.53
Contribution[b] from	Capital	1.10	1.32	0.37	0.53
	Labour	0.57	0.57	−0.35	−0.35
	Multi-factor productivity	1.48	1.26	2.51	2.35
Total contribution from ICT[b]		0.48	0.66	1.54	2.09
Contribution from ICT capital		0.22	0.44	0.24	0.43
Contributions from MFP	ICT production	0.26	0.22	0.91	0.89
	Spillovers from the use of ICT capital	–	–	0.39	0.77
Memoranda					
Income share of ICT capital[c]		2.45	2.62	4.63	4.62
Volume growth of ICT capital[a]		8.80	17.00	3.92	7.83
Output share of ICT production[c]		5.53	5.53	10.06	10.06
MFP growth in ICT production[a]		4.76	3.97	9.05	8.75

Source: Jalava and Pohjola 2008, pp. 270–287, Table 3
Notes: (a) Estimates based on non-hedonic ICT prices
(b) Estimates based on hedonic ICT prices
[a]In per cent
[b]In percentage points
[c]In per cent

Jalava and Pohjola (2008) divided the period between 1980 and 2004 into two sub-periods, 1980–1990 and 1990–2004, and analysed factor contributions to the output growth of Finland for each sub-period (Table 5.6). Regarding the effect of each component on GDP growth, contributions from ICT to GDP were investigated

Table 5.7 Average growth of labour productivity and its components in Finland, 1995–2005

	Share of GDP (%)	Volume growth (In %)	Contribution (In %)
GDP at market prices	100.00	4.06	4.06
Hours worked		1.19	1.19
Labour productivity		2.87	2.87
Capital deepening	34.62	1.86	0.66
Dwellings	9.92	1.15	0.13
ICT capital	3.27	13.95	0.46
Other capital	21.42	0.01	0.07
Labour quality	65.38	0.22	0.14
Multi-factor productivity		2.07	2.07
ICT related contribution			1.41
Other contribution			0.66

Source: Jalava and Pohjola 2007, pp. 463, Table 2
Notes: Numbers may not sum to totals due to rounding

by three categories: ICT production, ICT capital, and spillovers from the use of ICT capital. ICT production includes ICT manufacturing for electrical and optical equipments, and post and telecommunication services. ICT capital refers to the assets invested in ICT industries. The spillover effects by the use of ICT capital are estimated by investigating 21 industries—including agriculture, mining, manufacturing, gas, and water—classified by Nordhaus (2002). In other words, these three categories correspond to the previously mentioned impacts of the digital economy on the ERS: ICT production is an equivalent term for the creation of new industries by ICT, and ICT capital and spillovers from the use of ICT capital represent the efficient uses of traditional industries.

Table 5.6 shows ICT's total contribution to GDP growth from 1990 to 2004 was almost three times the 1980–1990 rate. Contributions from ICT production increased 3.5 times, but the increase from ICT capital was not significant. Even if the spillover effect is excluded, the contributions from ICT production and ICT capital to GDP growth from 1990 to 2004 increased almost 2.5 times (about 3 times if the spillover effect is included).

According to Jalava and Pohjola (2007), Finland's labour productivity grew 2.87 % from 1995 to 2005. Table 5.7 shows ICT's contributions to labour productivity. The data confirm that the influence of ICT on the creation of new industries is substantial. The ICT impact on total labour productivity, which is the sum of ICT capital and ICT-related contribution, was found to be about 65 %.

Figure 5.14 illustrates the GDP share of the ICT sector in Finland. The proportion of the ICT sector increased at an accelerating rate from the early 1990s and doubled by the early 2000s to reach 10 %. On the other hand, the percentage of the forest industry, which was traditionally strong, dropped lower and lower, to nearly 3 %. The Fig. 5.14 reveals the effects of the creation of new industries by ICT, and shows that ICT was the driving force of the rapid growth of Finland in the 1990s.

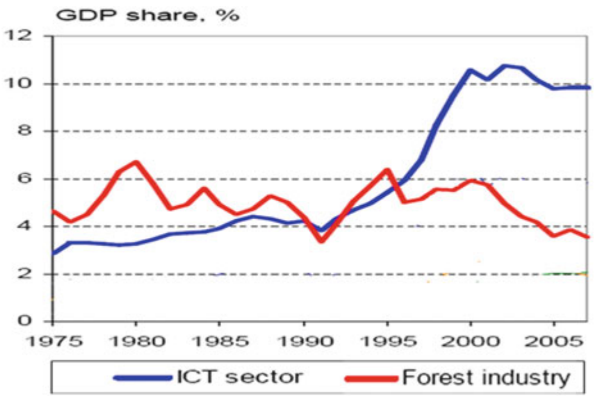

Fig. 5.14 Changes in the GDP shares of ICT sector and forest industry in Finland (Source: Pohjola 2008)

5.5 IT Paradox of the Digital Economy Revisited

In the cases presented in the previous section, we saw that ICT contributed a substantial part of economic growth. However, some researchers argue that the New Economy of the 1990s ended unsuccessfully in the US. Finland and Ireland also have recently gone through economic crises. According to the OECD report of 2007, ICT capital accounted for not more than 20 % of GDP growth in an average country. From these arguments, it is still debatable whether ICT has a direct effect on improving productivity and accelerating economic growth. Actually, these doubts have existed for a very long time.

The term IT productivity paradox can be traced to what Solow said in 1987: 'You can see the computer age everywhere but in the productivity statistics.' There are largely two arguments about why the IT productivity paradox provokes controversy: First, some scholars argue that the effects of IT investments on production are not as apparent as we would expect because statistical methodologies are not sufficiently developed yet to calculate the relationship exactly. Others claim that ICT is simply not yet fully mature to be effectively incorporated into every step of production and its organizations, and thus the effects of ICT are not completely revealed yet. The latter insist that productivity effects from ICT appear with a time lag after the technologies are developed (Hilbert 2001).

Since Solow stated the IT paradox, many research studies have investigated whether there is a positive relationship between ICT and productivity. One of them was Schreyer's (2000), which reaffirmed that ICT capital was a critical factor for economic growth in all G7 countries, though to a different degree in each country. Hilbert (2001) also validated the high growth from IT and tried to measure it in different ways.

On the other hand, David (1990) and Crafts (2002) proposed a time lag to explain the IT productivity paradox. Both of them pointed out that it took more than a century for the invention of the steam engine in England, during the Industrial Revolution in the eighteenth century, or the invention of electricity in

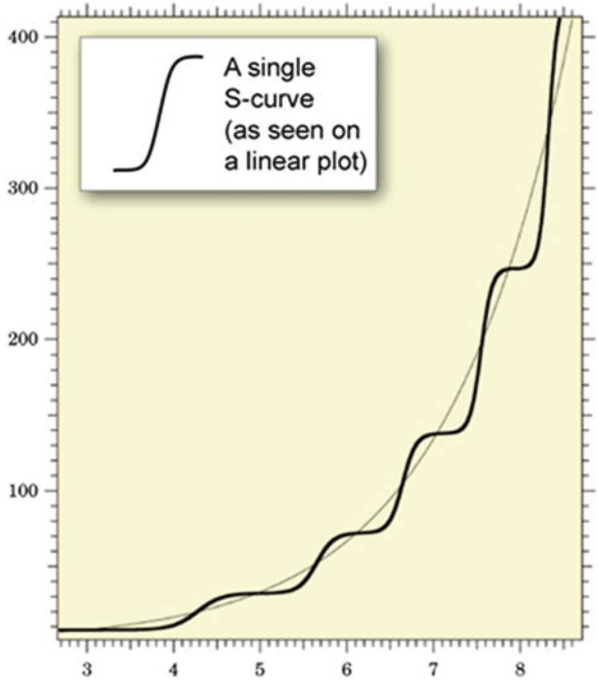

Fig. 5.15 An ongoing exponential sequence made up of a cascade of S-curves (linear plot) (Source: Kurzweil 2005, p. 43)

the nineteenth century to demonstrate practical influences on economic growth. Therefore, both of them were sceptical about Solow's productivity paradox as it judged the relationship between ICT developments and economic growth only on the basis of current observed data. David (1990) warned that productivity might be underestimated as it was very hard to measure all the relevant outputs that a technology produced when productivity was evaluated. In the case of electricity, although the filament was invented in 1879, it was not until the early 1920s that electricity affected productivity improvement, because the relationship could be visible only after electrical equipment spread among at least a half of factories, stores, and homes.

Figure 5.15 shows that a single technological paradigm forms the S-curve by going through the three steps of slow growth, rapid growth, and leaving off, while the overall sequence of cascaded technological paradigms sticks to an exponential growth trend (Kurzweil 2005). Kurzweil's (2005) S-curve explains the contradiction that the productivity does not increase, and even appears to decrease, as a technology progresses in the early years of the technological revolution. This is not an uncommon phenomenon during the period of a paradigm shift.

Meanwhile, Hilbert (2001) presented the theory of creative destruction of innovation, which proposes that one technological innovation pulled the next, the former becoming the foundation for the latter in the process. According to this mushroom effect of innovation, the next technological innovation has already begun when the former reaches its peak, but has a latent period to capture the

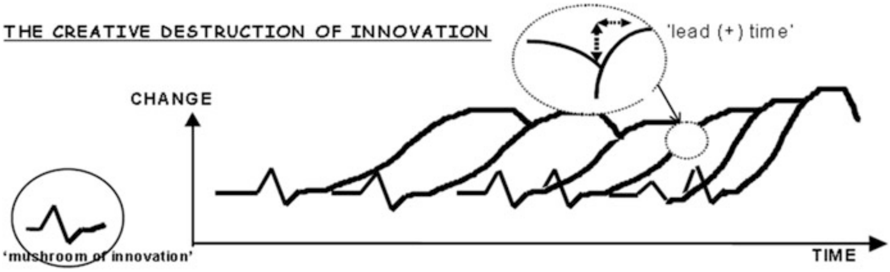

Fig. 5.16 The creative destruction of innovation (Source: Hilbert 2001, p. 53)

market in an industry or a society. From this point of view, the effect of a new technology on industries in general, or on productivity improvement in particular, may well appear to be relatively lower than that of the existing technology in its incipient stage (Fig. 5.16).

It is possible that the growth of the digital economy, at the start, is slower than that of the existing industrial societies. However, it just looks slower because this new economy is in its initial phase. Brynjolfsson and Hitt (1998) said that the long-term benefit from IT investments was profit, not only directly from IT but also indirectly, from changes of technological systems and organization. They forecasted that even if computerization could not improve the current productivity, it would finally bring in productivity growth as ICT grows progressively faster. David and Olsen (1986) mentioned that the speed of technology adoption was slower than the social optimum needed for the transfer of technology in an industry. Gordon published a paper in 2002 proposing that technological acceleration through ICT in the 1990s could create an IT boom based on the social infrastructure that the US already had, but could not tell if it affected the productivity growth of other industries and the whole society. However, in another paper of his, published in 2003, he agreed that the sudden productivity increase in the early 2000s was due to the continuous increase of ICT investments. As with these studies, during the relatively short period of time called the 'transition period', the positive relationship between ICT development and economic growth might not be fully recognized. Putting all the above ideas together, the stagnation of the digital economy at its immature stage is also a part of its faster-accelerating characteristics, which is the main topic of this paper, because an accelerating curve exhibits the characteristic of the very slow rate of increase in the initial phase. This situation is almost identical to the history of the industrial society. A controversy about the Industrial Revolution existed in the initial stage of the industrial society as well. Scepticism about the Industrial Revolution was on the rise among people who experienced low growth in the initial stages of the industrial society, but later it turned out that this was due to a misunderstanding about the characteristic of accelerating economic growth of the industrial society. Thus, this paper predicts a faster-accelerating economic growth through ICT as an inevitable outcome, notwithstanding the IT productivity paradox of the current digital economy.

Furthermore, the state-of-the-art science and technologies such BT and NT, which are advancing phenomenally, are expected to be drivers of an explosive growth to power the economy towards the faster-accelerating knowledge-based society.

5.6 Discussion and Conclusion

The knowledge-based society is expected to bring about significant changes in the production process, which means that intellectual production factors such as knowledge and information will substitute for a large portion of traditional material production factors such as labour, capital, resources, and energy. In the future, new knowledge-based goods and services made of these new production factors will provide the driving force for economic growth and national development. The ICT Revolution that has given rise to the digital economy is the very first key to open the knowledge-based society.

Regardless of whether the digital economy represents a continuation of the previous industrial economy or the emergence of a new type of economy, it is clear is that a transition to the digital economy brings about faster changes and development than were ever witnessed in the previous industrial societies. This paper concludes, from an investigation into the definition, characteristics, and mechanism of the faster-accelerating digital economy, that the digital economy is a new economic growth structure, which is qualitatively different from the former industrial society, despite the similarity in the growth pattern. In addition, it is confirmed that the innovative development of ICT is the force behind the faster acceleration of the digital economy.

The major contribution of this paper is to classify the reasons of the digital economy's faster-accelerating economic growth into three groups and to investigate how these features make the ERS of an economy more efficient. The digital economy has already been studied by many scholars, who have advanced various theories, including the increasing returns of software industries, path dependency, network externality, and the tipping effect in technology standardization. However, although these theories could explain why a certain industry accomplished a sudden growth in the digital economy, they were insufficient to describe the changes of an economy as a whole or explain how different from former societies is the one arising from the digital economy in exhibiting its growth pattern. This paper segmented the ERS of the digital economy by dividing the ICT development effects in the economy into the efficient uses of traditional industries through convergence, the creation of new industries by ICT and the IRS production function driving new demand, and the total social changes expediting the economic circulation. In particular, we theoretically verified that the faster-accelerating economic growth, distinct from the industrial society, occurred because the IRS short-term production function along with the rapid technological progress of the digital economy could accelerate the growth curve of the digital economy faster than the previous industrial societies in the long term.

The second contribution of this paper is to demonstrate real-world examples that the digital economy indeed surpassed the traditional industrial societies in the rate of economic growth and to reaffirm the potential for the advancement of the knowledge-based society of the future. The examples provided in this paper, the US, Ireland and Finland, experienced faster economic growth than before by the advancement of ICT industries and the technological innovation. The effect of the efficient uses of traditional industries by ICT, combined with the effect of the creation of new industries by ICT, led to the improvement of labour productivity. Besides, the effect of the creation of new industries by ICT influenced the growth of GDP as well as the change in labour productivity. These examples showed that the countries far surpassed other countries in terms of GDP and the gap became progressively larger because they entered the digital economy earlier than others. Although all three countries seemed to face stagnation in their economies by the late 2000s, this was due to other problems not directly related to the characteristics of the ICT-based digital economy. It is easily expected that, when the knowledge-based society becomes fully mature in the future, the digital economy based on ICT will be the society in which economic growth will accelerate faster than in any society that existed previously.

Third, this paper pointed out that the ICT productivity paradox was based only on short-term and temporary situations at the incipient stage of the digital economy. The ICT productivity paradox arose from a contradiction when the effect of ICT investments for economic growth fell short of expectations. It is possible that the growth rate of the digital economy, in spite of its faster-accelerating property, may be slower, for a while, than that of the existing industrial society that has reached full maturity, because the digital economy has just started. This situation is similar to the development process of the industrial society. The economic growth of the industrial society started slowly in the beginning despite the inventions of steam engine and electricity. However, after the dissemination and utilization of the technologies began in earnest, no other old production style could catch up with the mass production of the industrial society. Therefore, the digital economy based on ICT might also exhibit low growth during the transition period, which caused scepticism about the Industrial Revolution in England. However, it will ultimately reveal its original characteristic of faster acceleration.

Finally, the paper provides insights into the economic growth of the knowledge-based society. If it was the Industrial Revolution that overcame the Malthusian trap of the agricultural society, it will be the knowledge-based revolution initiated by ICT that will resolve the fundamental challenges and hardship that modern industrial societies are now facing. Global issues such as the exhaustion of energy resources, global warming, and the destruction of the ecological environment are problems caused by industrial societies, which industrial technologies could not resolve. They are basically considered as the unavoidable cost paid to accomplish the remarkable benefits that caused the population to increase about 6.8 times and the income level to rise about 9.1 times compared to the days of the Industrial Revolution in the late eighteenth century. In order to resolve the cost issues without abandoning these achievements, we have to pursue future state-of-the-art new technologies like ICT, BT, and NT, which generate new value, rather than adopt solutions based on the social sciences, like the law and the regulations. Moreover, it is true that there is no better solution than to rely on state-of-the-art new technologies for the desperate issues humankind confronts in these days, and for the improvement of the quality of life while absorbing the rapid increase of the developing countries' populations. No one yet knows how BT and NT, which we will develop some day in the not too distant future, will contribute to the welfare of humankind through economic growth and development. In this regard, this paper, which investigated the fruits of the digital economy that humankind has already tasted to some extent, though it has just arrived, is expected to provide clues for the discovery of the wonderful realities of the future knowledge-based society that will have reached full maturity.

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Chapter 6
The Faster Accelerating Growth of the Knowledge-Based Society

Tai-Yoo Kim, Mi-Ae Jung, Eungdo Kim, and Eunnyeng Heo

Abstract The first contribution of this study is to identify the economic growth patterns of the emerging knowledge-based society of the future, compared to the agricultural society or the industrial society, by analyzing the aspects of future technologies and new humankind and their effects on the value creation structure. The second contribution of this study is to highlight the characteristics of the new humankind in a knowledge-based society. A number of studies related to economic growth from the long and macro perspective have considered only the conventional aspects of individual humans—for example, a rational consumer or a labor

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supplier—but this study has considered newly emerging groups with different socio-economic characteristics and their effects on the economy and society.

Keywords Knowledge-based society • Future technology • New humankind • Digital Native • Active Senior • Economic growth • Faster acceleration • JEL Classification Numbers: D83; L63; L86; L96; O33; O47

6.1 Introduction

The pattern of economic growth in a knowledge-based society is expected to be different from that in an industrial society, which depends more on tangible factors of production, such as land, iron, or oil, than on intangible factors (David and Foray 2003; Drucker 1998; OECD 1996). Especially the information technology (IT)-driven economic growth in the era of the 'new economy' at the end of 1990s in the U.S. suggests the possibility of a new society and new pattern of economic growth.

The digital economy,[1] based on IT innovation, has changed society with increasing speed; examples are the shortening of the cell-phone technology cycle or the emergence of rapidly growing companies like Google. Such a rapid change of technological and industrial environment brings not only changes in firm management but also social changes and, in particular, the emergence of a digital generation (Tapscott 1999, 2009). The newly emerged generation, as the main actor in consumption and production, drives technological development and industrial growth, and accelerates market expansion (Giurgiu and Barsan 2008; Ritzer and Jurgerson 2010).

The bio-economy, driven by economic growth and population aging, will have an impact on the entire economy, including the health, energy, and agriculture sectors (OECD 2009a). An active senior group, based on economic growth and population aging, is expected to grow rapidly and to have an enormous impact on future consumption patterns (Silvers 1997; Wolfe and Snyder 2003). Economic growth and high income will increase health demands. In particular, the growing population of elderly will increase the market demand related to health care and wellness and, therefore, will drive bio-economic growth (Meara et al. 2004; OECD 2009a).

The computer, electrical device, and airline industries grew rapidly from the 1970s to the 1990s, reaching a 20–25 % share of total production and export in the OECD countries; and more knowledge-intensive industries, such as the education, communication, and information sectors, have been developing more rapidly (OECD 1996). The annual average growth rate of the U.S. bio-industry, having a share of more than 70 % in the world bio market, remained at 14 % for 10 years after 1966 (BIO 2008).[2]

Knowledge-based industrial growth is changing the firms' value-creation mechanism from tangible-factor based to intangible, intellectual-factor based. Investment on intangible assets in the firm has already increased to the level of investment on tangible assets (OECD 2008). A U.S. economist, John Kendrick, said that the intangible capital: tangible capital ratio was 30:70 in 1929 in the U.S., but

[1] The definition of digital economy is described in Appendix 1.

[2] Calculation using the data from the annual issues of BT industry report by Ernst & Young.

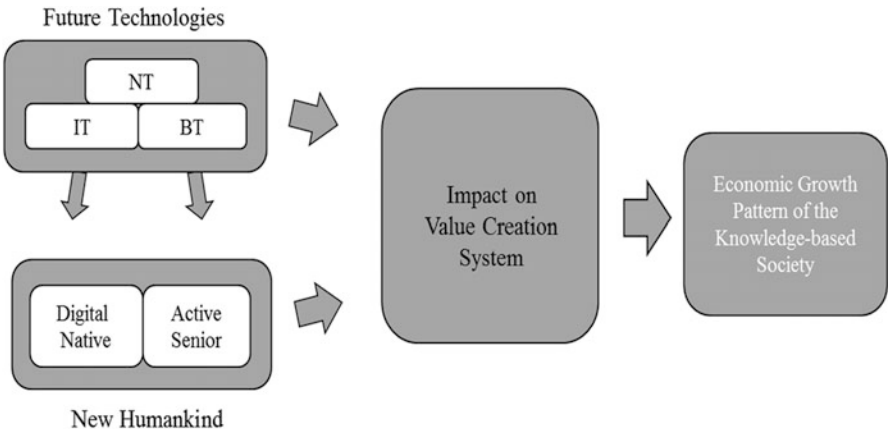


Fig. 6.1 Research framework

intangible capital overtook the tangible, with a ratio of 63:37 in 1999 (Seubert et al. 2001). Drucker (1998) foretold the birth of the knowledge-based society in which knowledge would substitute for physical capital or labour.

Joseph Schumpeter and neo-Schumpeterians have theorized and empirically proven the relationship between technological change and economic growth. Most research on economic growth focuses on determinants of the economic growth rate across countries (Barro 1991; Freeman 1995; Nelson 1993). However, not enough studies identify long-term changes in the economic growth pattern from technology, especially as related to the emergence and development of scientific knowledge-based technology and its co-evolution with humankind and society. This study aims to identify the economic system and growth pattern of the future knowledge-based society, and the continuation of hyper-long-term social changes, subsequent to agricultural and industrial societies.

This study presents three phases to analyse the differences between the economic growth patterns of the knowledge-based society and the industrial society (Fig. 6.1). The first phase identifies aspects of the future knowledge-based society by studying the characteristics of future technologies and their impacts—which are main parts of future global trends—on industry and society (Sect. 6.2).

According to the various prospects of future technologies and MIT's annual projections,[3] future technologies can be classified into IT, Biotechnology (BT), Nanotechnology (NT), and convergence technologies among these or with traditional industrial technologies. Therefore, this study analyses IT, BT, NT, and their convergence technologies to identify technological and socio-economic aspects of a future knowledge-based society. In particular, this study examines the socio-economic aspects of the new society to include changes in human behaviour, focusing on Digital Natives and Active Seniors who behave differently from conventional consumers in a traditional industrial society.

[3] MIT (2001–2009) makes a list of top 10 emerging technologies, technologies every year (2001–2009).

The second phase analyses changes in the value creation system of an industrial society from the economic and social aspects of a knowledge-based society (Sect. 6.3.1). The third phase defines the economic growth pattern governed by a transformed value creation system in the knowledge-based society (Sect. 6.3.2). This study does not, however, discuss whether or not a knowledge-based society should be defined as fundamentally different from an industrial society.

6.2 Characteristics of the Knowledge-Based Society

In this chapter, we discuss the technological characteristics, as well as the economic and social influences of IT, BT, and NT, the core technologies of the knowledge-based society, and the convergence technologies that connect legacy industries.

6.2.1 IT, BT, and NT: Rules of Technological Progress

6.2.1.1 IT

Information Technology (IT) is technology for handling information, including the acquisition, storage, transmission, process, display, and protection of information (Longley and Shain 1985). Canton (2006a) points to the computer, the microchip, and the Internet as the technologies with the greatest influence on jobs, communication, creativity, and entertainment.

The most fundamental convergence technology is IT because it allows information processing to converge with other technologies. The development of semiconductor/computer technology leading IT is represented by Moore's Law (1965). The law states that the power of computing doubles every 18 months while the cost does not; hence, the cost of computing falls over time.

The most important characteristic of IT is that the technology develops information systems to increase the benefit from the enhanced productivity of other industries. An industry's computerization and digitalization make each production process faster and more efficient, thereby improving productivity. In spite of controversy over Solow's productivity paradox in 1987, Brynolfsson and Hitt (1998) assert that even though computerization does not automatically deliver a productivity increase, the changes to industrial structures do increase productivity.

The second characteristic of IT technology is its network and tipping effect. Shy (2001) theoretically defines the network effect as shown in computer hardware and software industries. His study on the market's characteristic difference arising from the unique characteristics of software products (easy reproduction and network effect) reveals that while the characteristics of competitive markets for traditional products are not shown in the software market, one technology dominates the market in advance. This kind of tipping effect becomes a fundamental of technology-centred growth acceleration in the digital economy. Harrington and Reed (0)1 also showed a 'virtuous cycle of e-commerce growth'. Based on the circulation structure

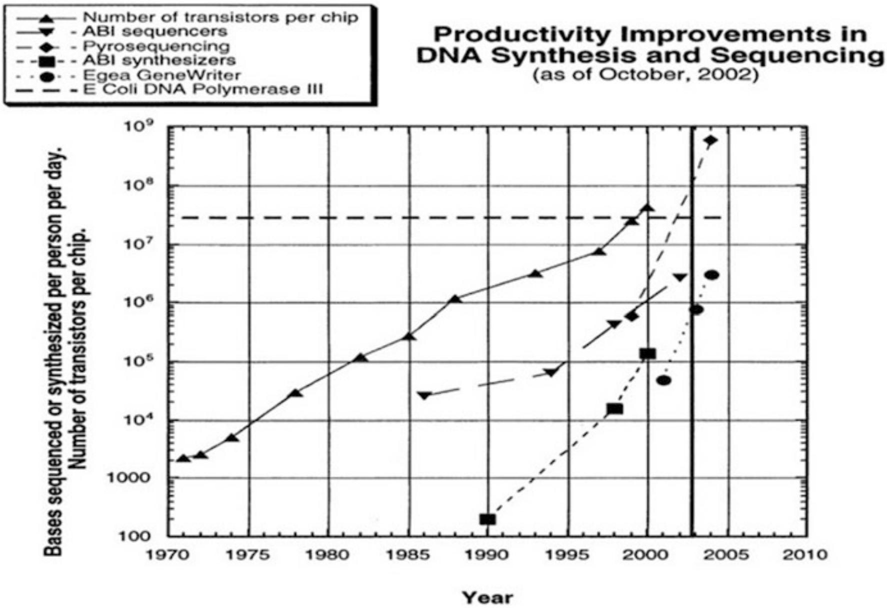


Fig. 6.2 Productivity increase of DNA synthesis and sequence analysis

and having e-commerce itself as a production index in the digital economy, its accelerated revenue increase is well demonstrated.

6.2.1.2 BT

Bio Technology (BT) is based on the life sciences. The Office of Technology of the U.S. Congress defines BT as the technology for improvement of plants and animals; it also includes technology using living organisms and/or substances to develop microorganisms for special purposes. The European Federation of Biotechnology (EFB) defines BT as the integration of natural sciences of the individual, the cell, a part of the cell, and the molecule for products and services (Smith 2009).

Since the products and services of the BT industry relate to living phenomena, the technology requires complicated processes and source-based technologies. BT is also dependent on basic technologies so that the injected intangible value creates high value-added. Therefore, BT is based on cutting-edge knowledge in need of advanced intellectual talent, while it heavily influences change in the industrial structure not only for manufacturing, but also for IT and NT (The Gyeongnam Development Institute 2008).

BT's production characteristics can be examined through the Carlson Curve (Carlson 2003), which shows the changes in BT's productivity and cost. In 2003, Carlson forecasted that the efficiency of the DNA interpretation machine used in the genome project would double every 18 months and that DNA synthesis would accelerate at a faster rate. He also anticipated that the sharp decrease in the cost of

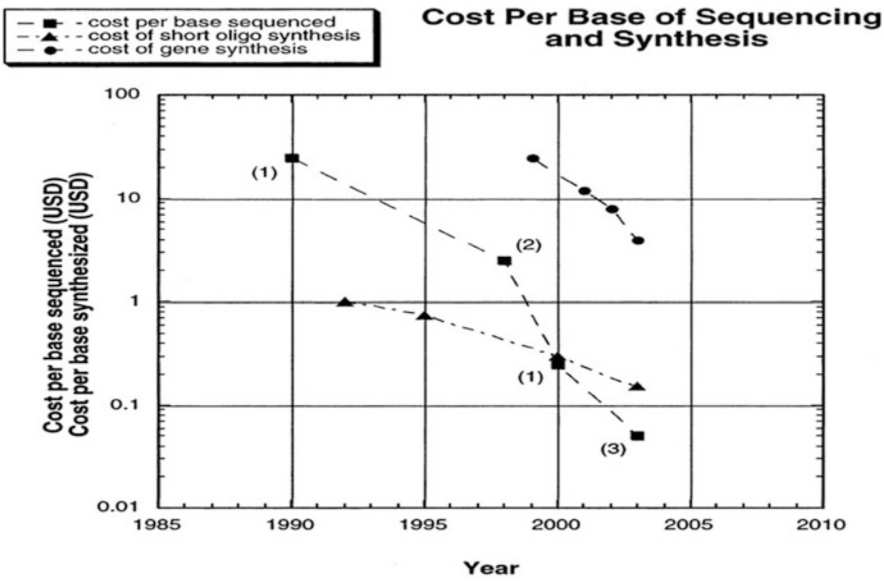


Fig. 6.3 Base sugar synthesis and sequence analysis cost

DNA synthesis would continue and that the DNA sequence analysis cost would drop to the $2 range from $10–12 in the year 2000.

Figure 6.2 shows the phenomenon very well: compared with Moore's Law, the representative law in IT, we can see that productivity increases faster. From a cost perspective, the tendency of the analysis construct is found to be decreased (Fig. 6.3).

The transistor density applied to Moore's Law is heavily influenced by large-scale investments. However, the cost of biology is relatively lower, so the effect of the investment scale is lower while the change is faster. Over time, it is also expected that the error of productivity will be lowered. Thus, it can be forecasted that BT's production function will show a larger acceleration than IT's production function. The data also shows that by 2009, productivity had increased and cost had decreased continuously (Carlson 2009).

6.2.1.3 NT

Nanotechnology (NT) is technological manipulation of matter on an extremely small scale known as the nano-scale. Though a standard global definition of NT does not exist, in general, it includes the following three elements (Bhushan 2006): first, 1–100 nm is the standard scale; second, nanotechnology deals with the characteristics and structures of material; third, it deals with the measuring and restructuring of the structures (Goddard 2007).

NT has three main advantages. First, since it is based on multidisciplinary characteristics, it promotes convergent development for IT and BT and provides

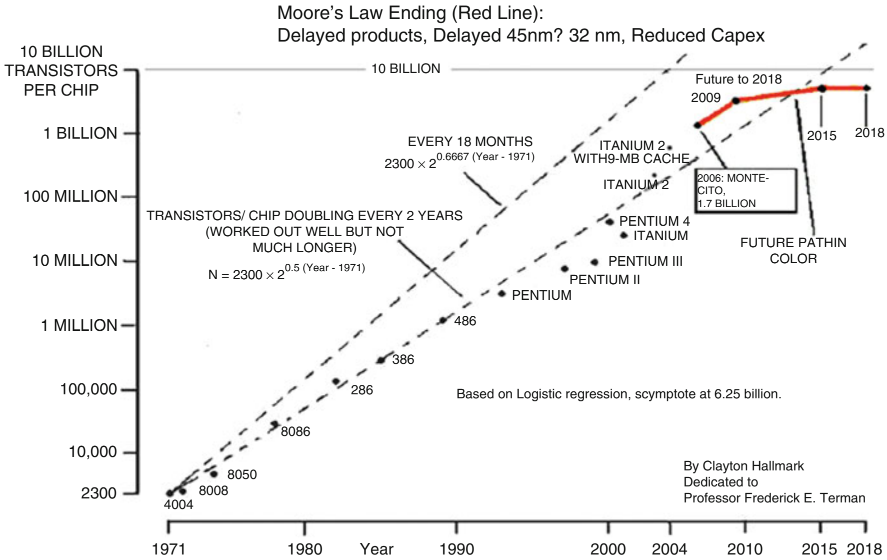


Fig. 6.4 Moore's law ending (Zhirnov et al. 2003)

immense possibilities in such divergent fields as agriculture and medicine (Hullmann 2006; Perkel 2003). Second, NT is particularly suited to efficiency and miniaturization; for example, electronic components can be manufactured to consume less power, and lightweight, strong materials have been developed for more efficient use of energy and space (Ministry of Education, Science, and Technology 2008). Finally, NT is forecasted to be an extremely influential technology that will provide breakthroughs in engineering and technology via research on the atomic and molecular levels into the basic structure of materials. It is also expected to contribute to human welfare improvement in convergence with bioengineering and information technology (Roco 2004).

Nanotechnology is expected to overcome the approaching limits of IT and BT development, hence continuing the accelerated development of technology (Canton 2006b). First, NT is thought to have the greatest potential to break through the limit encountered by Moore's Law, the representative law of IT industry growth, which according to an announcement from Intel in 2003, is forecasted to reach its end in 2013 with no possibility of continuation after 2025 (Fig. 6.4). NT also plays a role in fostering the continuous development of IT (Kurzweil 2007).

The demise of Moore's Law is due to physical and cost limits. Because of the tunnelling effect, controlling electrons becomes physically impossible, precise signal delivery cannot occur, and heat is produced in chips. In theory, it is possible to reduce the size of the gate to four nanometres. However, in this case, the amount of energy required to reduce the tunnelling effect generates more heat so that the chip is melted. Therefore, it is expected to be unusable (Griffiths 2004; Zhirnov et al. 2003).

In terms of cost, the cost of building a semiconductor factory doubles every three years. Currently, the cost per fabrication facility (Fab) is three billion won (Jurvetson 2004), which means that the increasing cost of chip manufacturing devices has become an issue. Len Jelinek, an analyst at iSuppli, a market research firm, forecasts that Moore's Law, which has been applied to the semiconductor

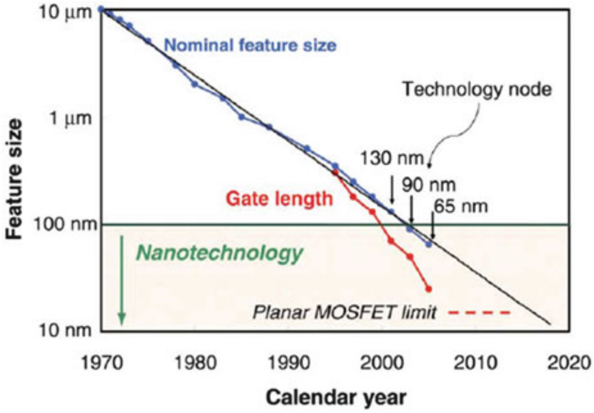


Fig. 6.5 Semiconductor feature size reduction aspect (Thompson and Parthasarathy 2006)

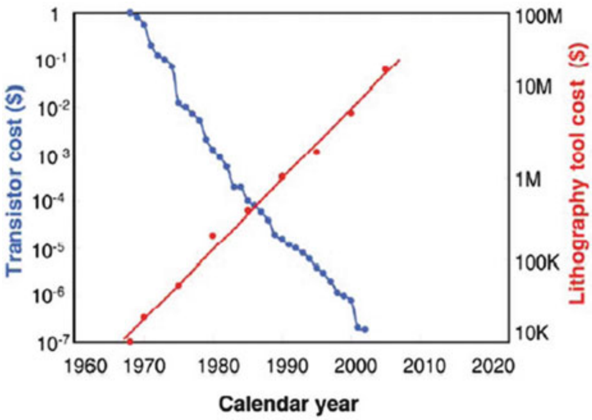


Fig. 6.6 Semiconductor price decrease and tool cost increase (Thompson and Parthasarathy 2006)

industry, can be sustainable only if it is converged with NT after 2014 because the high price increase of chip manufacturing devices will make the business unprofitable, as shown in Figs. 6.5 and 6.6.

Regarding the relationship between NT and BT, NT provides the tools and the technical platform for BT (Roco 2003) in showing the way to find the basic methods of biological processes, including self-assembly, cell processes, and the working of bio systems. Measurements based on NT have allowed for understanding the bio-cell as a molecular information machine, capable of highly organized self-maintenance and self-replication, so that critical progress becomes possible in BT (Roco 2003). NT also provides new solutions for developing applied technologies in such disciplines as bio-processing and molecular pharmaceuticals (Roco 2003).

6.2.2 *Impacts of IT, BT, and NT: Economic and Social Perspectives*

Industry's computerization and digitalization have changed the industrial structure, resulting in faster and more efficient production (Brynjolfsson and Hitt 1998).

Convergence in existing industrial technology and IT is improving many industries, including automobile, machinery, and shipbuilding (Kim et al. 2010c) (see Appendix A1.2 for more detail). The sharing of tactical knowledge has also become smooth via IT-driven networks; hence, efficiency improvement in the craft production methods of traditional industry areas is expected as well (Thompson 2004).

IT technology has resulted in products and services previously unknown to traditional industry, and new industries have begun, known as IT manufacturing or IT services. This new industry group has created brand new needs and/or expanded existing needs: examples are the identity management system, following Internet access expansion (Mueller et al. 2006), and the online music market growth, following development of the mp3 player. Based on the development IT technology, the digital economy is emerged. The detailed characteristics of the digital economy are explained in Appendix A1.2.

BT contributes to productivity increase and added value in the various traditional industries through process replacement or technology convergence. BT improves efficiency in a wide range of industrial areas through the increasing introduction of GM crops; application of molecular biology in remedial agents, diagnostic agents, or pharmacogenomics; and substitution of fermentation technology for chemical synthesis (OECD 2009a).

For example, in two acryl-amide production methods, one produced by a traditional chemical method and the other by a BT-based method, the latter is found to have higher concentration in a bioreactor with lighter conditions and to use only 20 % of the energy needed for the traditional method (Vandamme and Bienfait 2004). Through gene synthesis, chemical substances and materials can be produced more effectively at a lower cost than when using traditional approaches (Newcomb et al. 2007).

NT is also expected to deliver efficiencies and productivity improvement to traditional industries in most applicable areas, such as the manufacturing business (Roco 2004) and in all processes of the food industry (Joseph and Morrison 2006). It is expected to be profitably applied to sustainable development issues involving water, energy, health, the environment, and agriculture (Sastry et al. 2007). Convergence of traditional industrial technology and NT is expected to enhance such industries as chemical processing, machinery, and consumer products.

Among the new industrial areas created by IT, BT, and NT, those based on convergent technology are particularly promising. Examples include bio-informatics based on BT-IT convergence, bio-chips based on BT-NT convergence, nano-sensors based on IT-NT convergence, and bio-sensors and bio-chips in which BT-IT-NT converge. A high demand is expected in wellness-related products because of economic growth and population ageing, and the supply will be enabled by BT-IT-NT convergence: among MIT projections for future technologies are nano-medicine, personalized medical monitors, and cheap genome analysis.

6.2.3 New Humankind: Digital Natives and Active Seniors

With regard to the social characteristics of a knowledge-based society, two new human groups have appeared: the Digital Native (Prensky 2001; Tapscott 2009) and the Active Senior (Schiffman and Sherman 1991). These two economically active groups with their new characteristics have appeared with the aging trend, along with the digital revolution and economic growth caused by IT industry development. These groups, which are highly influential in technology innovation, productivity improvement, and increased demand, are highly significant to the economic growth of a knowledge-based society.

At the beginning of the twenty-first century, with the change from analogue to digital, the big-bang of digital media was completed, and human life was changed. The new generation was variously called the Net Generation, Generation Y, or the Digital Native. The Digital Native grew up in the middle of the digital revolution, marked by the popularization of the personal computer in 1980s and the spread of mobile phones and the Internet in the 1990s (Tapscott 2009). Each researcher defines this generation slightly differently; however, in general, most of the members were born after 1980, had sent and received at least 200,000 messages in texts and e-mails, according to one estimate from 2003, and had spent at least 100 h using mobile phones and playing video games (Holeton 2010). Digital Natives comprise about 27 % of the U.S. population (Digital Natives Project 2011). This group accepts information rapidly, performs different tasks simultaneously, expects instantaneous compensation, and tends to think that work should be more fun than serious (Prensky 2001). The digital generation is portrayed in Table 6.1, and the resulting economic impact will be reviewed in discussing the impact on expanded reproduction.

On the other hand, Active Seniors, who comprise an elderly population with new characteristics, have appeared due to the birth rate decrease and the aging phenomenon from the extension of the average life span. Unlike the traditional concept of seniors, Active Seniors, sometimes also referred to as the ‘New-Age Elderly’ are the over-60, economically active population with economic power, self-confidence, and high control of their own lives (Schiffman and Sherman 1991). In the United States, this group comes mostly from the baby-boomer generation, which differs from the ‘silent generation’. The latter, born between 1925 and 1944, had lower income, labour participation rate, and consumption along with more children than the Active Senior generation. The baby boomer generation, born between 1945 and 1964, has a high economic influence because of higher income and labour participation rate (Schiffman and Sherman 1991).

The baby boomer generation is divided to three groups—the confident, the vulnerable, and the disadvantaged—according to their attitudes and prospects. The confident group is financially well prepared for the future and has positive attitudes. Research has shown that this group is richer, healthier, and better educated than other groups, comprising 46 % of the baby boomer generation (MGI 2008).

Globally, the senior population shows the fastest growth: with an expected population growth rate of 223 % from 1970 to 2025, their numbers are expected to reach 1.2 billion persons in 2025 and 2 billion in 2050 (World Health Organization 2002). The development of sanitation, public health, food science, pharmaceuticals, and surgical techniques has also promoted the aging of the population not only in the U.S. but also in the whole world (Dychtwald 2001).

Table 6.1 Characteristics of digital native and active senior

Digital native			Active senior		
Characteristics		References	Characteristics		References
(Y1) Innovativeness	Active in using new technology, challenging Open and horizontal thinking	(Tapscott 1999) (Tapscott 2009)	(O1) Healthy life	Pursues healthy life High demand for food/exercise control and health care services	Wolfe and Snyder 2003) (Friis 1991)
(Y2) Collaboration	Active cooperation through various media Cooperation with firm for better products and services	(Tapscott 2009) (Rheingold 2002) (Giurgiu and Barsan 2008)	(O2) Wealthy	High income level Well prepared for elderly life High purchasing power	(Iyer and Eastman 2006) (MGI 2008) (Silver Business in Japan 2010)
(Y3) Cyberspace respect	Shows respect in cyberspace Regards online experience as important as offline	(Jeff 2009) (Basso 2008)	(O3) Personal development	Tries to continue an independent life Lifelong education High interest in cultural life and youth	(Leventhal 1997) (Wolfe and Snyder 2003)
(Y4) Fun	Pursues entertainment and pleasure Regards life quality highly	(Tapscott 2009)	(O4) Value consumption	Positive consumption tendency for perceived valuables	(Schiffman 1972) (Schiffman and Kanuk 1987) (Gilly and Zeithaml 1985) (Silvers 1997) (Healy 2004)

(continued)

Table 6.1 (continued)

Digital native			Active senior		
Characteristics		References	Characteristics		References
(Y5) Customization	Pursues differentiated products and services	(Silveira et al. 2001)	(O5) Working desire	Desires continuous labour activity	(MGI 2008)
	Pursues various projects and customization	(Tapscott 2009)			
(Y6) Immediate response	Fast information exchange through instant interaction and real time response	(Tapscott 2009) (Solomon 2009)	(O6) Relation	Tries to build relationships with new people	(Leventhal 1997)
	Favours information sharing			Increases leisure activities, such as religion/hobby/friendship	(Schiffman and Sherman 1991)

Several negative impacts may be realized from the Digital Native generation. First, because this generation places great value on the individual's right to privacy and has relatively less interest in community issues and activities, its tendency might have a negative effect on the circulation speed of technological innovation, productivity improvement, and value creation system. Some research results show that the digital generation is unconcerned about social issues, resulting in less trust of government, lack of participation in politics, and weaker civil consciousness compared to other groups (Carpini 2001). Both social trust and interpersonal trust have decreased in this generation as well (Keeter et al. 2002).

Second, Digital Natives frequently cause distrust, disconnection, and conflict between individuals, between individuals and corporations, and between individuals and governments by their addiction to games, entertainment, chatting, and text messaging—in short, their obsession with digital devices. Other negative phenomena include the spread of pornographic and violent materials, cyber-terror, cyber-crimes, electronic stalking, and invasion of privacy, lending to lack of societal integration and hindering social development (Rheingold 2003; Solomon 2009). The new values and life styles of the digital generation are not supported by existing laws and codes, and gaps in technological and institutional environments produce confusion in values and inhibit the positive aspects that would enhance society's development and evolution (Carpini 2001; Keeter et al. 2002).

Another characteristic of the Digital Native generation is its excessive consumption, which inhibits capital accumulation and market balance. The Digital Native believes that one's position and status is determined by possession of brand-name products that reflect one's self. For example, 82 % of U.S. high school students own iPods, indicating the product's position as a representative icon. Strong buying frenzies of such items, caused by the imitation mentality, has promoted an unnecessary consumption boom, inhibiting capital accumulation and upsetting the market balance (Prensky 2001).

Despite drawbacks, the existing literature points out six comprehensive features of Digital Natives and Active Seniors that are a positive societal influence. Positive characteristics of Digital Natives include innovativeness, collaboration, cyber-space respect, fun, customization, and immediate response. The active senior has such characteristics as a healthy life, wealth, personal development, value consumption, desire to work, and relationship skills (see Table 6.1).

6.3 The Faster-Accelerating Growth of the Knowledge-Based Society

The value creation system of the traditional industrial society is the virtuous cycle of expanded reproduction: it expands every cycle by capital accumulation and technology innovation, increasing supply and demand. This expanded reproduction structure creates accelerating economic growth (Kim et al. 2010b). This structure is fundamentally different from the simple reproduction system of the agricultural society, which is based on primary production, thereby resulting in stagnation of production and demand (Kim et al. 2010a). Transformation of the indigenous value creation system of the industrial society is expected to create new value through increasing dependence on IT, BT, and NT.

6.3.1 The Value Creation System of the Knowledge-Based Society: The Change from the Industrial Society

6.3.1.1 IRS Production of the Knowledge-Based Industry

An economy driven by knowledge-based industries grows much faster than an economy based on traditional industries because of the increasing-returns-to-scale (IRS) production function of knowledge-based industries. IRS refers to a certain trend in which the more the units of the input factor, the greater the output per unit of the input factor. Ray et al. (2002) insisted that IRS appears in the knowledge-based society due to the substitution of material capital for knowledge capital and its self-reinforcing nature in the process of knowledge accumulation as the driving force.

New product development and productivity improvement, mass production, existing demand growth, and new demand creation all allow the expanded reproduction system of the industrial society to expand more every cycle (inner cycle shown in Fig. 6.7). As explained in the previous section, IT, BT, and NT in a knowledge-based society encourage technology innovation and knowledge accumulation through converging with the existing industrial technologies in the traditional industrial society (see link between inner and outer cycle in Fig. 6.7). These technologies also create new demand, previously non-existent in the traditional industrial society, by creating new industries and new knowledge-based products. Such productivity improvements in the existing industries and creation of new industries through the development of IT, BT, and NT have a positive effect on the supply and demand expansion in every cycle of the value creation system (see outer cycle in Fig. 6.7).

The simultaneous growth of demand and supply and capital accumulation in the value creation system of the knowledge-based society is similar in terms of function to the expanded reproduction system[4] of the industrial society. The fundamental

[4] Expanded reproduction is first mentioned by Karl Marx (1967) to explain economic growth in an industrial society: the new surplus value created by waged labor is reinvested in production so that accumulation and reproduction takes place on an Extended Scale. In this paper, we have added the value of "technology advancement" so that we can explain not only expansion of quantity in scale but also expansion of quality of product by advanced technology. The expanded reproduction system of the knowledge-based society includes the value creation structure of the industrial society. If the value creation structure of the industrial society should be separated, the traditional industrial society and knowledge based industrial society can be segregated from each other according to the mode of production.

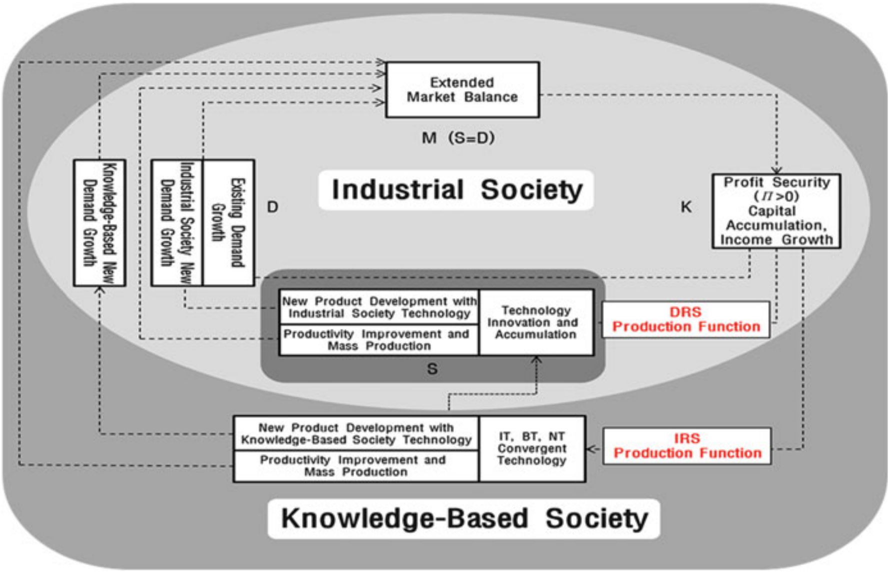


Fig. 6.7 Expanded reproduction system of the knowledge-based society

difference between the value creation system driven by IT, BT, and NT in a knowledge-based society and that of the traditional industrial society is the introduction of a new type of production function by the increasing rate of intangible factors, especially knowledge input. The following numbers demonstrate the substitution of intangible knowledge input for material input: in 2006, high-tech industries had more than a 52 % share of total manufacturing in OECD countries (OECD 2009b). R&D investment by U.S. bio-firms has been increasing by 11 % annually for 10 years since 1996 (BIO 2008). NT is expected to contribute to weight decrease in the auto industry by 10–15 % and in spacecraft by 3 % (Holister and Harper 2002).

The increasing rate of intangible factors will expand increasing returns-to-scale (IRS) production in the knowledge-based society for various reasons. First, with knowledge input as the main factor of production, the tangible physical factors governing production conditions will change. Romer (1986) has insisted that production function with knowledge input shows IRS production because of the increasing marginal productivity of the stock of the knowledge input. An endogenous economic growth model is established with the assumption of an increasing marginal return of knowledge stock, compared to the diminishing marginal return of traditional capital stock.

Adams (1990) established an economic growth model with the assumption that conventional decreasing returns-to-scale (DRS) production functions will be changed to the IRS production functions because of knowledge spill over. The OECD (1996) highlights the knowledge factor as a tool to offset the decreasing return from physical capital. Bontis et al. (1999) indicated that an economy based on intangible factors, such as knowledge or information, has a non-zero-sum effect and increasing returns to scale, compared to the decreasing returns of land, labour, or physical capital—i.e., traditional economic resources.

Arthur (1996) has insisted that while the traditional sectors in the economy are governed by the law of decreasing marginal returns, new industrial sectors—especially knowledge-based industries—are governed by increasing marginal returns. He also noted that the economy has been changed from mass production to technology design and use, from resource process to information process, and from raw energy application to idea application. From the perspective that the position of the knowledge-based society is in continuous change from a DRS to an IRS economy, allowing the flexibility of production functions, Ray et al. (2001) prove theoretically that characteristics of capital stock transform to an increasing marginal return above the threshold level of the rate of intangible capital in the total capital stock.

Industries that produce knowledge—for example, in bio-industry the research laboratory-based industry that produces mere knowledge—show IRS production naturally because most of the production cost is fixed capital, and as the number of users increases, average cost decreases (Harris 2001). Computer or software industries are representative examples of IRS production function in the real economy, because of the decreasing marginal cost. In the case of software industries, the marginal production cost is regarded as converging almost to zero (Ellison and Fudenberg 2000).

The production function of the knowledge-based society based on IT, BT, and NT will be IRS because of the increasing knowledge input, compared to the DRS function of the industrial society, dependent as it is on tangible physical factors. Outputs from IRS production, such as technology-intensive products or services provided by biotechnology laboratories or software development companies, influence technology innovation and knowledge accumulation in the DRS economy of traditional industry through convergence and integration with traditional technologies. Therefore, the expanded reproduction structure of a knowledge-based society will result in greater expansion than can exist in the industrial society each cycle. For this reason, IT, BT, and NT need to be regarded as new technology classes, separate from traditional industrial technologies, for properly understanding the expanded reproduction structure of the knowledge-based society.

6.3.1.2 The Economic Force of the New Humankind upon the Knowledge-Based Society

The positive impact to the expanded production system from the Digital Native and Active Senior is shown in Fig. 6.8.

Technology Innovation and Productivity Improvement

The Digital Native's characteristics of innovativeness, collaboration, and customization and the Active Senior's characteristic of value consumption positively

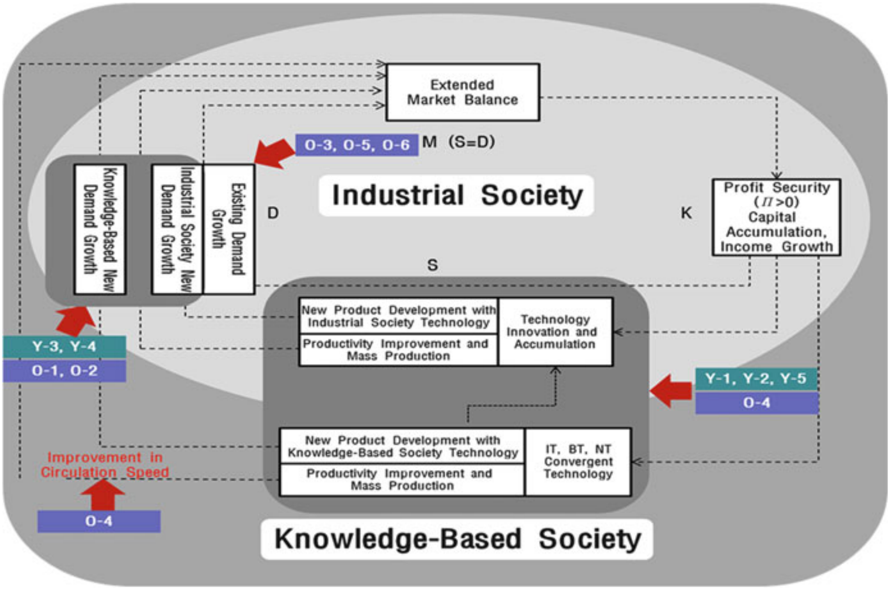


Fig. 6.8 The impact caused by each characteristic of new humankind to the expanded production system

influence technology innovation and productivity improvement. Due to innovativeness, the Digital Native is enthusiastic about new technologies and products, quick to adapt new products, and desirous of having the newest and best products. This characteristic produces a faster corporate productivity improvement and innovative development cycle. According to recent articles, the mobile phone replacement market in 2011 is expected to be worth 990 million won, a 37.4 % increase from 2010. 'The replacement cycle, in comparison to 82 months in 2009 and 2010, is forecasted to be shortened to 79 months in 2011. Therefore, led by electronic devices, the product replacement cycle is shown to be reduced.[5]

The Digital Native's collaborative characteristic provides opportunities for sharing thoughts, resulting in a positive impact on the acceleration of technology innovation and accumulation by reducing the time required for new product development. Online space is full of information on products and services uploaded by the innovative Digital Native, who is simultaneously a consumer and a producer. About 83 % of Digital Natives tend to research their intended purchases online; hence, companies should market more attractive products online (Tapscott 2009; Tapscott and Ticoll 2003). In addition, because of the Digital Native's customization characteristic, companies have developed mass production skills that, nonetheless, can individualize products for their customers, resulting in a positive impact on technology innovation (Silveira et al. 2001).

[5] http://www.mt.co.kr/view

On the other hand, the Active Senior's value consumption characteristic means that, since product quality and long-term investment are important, the companies' technology innovations and product quality improvements can be realized. The donation culture, more noticeable in the senior population, is expected to have a positive impact on technology innovation: for example, a fund might be established for donations to provide technological development and research for human life quality improvement. Such projects result in overall technology innovation.

Existing Demand Expansion

The Active Senior's characteristics of working desire, personal development, and relation may have a positive impact on existing and new demand. First, the working desire characteristic relates to the Active Seniors' desire for continuous work in order to maintain their existing consumption levels and to interact with society (MGI 2008). Japan's job maintenance policy, Silver Business in Japan, 2010, and WHO's active aging policy (2002) are the best known policies in the world relating to job maintenance. Le Tip and Nano Corp are projects that were developed to support private business activities. Nano Corp, unlike traditional business organizations, helps individuals to run businesses of a manageable size. With this kind of support, the number of middle-aged people and seniors who open businesses after retirement has recently been growing (Murata 2006). If Active Seniors maintain a continuous income through their business activity, unlike the existing Silent Senior generation whose consumption had to be reduced after retirement, this generation is expected to enhance the existing consumption increase.

The personal development characteristic refers to maintaining a life in which self-respect and self-sufficiency are possible through lifetime learning and self-development (Wolfe and Snyder 2003). The Active Senior desires activities for self-development, such as lectures and lifetime education courses. Therefore, the demand for education and related various services is expected to increase (Schiffman and Sherman 1991). A representative example is 'Elder Hostel' (now called 'Road Scholar'), a U.S. institution that is the world's largest lifetime education centre for seniors with more than 200,000 participants worldwide. The participants learn various cultural subjects and experiences from hosts and instructors with expert knowledge (Murata 2006).

The relation characteristic is reflected in a strong desire to meet new people and form relationships (Leventhal 1997). The Active Senior generation responds by broadening relationships through religion, socialization, meetings for hobbies, etc.; family relations are considered very important as well, so the demand for existing industries, such as leisure, recreation, and travelling, is expected to increase. The travel industry that caters to the healthy post-retirement senior class is already enjoying a great deal of profit. According to research from Austria in 1999, 75 % of the over-60 population had travelled domestically in the prior year, spending $985 million (Healy 2004).

New Demand Creation

New demand from the Digital Native tends to arise out of two characteristics, cyberspace respect and fun. Not having experienced so much real need as either of the two previous generations, the Digital Native can be considered according to Maslow's 5-level Pyramid of Human Desire. According to Maslow (1970) human desire can be divided into five levels, consisting of physiological desire, the most basic level; the desire for safety; the desire for a sense of belonging and for love; the desire for respect; and the desire of self-realization. After fulfilment of the basic desires, the human wants satisfaction for the higher levels of desires.

The Digital New Humankind uses digital technology for personal fulfilment. Through community activity and interaction with others, New Humankind fulfils the desires for a sense of belonging, love, and respect, the third and the fourth levels of desire. In addition, through cyberspace and the avatar, this generation's fifth level of desire, the desire for self-realization, becomes to be satisfied. According to Basso (2008), U.S. cyberspace users are motivated by accomplishment, amity, the experience of immersion, escapism, and market manipulation. Basso has noted that users want to learn meaningful human relationships, strong emotional experiences, and leadership skills from the cyber world that may be applicable to reality. In other words, the generation attempts to fulfil the higher level desires of Maslow's human desire levels through games, as well as through the rest of the cyber world. From these factors, new demands are introduced, and new industries to fulfil the new demand are rapidly growing.

The most noticeable examples of the new demand are the game industry and SNS (Social Network Services). These industries have growing quickly. The global game market is forecasted to expand 5.5 % per year on average (CAGR) to become 143 billion in 2010 to 420 million dollar in 2014 (Korea Creative Content Agency 2010). In the case of SNS, the number of U.S. teenage users (12–17 year-olds) was projected to grow from 11.5 million in 2006 to 17.7 million in 2011. Advertising for SNS has grown rapidly as well, from $480 million in 2006 to $1.2 billion in 2007, with projected growth to $4.1 billion in 2011 (eMarketer 2007).

On the other hand, the Active Senior characteristics that influence new demand creation are healthy life and wealthy. The Active Senior's higher interest in health and lower endurance against disease compared to former generations, in combination with the generation's average yearly household income of $50,000, will create a high demand for applied biotechnology in healthcare services and in the pharmaceutical and other industries (MGI 2008).

According to a report from the Korea Institute for Health and Social Affairs, Koreans' expected life span is 78.6 years, whereas the healthy lifespan is only 68.6, with the remaining 10 years subject to pains, physical discomforts, and emotional uneasiness caused by diseases or accidents. Therefore, expansion of the healthy lifespan is likely to become the core of national health policy (Dong-A Ilbo 2007). Such concerns will necessarily also lead to an increased demand for BT to address a variety of declining physiological functions, such as degenerative arthritis, osteoporosis, and sexual dysfunction. In 2008, the senior population, which comprises

9.8 % of the whole population, accounted for 29.9 % of the medical expenditure. Thus, as demonstrated here, the Active Senior's pursuit for a healthy life will become a large driving force in creating new needs (Kim and Lee 2007). In the U.S., as well, the health and medical industry has produced 1.7 million jobs in manufacturing since 2001, giving rise to 'Health Belts' in various area of the nation. The industry's positive role is noticeable in the entire national economy.

Expanded Reproduction System Circulation Speeds Improvement

The Digital Native's immediate response characteristic translates into instant response to products and public opinions cooperatively through the networks. Therefore, consumers' needs and feedback on products are delivered to companies quickly enough that the time needed for developing new products and improving existing ones is greatly reduced. Rapid and accurate information exchange establishes a business environment wherein a company cannot survive without maintaining the high standards and efficiency necessary to compete with other companies. The change will increase the speed of the overall extended reproduction system's circulation consisting of an expanded market balance, capital accumulation, and supply expansion of the company.

6.3.2 The Time-Output Relationship in the Knowledge-Based Society

The fundamental difference between the value creation system of the knowledge-based society and that of the industrial society is the introduction of IRS production functions from IT, BT, NT, and their convergent technologies, as mentioned in Sect. 6.3.1.1. Therefore, the economic growth pattern of a knowledge-based society can be understood by analysing the shift of input–output relationship as observed from different DRS and IRS production functions over time.

Prior to understanding the shift of IRS production functions, we describe the shift of DRS functions over time, which is generally considered for explaining the economic growth patterns of an industrial society. Figure 6.9a shows the positions of DRS aggregate production functions (APFs) at different time frames ($t = 1, 2, 3, 4$). Each APF reflects the technology level at the time. As time passes, technological innovation occurs and shifts the APF upward, though the range of technological change gets smaller. Figure 6.9b is a long-term time-output path, which follows the points of input–output intersection observed at each point of time. We define this path as an APF production expansion path, which means the production records of the APF observed at each point of time as an APF moves according to technological changes (Kim et al. 2010a). Figure 6.9b indicates that the economic growth of the society which has this kind of an APF production

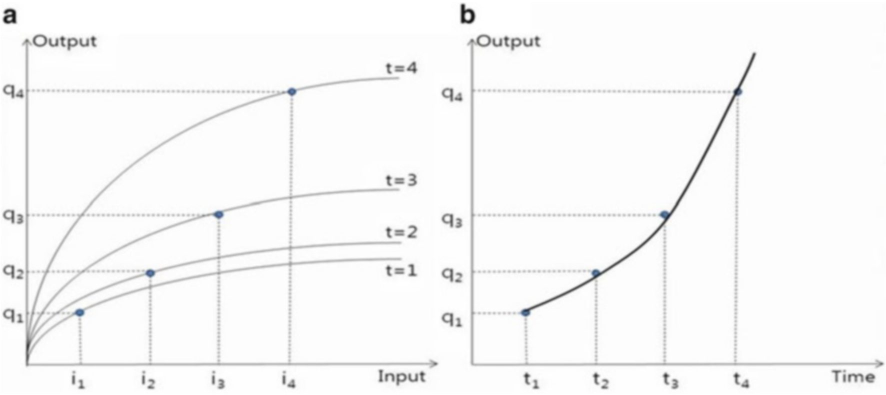


Fig. 6.9 Time-output relationships with DRS production function and technical progress

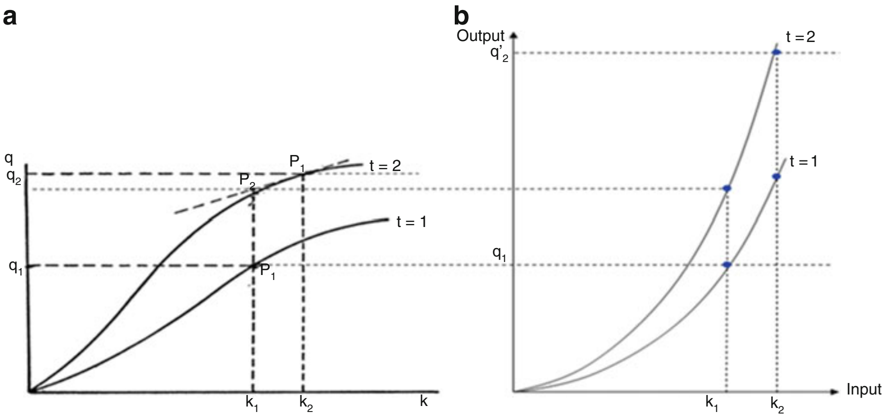


Fig. 6.10 Comparison of the time-output relationships from the shift of DRS and IRS production functions in the case of the same technical progress rate (Source: (a) Solow (1957))

expansion path tends to gradually decelerate in the long run. A pure agricultural society before the Industrial Revolution falls under this category, where the economy stagnates over time because of slow technological changes.

Kim et al. (2010b) have explained the economic growth pattern of the industrial society with DRS production function and technological progress (Fig. 6.10). The economic growth pattern, represented by a line linked between the points over different production functions that are shifted by technical progress, appears to be accelerating (Kim et al. 2010b).

Kim et al. (2010c) compared the shift of IRS production functions with the shift of DRS production functions in an industrial society on the assumption of the same speed of technical progress (Fig. 6.10). (See Appendix 2 for more detail) The output curve from IRS production functions shows faster accelerating growth than the line

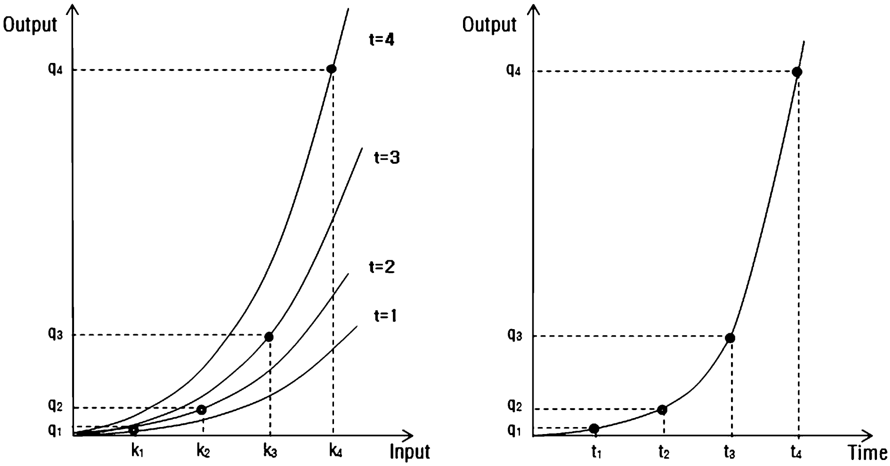


Fig. 6.11 Time-output relationship from the shift of IRS production functions over time

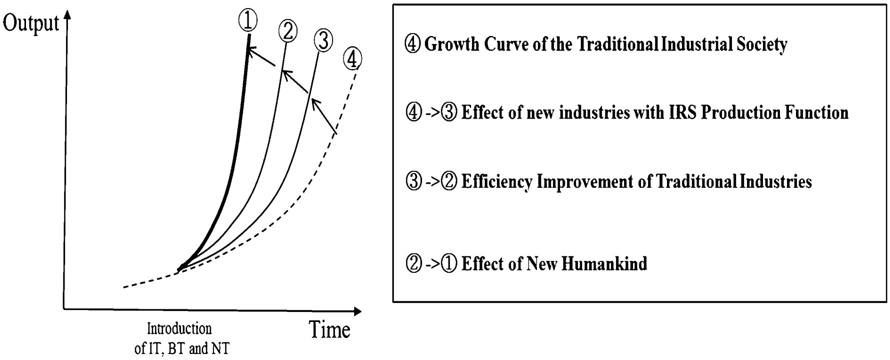


Fig. 6.12 Faster acceleration of output growth in the knowledge-based society

from DRS production functions (Fig. 6.11). As a knowledge-based society includes two types of production function, DRS and IRS, the acceleration of net output increase over time in this society will be faster than the speed observed in the traditional industrial society following only DRS production. The more the economy based on the IRS production function expands, the faster the acceleration of economic growth will be.

From several cases, including the 'new economy' in the U.S. (from the late 1990s to the early 2000s), the economic pattern of the digital economy appears to be faster accelerating,[6] differing from the economic growth pattern of the traditional industrial economy (Kim et al. 2010c; Van Ark et al. 2002). IT will overcome the

[6] The examples of digital economy are explained in Appendix 6.C.

limit of Moore's law by technical progress and, above all, by IT-NT convergence. The biotechnology progress rate exceeds the IT progress rate of Moore's law (Carlson 2003). If convergence technology with BT or NT is industrialized and if its fast progress rate affects the IRS production function shift, the consequent economic growth rate is expected to be higher than that achieved by either the industrial society or the digital economy.

In addition to the technological and production characteristics of the knowledge-based society, the social aspect characterized by the new humankind will accelerate economic growth.

In Fig. 6.12, ④ is the economic growth curve of the traditional industrial society. The difference between ④ and ③ can be explained by the creation of new industries with IRS production functions. Improved efficiency in the traditional industries from IT, NT, BT, and their convergence technologies will bend the growth curve inward (③- > ②) and the new humankind will do so more (②- > ①). For such reasons, the economic growth pattern of the knowledge-based society will show faster accelerating growth.

Figure 6.13 compares the shifting patterns of APFs over time among the agricultural, industrial, and digital economies. On the assumption that the shift in each APF starts at the same time (t_1), the pattern of each society's economic growth can be compared in one graph. In other words, we will compare the decelerating agricultural society with the industrial society and the digital economy that diverged from the agricultural society at t_1.

The agricultural society and the industrial society have DRS production functions, but technical progress differentiates an accelerating industrial society from a decelerating agricultural society. Meanwhile, an industrial society and a knowledge-based society both show economic growth acceleration, but the speed of acceleration in the knowledge-based society is faster than that in the industrial society because of the fundamental difference in the characteristics of the production functions in terms of returns to scale (Fig. 6.13).

The R&D paradox, the controversial phenomenon of disconnection between economic output or GDP growth and input for knowledge creation—such as R&D investment or education (Dosi et al. 2006)—seems against the faster accelerating growth of the knowledge-based society, as does the IT productivity paradox. As Solow said in 1987, 'You can see the computer age everywhere but in the productivity statistics'. The process of knowledge accumulation and diffusion requires time (Audretsch and Keilbach 2008). In sectors based on science like BT, there is a considerable time lag before an R&D product materializes (Cockburn and Henderson 2001). Productivity effects from IT also have a time lag after the technologies are developed (Hilbert 2001). Therefore, the economic effect of knowledge input or IT cannot be represented merely by relationships between R&D expenditure or IT capital and GDP in the same period. A recent study identifying that the R&D paradox is observed in the fastest-growing industries (Ejermo et al. 2011) notes that industries investing in the knowledge base have been growing the fastest, therefore supporting the result of this study.

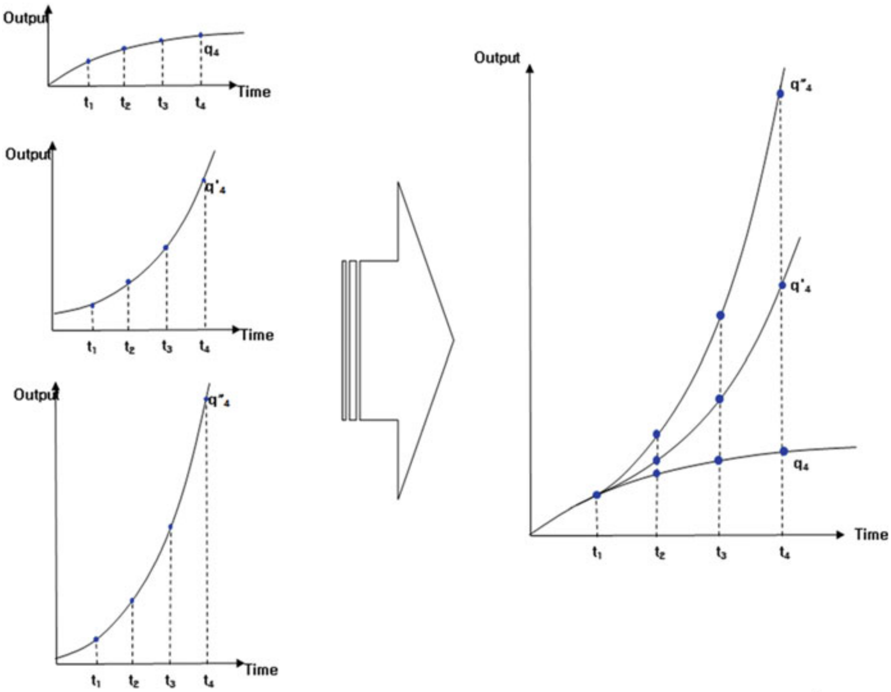


Fig. 6.13 Comparison of output growth between the agricultural society, the industrial society, and the knowledge-based society

6.4 Conclusion

From observing the decelerating agricultural society and the accelerating industrial society in terms of economic growth, we learn that the economic growth pattern of a particular society is determined by the inherent value creation structure. An IT-driven digital economy enhances prospects for a new society, with differentiated, faster accelerating economic growth. This study analysed both the economic and social aspects of future technologies as well as the effect on an expanded reproduction system. Our research clarifies why and how the accelerating economic growth of the traditional industrial society will be transformed in the future knowledge-based society.

Whereas the agricultural society depends on primary products from the land, the industrial society depends on capital accumulation and technology innovation, on creating new demands and expanding the scales of production, thereby accelerating economic growth. Production modes that depend on material inputs, such as fossil energies, plant equipment, or machinery, in the industrial society usually have DRS production functions.

The knowledge-based society is differentiated from the industrial society by the emergence of a fundamentally new mode of production with rapidly increasing intangible input and output. The development of IT, BT, NT, and their convergent technologies improves the efficiency of the traditional industries and encourages the emergence of new industries because of rapid technical progress and IRS production functions, which increase the knowledge input and output in the economy. The foregoing characteristics of the knowledge-based society contribute to the growth and expansion of IRS economy. In addition, the new humankind, enhanced by new technologies and economic growth, enables more accumulation of profit and capital, more technology innovation, more supply and new demand, and faster circulation of the expanded reproduction system, thereby accelerating the economic growth of the knowledge-based society over that of a traditional industrial society.

The contribution of this study is to identify the economic growth patterns of the emerging but immature society of the future, compared to the agricultural society or the industrial society, by analysing the aspects of future technologies and new humans and their effects on the value creation structure. This study is from the same context as some previous studies, aiming to distinguish the industrial society from the agricultural society by modes of production and economic growth patterns (Hansen and Prescott 2002; Hayami and Ruttan 1970; Kim et al. 2010a, b). We have verified that a new mode of production based on IT, BT, and NT results in the faster-accelerating economic growth of the future knowledge-based society. Therefore, the results of this study may encourage society to develop more smoothly and faster toward the knowledge-based society, like a compass pointing toward our future.

The second contribution of this study is to highlight the characteristics of the New Humankind in a knowledge-based society. A number of studies related to economic growth from the long and macro perspective have considered only the conventional aspects of individual humans—for example, a rational consumer or a labour supplier—but this study has considered newly emerging groups with different socio-economic characteristics and their effects on the economy and society. This study demonstrates the need to research the effect of the new humankind's co-evolution with technology, the economy, and society in a new economic growth pattern.

Appendix 1 The Definition and Characteristics of the Digital Economy

A1.1 The Definition of the Digital Economy

The digital economy is considered as a step toward the knowledge-based society. The term 'digital economy' was first used by the US Department of Commerce in its 1998 annual report to describe an economy that grew much faster than previous societies accelerated by ICT innovation. One important property of this economy is its inclusion of knowledge and information in main production factors, besides three major production factors - labour, capital, and land—of an industrial society. The digitalization of core economic activities including production, distribution, and consumption of goods and services is another main property of the digital economy (US Department of Commerce 1999).

Brynjolfsson and Kahin (2000) also defined the digital economy with digitalization of information. According to Lyotard (1984), the development of IT technologies and the universal diffusion of knowledge make it possible to exchange knowledge as a good in the marketplace. Therefore, the development of IT technologies is regarded as a critical factor for the establishment of the digital economy. Advanced IT technologies have led to the advent of new media, such as network based databases, and the development of computer networks and the Internet have made it easy to collect information and knowledge from all over the world. Information or knowledge intensity enabled by IT technologies has increased the importance of information and knowledge as production factors of an economy.

A1.2 The Characteristics of the Digital Economy

A1.2.1 IT's Contribution on the Efficiency Improvement in Traditional Industries

The development and diffusion of IT has increased the convergence between IT and existing technologies in other industries. The technological advancement due to increasing IT use in traditional industries has resulted in raising the added value and improving the productivity of traditional industries.

Computerization and digitalization of industries have influenced the entire production process, introducing faster and more efficient procedures. Solow (1987) provoked the productivity paradox dispute, but Brynjolfsson and Hitt (1998) refuted his statement by showing that IT does lead to productivity improvement. They contend that computerization changes the industrial structure, leading eventually to productivity improvement. However, computerization by itself does not automatically bring about productivity improvement. As computerization matures, productivity improvement accelerates, and so does economic growth.

Many traditional industries, including the automobile, mechanical, and shipbuilding industries, attempt to improve their added values by developing new convergence technologies that graft state-of-the-art IT into the existing systems. Below Table 6.2 shows some important examples of technology convergence between traditional industries and IT.

A1.2.2 Production Function of the Digital Economy

An economy driven by digital industries grows much faster than an economy based on traditional industries because of the increasing-returns-to-scale (IRS) production

Table 6.2 Contributions from IT to the growth of labour productivity in the US

		1974–1990	1991–1995	1996–2001
Growth of labor productivity[a]		1.36	1.54	2.43
Contributions from	Capital deepening	0.77	0.52	1.19
	Labour quality	0.22	0.45	0.25
	MFP	0.37	0.58	0.99
Contribution from IT	Total	0.68	0.87	1.79
	IT capital	0.41	0.46	1.02
	IT production	0.27	0.41	0.77

Source: Modified from Oliner and Sichel (2003), Table 6.1

[a]In the nonfarm business sector, measured as the average annual log difference for the years shown multiplied by 100

function of ICT industries. Whereas the traditional manufacturing industries of industrial societies show DRS, the production function of the digital economy has the IRS characteristic (Romer 1986; Ray et al. 2002). Computer and software industries are representative examples that show the IRS production function. IRS reflects the continual increase of productivity due to the decrease of marginal cost to produce additional outputs. The marginal production cost of the software industry is considered to be close to zero (Ellison and Fudenberg 2000). Besides, Romer (1986) claimed that technology development can lead to continuous economic growth, and many economists believed that the phenomenal economic growth of the New Economy in the US had been built on ICT technologies (Gordon 1999; Stiroh 2002).

Arthur (1994) mentioned that the economic growth of the digital society accelerated faster than that of the traditional industrial society. Arthur (1994) explained the acceleration effect of the digital economy based on the IRS characteristic in production and the path-dependent economy. Shy (2001) theoretically proved the network effect observed in the computer hardware and software industries. His research on the distinctive feature of markets according to the different characteristics of software products (e.g. ease of reproduction and network effects) indicated that the software market, unlike the traditional product market, is not a competitive one but is dominated by a single technology. This kind of tipping effect in production is the basis of the technology-oriented accelerating growth of the digital economy. Harrington and Reed (1996) also mentioned the virtuous cycle of e-commerce growth, which represented the accelerating increase of e-commerce revenue well, when e-commerce was regarded as one of the production indicators of the digital economy. According to them, the faster-accelerating growth of the digital economy is significantly different from the economic growth trend of the traditional industrial societies, which have the DRS production function.

A1.2.3 Social Changes in the Digital Economy

Not only does the ICT-based digital economy affect the economic area, it also brings about all-round social change. The digital economy brings about economic and social transformation, which accelerates economic growth by stimulating the cycle of the expansive reproduction system (ERS). There are five examples of such changes: (1) The digital economy creates new demand for digital products, (2) allows flexible economic structures, (3) helps manage fluctuation in prices, (4) restructures firms and employment types, and (5) facilitates the emergence of the digital generation.

Appendix 2 Time-Output Relationship with IRS Production Function when the Speed of Technological Change is the Same

In order to estimate the technological progress in Fig. 6.14, which measures how fast the production function shifts, the difference between the two time frames of a production function needs to be divided into two parts as in Fig. 6.14a: increase due to input changes and increase due to technological changes. Solow (1957) explained that because of the time lag between the two observed production points, the output movement along the production function and the shift of the production function itself are mixed in the shift of the production function estimated from the two sets of observations. Of the two movements, the shift of the production function itself is only related to the technical change between the two production points. In order to calculate the technical change, Solow (1957) drew a tangent line at P2, which was the input–output point at $t = 2$, and found P12, at which the tangent line met the input level of $t = 1$. Then, he calculated the technical change from the difference between P1 (the output level of $t = 1$) and P12 (the output at $t = 2$ adjusted to the input level of $t = 1$). Figure 6.14a illustrates this process. As regards the difference between the production functions at $t = 1$ and $t = 2$, the output increase due to an input increase at the same technology level, that is, along the same production function, is expressed as A1; the change of the production function itself from technological advancement is indicated as A2. B.1 represents the difference between the outputs with and without technological innovation at $t = 2$. B2 measures the output difference between $t = 1$ and $t = 2$.

When the DRS production function of the industrial economy changes to the IRS production function of the digital economy, it is generally assumed that technical progress becomes faster. However, even if the technical progress is assumed to be the same as with A2, the output increase would be much bigger (see Fig. 6.14b). Even if the production function only changes to the IRS type, the difference between the outputs with and without technological innovation at $t = 2$ ($B'1$) is much wider than with the DRS type of production function ($B1 < B'1$). As a result, the difference between the total outputs $q = 1$ and $q = 2$, at $t = 1$ and $t = 2$, respectively, is also much larger with an IRS than a DRS ($B2 < B'2$) production function.

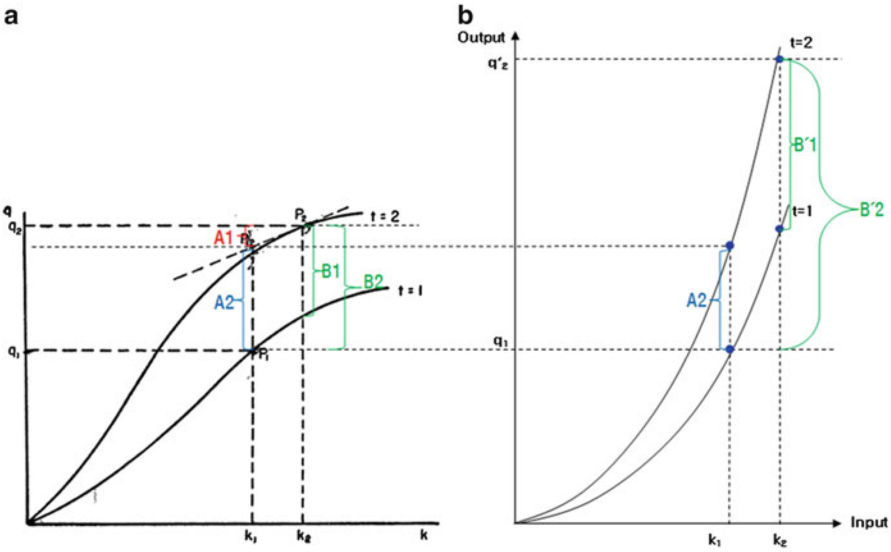


Fig. 6.14 Time-output relationship with DRS production function (**a**) and IRS production function (**b**) IRS production function when the speed of technological change is the same (Source: (a) Solow, 1957, p. 313, chart 1)

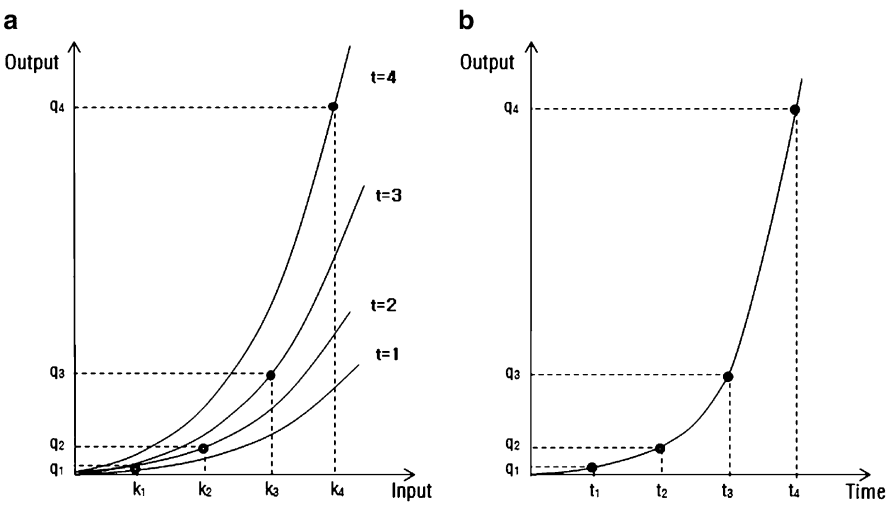


Fig. 6.15 Time-output relationship

Finally, the shift of the digital economy's APF with time appears to be similar to Fig. 6.15a. Looking at Fig. 6.15b, which traces the output according to the time frame of Fig. 6.15a, the long-run output curve of the digital economy accelerates faster than the curve of the industrial society.

Appendix 3 The Case Studies of the Digital Economy

First, we present the New Economy of the US, the leader of industrial societies. Next, we consider Ireland and Finland, both early digital economies of Europe. Their economic growth surpassed that of other industrial countries in Europe, even though they lagged behind other countries during industrialization.

A3.1 The Digital Economy of the US

The economic growth of the US, though a technology leader, is often predicted to be slower than other countries adopting its innovation. However, in the middle and late 1990s, the US enjoyed the highest GDP per capita and the fastest economic growth among major industrial countries. In the Economic Report of the President (White House 2001), this period of high economic growth of the US during this period was described as the 'New Economy'. The report mentioned that a notable feature of this period was the rapid growth of ICT industries.

During the New Economy period, the US grew faster than any other country, and ICT played a remarkable role in this rapid economic growth. Table 6.3 shows that in comparison with the EU total productivity recorded marked improvement in the US and the role of ICT increased rapidly between the early 1990s and the late 1990s, a period considered to be part of the New Economy phase. This means the US was one step ahead of the EU in its transition to a digital economy during this time.

Figure 6.16 depicts the change of GDP per capita for the US and OECD-Europe from 1960 to 2006. The US economy grew rapidly from the middle of the 1990s. From 1995 to 2000, the GDP per capita increased annually by 3.87 % on average 3. In the same time frame, the GDP per capita for OECD-Europe increased annually by 3.13 % on average, which resulted in an expanding gap between the US and OECD-Europe. We can see that the New Economy left a large gap between the US and the EU in terms of economic growth.

Table 6.3 Rate of productivity increase and contributions from ICT: the US and the EU

	1990–1995		1995–2000	
	US	EU15[a]	US	EU15[a]
Total economy	1.08	1.88	2.52	1.41
ICT producing	0.51	0.33	0.75	0.47
ICT using	0.43	0.42	1.42	0.42
Non ICT	0.23	1.10	0.36	0.48

Source: Van Ark et al. 2002

[a]EU 15 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom

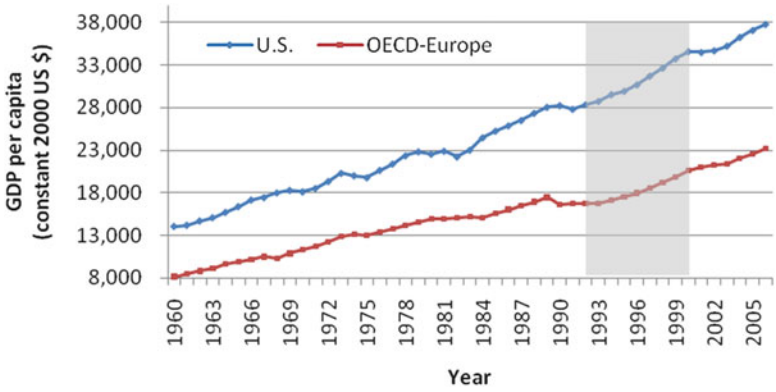


Fig. 6.16 GDP per capita for the US and OECD-Europe (constant 2000 US$) (Source: World Development Indicators Database 2008)

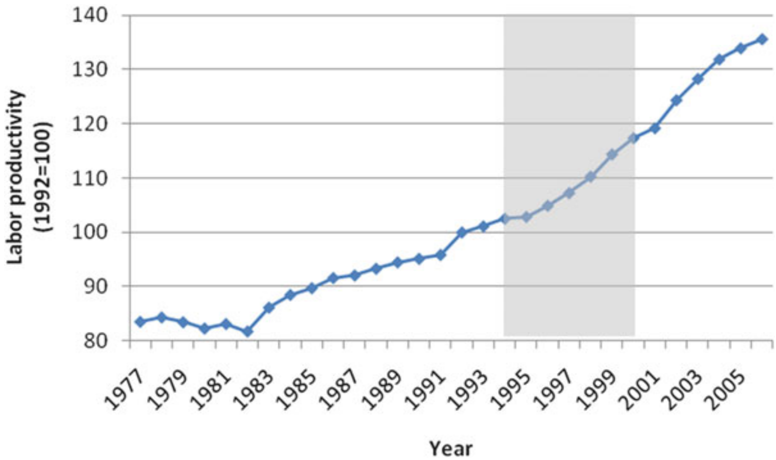


Fig. 6.17 Labour productivity of nonfarm business in the US (1992 = 100) (Sourc*e*: The Bureau of Labor Statistics 2010)

Figure 6.17 describes the change of labor productivity in the US nonfarm business sector from 1977 to 2006. Whereas the rate of increase of labor productivity on annual average was 1.7 % for the whole period, it increased to 2.3 % for the period 1995–2000. These data confirm the remarkable increase of labor productivity during this period. Many studies pointed out in common that ICT is the main cause explaining the rapid increase of labor productivity in the New Economy after the mid-1990s (Stiroh 1998, 2002; Jorgenson and Stiroh 1999; Jorgenson et al. 2003).

In order to look into this phenomena in detail, we will review research on Oliner and Sichel (2003), which estimated ICT contributions to labour productivity growth in the US from 1974 to 2001, categorized into ICT capital and ICT

Table 6.4 Contributions to the growth of labour productivity in the US

		1974–1990	1991–1995	1996–2001
Growth of labor productivity[a]		1.36	1.54	2.43
Contributions from	Capital deepening	0.77	0.52	1.19
	Labor quality	0.22	0.45	0.25
	MFP	0.37	0.58	0.99
Contribution from ICT	Total	0.68	0.87	1.79
	ICT capital	0.41	0.46	1.02
	ICT production	0.27	0.41	0.77

Source: Modified from Oliner and Sichel 2003, Table 6.1
[a]In the nonfarm business sector, measured as the average annual log difference for the years shown multiplied by 100

production (Table 6.4). Contributions from ICT capital was calculated by the capital deepening effect due to ICT assets, including computer hardware, software, and communication equipment. Contributions from ICT production was measured by multifactor productivity (MFP) from industries that produce ICT products, including semiconductors, computer hardware, software, and communication equipment. In other words, contributions from ICT capital are related to efficient uses of traditional industries by ICT, and contributions from ICT production are relevant to the creation of new industries by ICT. As the transition to the digital economy progresses, the proportion of its contribution to the improvement of labour productivity increases. ICT contributions to the growth of labour productivity for 1974–1990, 1991–1995, and 1996–2001 are estimated at 0.68, 0.87, and 1.79, respectivly, which translates to 50.0 %, 56.5 %, and 73.6 % of the total growth of labour productivity resulting from ICT capital and production. On the basis of this analysis, Oliner and Sichel (2003) concluded that the the accelerating growth trend of labour productivity in the New Economy after 1995 comes from ICT. In particular, the effect of ICT capital is noteworthy.

The GDP trend of ICT-producing industries in the US that influence the creation of new industries is drawn in Fig. 6.18. The GDP of ICT-producing industries in the US grew rapidly after the mid-1990s and reached about 4.2 % during 1995–1999. During the same period, contributions from ICT to the economic growth of the US reached about 30 % (White House 2001). Although the size of ICT industries is relatively small, they play a key role in economic growth as its driving force.

Later, similar to the IT productivity paradox pointed out by Solow (1987), ICT contributions to economic growth were challenged since the GDP share of ICT-producing industries in the US dropped heavily in the early 2000s. Regarding this issue, the Economic Report of the President (White House 2002) explained that the ICT sector declined because the overheated stock market driven by the rapid growth of ICT calmed down and the demand for ICT capital decreased after the heavy investments by companies in 2000 to prepare for Y2K were no longer needed. Oliner and Sichel (2003) and Martinez et al. (2010) refuted the IT paradox and showed that ICT contributed to the growth of labour productivity even after 2000. The decline of ICT in the early 2000s was only temporary, and ICT is still the key growth engine for the US economy.

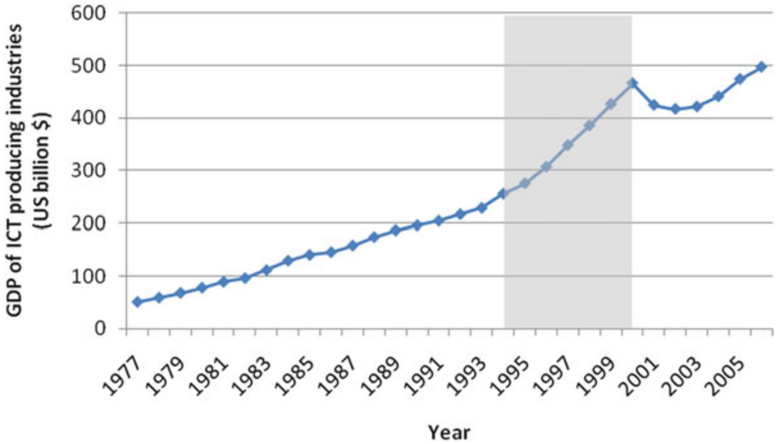


Fig. 6.18 GDP of ICT-producing industries in the US (in billion $) (Source: The Bureau of Economic Analysis 2010)

A3.2 The Digital Economy of Ireland and Finland

Despite the polarization in industrial societies, it is possible that following countries will overtake the leading countries if they adopt and develop a digital economy ahead of other countries. Figure 6.19 illustrates the process by which a faster-accelerating economy overtakes an accelerating industrial economy.

The speed of accelerating economic growth is measured by the slope of the time-output curve in Fig. 6.19. If the economies of leading countries are ahead in informatization, the gap between the leading and following countries will go on widening. However, if the following countries intensively invest in ICT to establish a faster-accelerating digital economy, the gap can be closed. In Fig. 6.19, the gap is broadening until t_2 in the process of industrialization. When the following countries enter the digital economy at t_2, the slope of economic growth becomes faster, and eventually the following countries overtake the leading countries at t_3. This paper presents two real-world examples among the following countries that show an outstripping economic growth curve: Ireland and Finland.

Ireland experienced a serious financial crisis in the 1980s because of political instability and excessive government expenditure, and its GDP per capita dropped below 70 % of the European average. In the 1990s, however, Ireland intensively promoted ICT industries and, as a result, achieved a rapid 9 % annual growth, on average, in the mid- and late 1990s. This growth rate was the highest among OECD countries at that period of time. As shown in Fig. 6.20, Ireland grew remarkably faster than other economies, starting from the early 1990s. In the late 1990s, Ireland's GDP per capita surpassed the OECD and EU-15 averages, and the country emerged as one of the richest in Europe. In 2006, its GDP per capita, at $30,736, ranked ninth in the world.

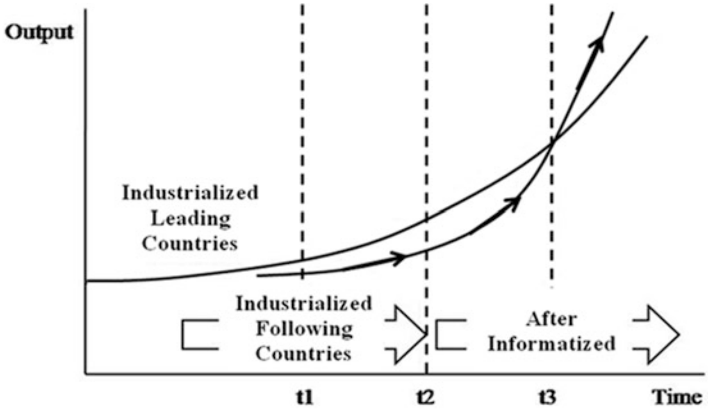


Fig. 6.19 Overtaking model of the digital economy

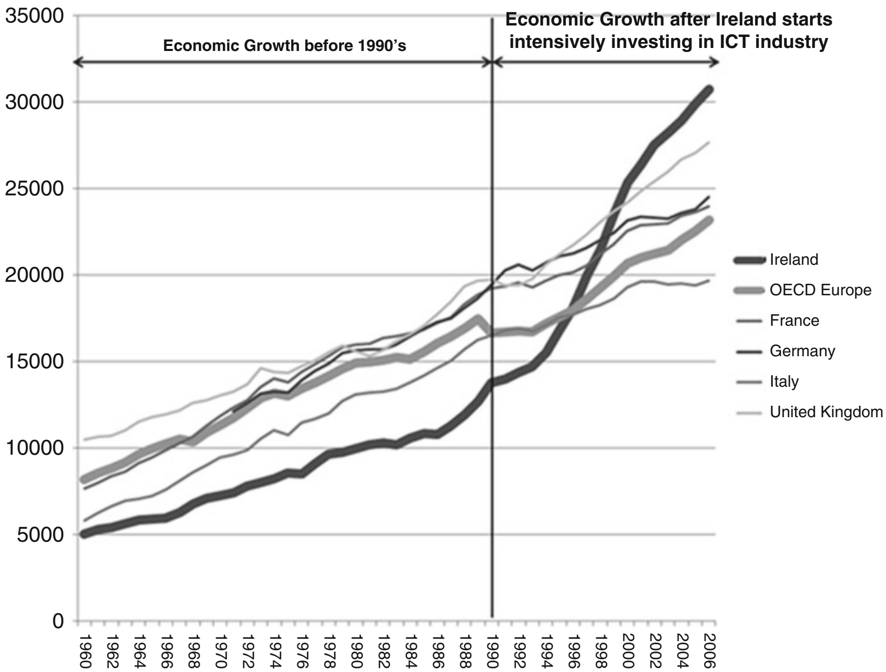


Fig. 6.20 GDP per capita of Ireland, OECD Europe (average), and other European countries (Source: World Development Indicators Database 2008)

Government policies that fostered software companies and focused on high-value-added ICT industries were the one factor that led Ireland into rapid economic growth. The country's domestic companies are technically inadequate, and the domestic market relatively small. From the 1990s, therefore, Ireland concentrated

Table 6.5 Contributions to gross-value-added growth in Ireland

	1990–1994	1995–1999
Gross-value-added growth	3.99	9.07
Contribution of capital input growth	1.37	3.51
(Contribution of ICT capital)	(0.25)	(0.71)
(Contribution of non-ICT capital)	(1.12)	(2.80)
Contribution of labor input growth	1.37	3.24
Contribution of multi-factor productivity growth	1.25	2.32

Source: EU KLEMS 2009

Table 6.6 ICT industries' contributions to labor productivity growth in Ireland

	1990–1995		1995–2000	
	Labor productivity growth	Contributions to productivity growth	Labor productivity growth	Contributions to productivity growth
Total economy	3.0		5.3	
ICT-producing industries	11.2	0.89	23.5	2.75
ICT-producing manufacturing	17.1	0.82	42.3	2.77
ICT-producing services	2.2	0.07	−0.2	−0.02
ICT-using industries	1.4	0.42	2.9	0.89
ICT-using manufacturing	6.1	0.37	8.7	0.56
ICT-using services	0.2	0.05	1.4	0.33
Non-ICT industries	2.6	1.48	2.7	1.65

Source: Van Ark et al. 2002

on policies that developed ICT industries by attracting competitive foreign companies. The Industrial Development Authority (IDA) offered various incentives such as tax benefits and financial support to attract foreign investments. As a result, many software companies, in particular, moved in and made considerable investments in Ireland. The development of ICT industries played an important role in the economic growth of Ireland, and the country achieved an annual average 4–5 % of economic growth, which was higher than the OECD average until the mid-2000s. However, Ireland began to experience economic downturn from the first half of 2008. According to IMF (2009), though, the main causes of the economic bubble lie in the finance and construction sectors.

Table 6.5 shows the average contributions from each component to GDP growth of Ireland during 1990–1994 and 1995–1999. The total gross value added increased 2.27 times from the first to the second half of the 1990s. Moreover, contributions from ICT capital during this period increased 2.84 times, exceeding those from other components. The table confirms that the economic growth of Ireland accelerated as ICT industries matured, and the proportion of ICT capital's contribution to this growth continued to increase.

ICT also contributed substantially to the improvement of labor productivity of Ireland after the 1990s (see Table 6.6). Van Ark et al. (2002) estimated the contributions of ICT industries to the improvement of labor productivity of Ireland

Fig. 6.21 GDP share of ICT-producing industries in Ireland (Source: The Groningen Growth and Development Centre 2005)

in the 1990s under three categories, following the international standard industrial classification of all economic activities (ISIC Rev. 3): ICT-producing, ICT-using (where the ratio of ICT capital is relatively high), and non-ICT industries. Contributions from ICT-producing industries represent the effects of ICT on the creation of new industries, and those from ICT-using are none other than ICT's effects on efficient uses of traditional industries. According to their analysis, the role of ICT industries, particularly the producers, was crucial to the improvement of labor productivity of Ireland.

However, the relatively high proportion of ICT industries in its economy helped Ireland achieve a faster-accelerating economic growth compared to the established industrial societies such as the UK, Germany, France, and Italy. Figure 6.21 shows the GDP trend of Ireland's ICT-producing industries.

On the other hands, Finland experienced high economic growth compared to OECD Europe in the early 1980s, as financial institutions became free to raise and manage funds after financial and capital liberalization policies were applied. However, this period is also characterized by careless management of finances with financial institutions buying real estate and providing loans excessively (Fig. 6.22a). In addition to this problem, the collapse of the Soviet Union, which was the most important export market, caused Finland to face a serious financial crisis after the late 1980s (Fig. 6.22a). The foreign exchange shortage and the severance of trade with the Russian Federation forced the industrial structure of Finland to change. As a result, ICT industries, including the mobile phone and other hardware-manufacturing sectors, were developed as key industries. Fuelled by ICT, the economy of Finland has been growing faster than OECD-Europe ever since (Fig. 6.22c).

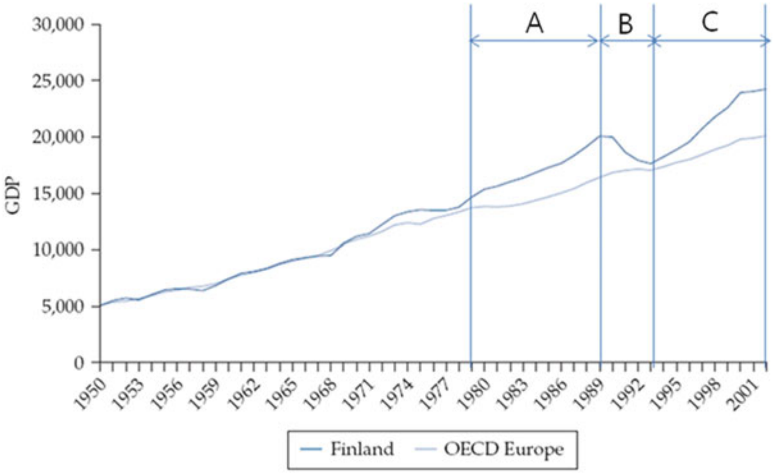


Fig. 6.22 GDP per capita in Finland and OECD Europe, at 1995 prices and purchasing power parity (PPP) exchange rates (Source: Carl et al. 2006)

Statistics reveal that the GDP growth from 1995 to 2001 was 5 %, on average, compared to 3.5 % from 1950 to 2001 (OECD 2002). In order to overcome the economic crisis, Finland announced an ICT promotion policy in 1994, before other countries did so (Fig. 6.22). The government proposed a new policy aimed at 'education, training and research in the information society', and pursued the adoption and development of information technologies as the key national policy. As a result of these policies, Finland enjoyed a high economic growth and is now one of the most competitive countries among EU members.

Jalava and Pohjola (2008) divided the period between 1980 and 2004 into two sub-periods, 1980–1990 and 1990–2004, and analyzed factor contributions to the output growth of Finland for each sub-period (Table 6.7). Regarding the effect of each component on GDP growth, contributions from ICT to GDP were investigated by three categories: ICT production, ICT capital, and spillovers from the use of ICT capital. ICT production includes ICT manufacturing for electrical and optical equipment, and post and telecommunication services. ICT capital refers to the assets invested in ICT industries. The spillover effects by the use of ICT capital are estimated by investigating 21 industries- including agriculture, mining, manufacturing, gas, and water-classified by Nordhaus (2002). In other words, these three categories correspond to the previously mentioned impacts of the digital economy on the ERS: ICT production is an equivalent term for the creation of new industries by ICT, and ICT capital and spillovers from the use of ICT capital represent the efficient uses of traditional industries.

Table 6.7 shows ICT's total contribution to GDP growth from 1990 to 2004 was almost three times the 1980–1990 rate. Contributions from ICT production increased 3.5 times, but the increase from ICT capital was not significant. Even if the spillover effect is excluded, the contributions from ICT production and ICT

Table 6.7 Factor contributions to the output growth of the Finnish non-residential market sector

		1980–1990		1990–2004	
		(a)	(b)	(a)	(b)
Growth of real gross value added at basic prices[a]		3.15	3.15	2.53	2.53
Contribution[b] from	Capital	1.10	1.32	0.37	0.53
	Labour	0.57	0.57	−0.35	−0.35
	Multi-factor productivity	1.48	1.26	2.51	2.35
Total contribution from ICT[b]		0.48	0.66	1.54	2.09
Contribution from ICT capital		0.22	0.44	0.24	0.43
Contributions from MFP	ICT production	0.26	0.22	0.91	0.89
	Spillovers from the use of ICT capital	–	–	0.39	0.77
Memoranda					
Income share of ICT capital[c]		2.45	2.62	4.63	4.62
Volume growth of ICT capital[a]		8.80	17.00	3.92	7.83
Output share of ICT production[c]		5.53	5.53	10.06	10.06
MFP growth in ICT production[a]		4.76	3.97	9.05	8.75

Source: Jalava and Pohjola 2008
Notes:
(a) Estimates based on non-hedonic ICT prices
(b) Estimates based on hedonic ICT prices
[a]In per cent
[b]In percentage points
[c]In per cent

Table 6.8 Average growth of labor productivity and its components in Finland, 1995–2005

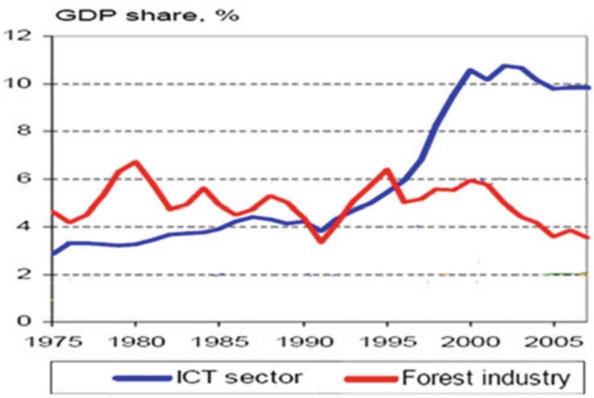
	Share of GDP (%)	Volume growth (In %)	Contribution (In %)
GDP at market prices	100.00	4.06	4.06
Hours worked		1.19	1.19
Labour productivity		2.87	2.87
Capital deepening	34.62	1.86	0.66
Dwellings	9.92	1.15	0.13
ICT capital	3.27	13.95	0.46
Other capital	21.42	0.01	0.07
Labour quality	65.38	0.22	0.14
Multi-factor productivity		2.07	2.07
ICT related contribution			1.41
Other contribution			0.66

Source: Jalava and Pohjola 2007
Notes: Numbers may not sum to totals due to rounding

capital to GDP growth from 1990 to 2004 increased almost 2.5 times (about 3 times if the spillover effect is included).

According to Jalava and Pohjola (2007), Finland's labor productivity grew 2.87 % from 1995 to 2005. Table 6.8 shows ICT's contributions to labor productivity. The data confirm that the influence of ICT on the creation of new industries is

Fig. 6.23 Changes in the GDP shares of ICT sector and forest industry in Finland (Source: Pohjola 2008)



substantial. The ICT impact on total labor productivity, which is the sum of ICT capital and ICT-related contribution, was found to be about 65 %.

Figure 6.23 illustrates the GDP share of the ICT sector in Finland. The proportion of the ICT sector increased at an accelerating rate from the early 1990s and doubled by the early 2000s to reach 10 %. On the other hand, the percentage of the forest industry, which was traditionally strong, dropped lower and lower, to nearly 3 %. The figure reveals the effects of the creation of new industries by ICT, and shows that ICT was the driving force of the rapid growth of Finland in the 1990s.

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Chapter 7
The Catch-Up Illusion: Why Developing Nations that Experience Rapid Economic Growth Can Never Catch Up with Advanced Countries

Tai-Yoo Kim and Seunghyun Kim

Abstract Previous research on the economic growth of late industrializing countries has been limited. This is primarily because most analyses are based on certain time periods and countries. The present paper tests the growth principles of latecomers and identifies the feasibility of closing the gap. In order to test the causality between exports and growth, a multivariate error correction model is tested, and intra-class correlation coefficient analysis is applied to compare the growth speeds of advanced countries and latecomers. The results show that latecomers acquire their economic growth through export-led industrialization and have similar economic growth speeds to those of advanced countries. However, despite the similarity between the growth speeds, the former cannot overtake the latter. First-generation latecomers that enjoyed rapid growth in the past, eventually failed to overtake the economic growth speed of the US. Thus, it is impossible for today's rapidly growing countries, such as China, to overtake the US.

Keywords Economic growth • Catch-up • Causality • Vector error correction • Export • JEL Classification Numbers: C33; F43; O11

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7.1 Introduction

In the second quarter of 2010, China's Gross Domestic Product (GDP) overtook that of Japan,[1] making its economy the second largest in the world after the US. Furthermore, economic organizations such as Goldman Sachs, the OECD, Deutsche Bank and the National Institute of Economic and Social Research (NIESR) have all forecasted that China will overtake the US in terms of its economic size within 20 years.[2] However, the accuracy of such forecasts is directly related to the basic question of economic growth, namely whether the economies of established industrial countries and those of the latecomers in industrial society will converge or diverge.

The forecast that a fast growing late industrialized country such as China would overtake the world's only superpower is not new. In the 1980s, the prospect that Japan would outrun the US economy once stirred up economic debate.[3] Previous studies of the economic growth of advanced countries and latecomers have long been conducted using the Convergence Hypothesis (Tinbergen 1961; Baumol 1986; Mankiw et al. 1992; Amable 1993) and World System Theory (Hopkins and Wallerstein 1977; Peacock et al. 1988; Pritchett 1997).

Nevertheless, the fundamental reason why the crisis theory of slowly growing advanced countries and the rosy prospects of fast growing latecomers are historically repeated is that there are few studies of economic growth from differentiated viewpoints. Another point is the overinflated economic growth rate, which stems from confusing growth rate with growth speed.[4] In 2007, the growth speed of China, which showed a 4.14 % growth rate, was \$255/year per capita, whereas that of the US was \$353/year per capita (1.13 % growth rate). Although the growth rate of China was four times higher than that of the US, the gap between fast growing China and slow growing US did not narrow. In fact, the gap between the low growth speed of China and the high growth speed of the US (\$98/year per capita) widened. Thus, deciding which indicator (GDP or per capita income) represents the development level of a national economy plays a certain role in causing this confusion. Therefore, the aim of this study is to show these: First, how latecomers could develop their economy fast, and, despite the similarity between the growth speeds of latecomers and those of advanced countries, why the former cannot overtake the latter.

We will first clarify the development indicator and its object of comparison and then analyze how latecomers actually develop based on previous theoretical studies

[1] According to the Japanese government, the GDP of Japan in the second quarter 2010 was \$1.28 trillion, \$50 billion less than that of China.

[2] Goldman Sachs by 2027, the OECD and Deutsche Bank by 2020 and the NIESR within 9 years.

[3] In 1984, the Japan Center for Economy Research predicted Japan would grow by at least 2 % per annum, namely above that of the US. Thus, by 2000, its per capita GDP would reach \$69,048, much higher than that of the US (\$38,333). However, in reality, Japan has not overtaken the US in terms of GDP growth rate since the 1990s. In particular, its per capita GDP has never once surpassed that of the US.

[4] Growth speed means the change in the amount of product compared with the change in time, i.e. $(pGDP_1 - pGDP_0)/(t_1 - t_0)$

of the development of latecomers. In other words, by analyzing how they maintain rapid growth, we will aim to inversely analogize why their growth rates cannot be permanently high. Because the economic growth of latecomers depends on the degree of their market openness, this will match the growth speed of rapidly growing latecomers with that of slowly growing advanced countries. In the conclusion, we will review the limitations of the economic growth of latecomers and their relation with advanced countries.

7.2 Literature Review

Studies of how latecomers among industrial countries that experience rapid economic growth pass through the stages of economic growth compared with advanced countries are scarce. However, studies of the principles of the economic growth of latecomers among industrial countries and of the convergence of between latecomers and advanced countries are now beginning to be conducted. Therefore, the present study reviews all previous studies of these two areas in order to understand the patterns and principles of the economic growth of latecomers and of advanced countries.

First, previous studies of the principles of the economic growth of latecomers have compared exports with economic growth (Maizels 1968; Balassa 1978; Fajana 1979; Feder 1983; Kavoussi 1984; Chow 1987; Goncalves and Richtering 1987; Esfahani 1991). The so-called export-led economic growth hypothesis analogizes and determines the cause of economic growth through the economic indicators of latecomers. It gives priority to indicators of the growth of advanced countries such as exports, openness, Foreign Direct Investment (FDI), imports, technology aid as a technology-related effect and technology transfer as well as the factors of policy choice, income inequality and education that have been studied as indicators of the growth of latecomers.[5]

These studies can be roughly divided into those that assess the causal relationship between exports and economic growth and those that consider other additional factors. Chow (1987) used the Sims procedure to analyze data on Brazil, Hong Kong, Israel, Korea, Singapore, Taiwan, Mexico and Argentina and found that exports influenced economic growth in all countries except for Argentina. However, according to Jung and Marshall's report (1985), only four countries showed a significant effect among 37 countries through Granger causality analysis. Later, Krueger (1990) claimed that East Asian countries could achieve accelerated growth rates by adopting an export-oriented open economic growth policy compared with the import substitution strategies of Southeast Asia. Bahmani-Oskooee and Alse (1993) confirmed that exports had a significant effect in nine countries.

Second, non-export-related studies mostly considered other factors as control variables such as imports, FDI and other trade-related indicators. Awokuse (2008)

[5] Furthermore, some studies use production factors such as capital and technology based on labor and savings rate. However, these review products compared with input factors, such as growth-like export-led type, import-oriented domestic type and so on.

studied the relation between trade openness and economic growth using Granger causality and the impulse response functions test (Engle and Granger 1987; Johansen and Juselius 1990; Johansen 1991; Lutkepohl and Reimers 1992; Riezman et al. 1996). Blomström et al. (1992) showed that the major role in economic growth was not played by income per capita at the early stage, but by FDI (into import technology or secure capital that enabled companies to imitate technology). However, they could not find an important causality among other factors. Islam (1998), realizing that external factors could influence the effect of exports on economic growth, showed that the export-led growth hypothesis was supported in over two-thirds of the countries studied. Kwan et al. (1999) assessed whether exports could lead to economic growth in Hong Kong, Singapore and South Korea using the weak and super exogeneity tests (Engle and Hendry 1993). They found that exports led to economic growth in Hong Kong and South Korea using the variables of labour and investment in addition to exports. However, even though labour and investment are production function variables and exports are included in GDP, they did not indicate the concrete basis for using these three variables together. Similarly, Sengupta and España (1994) studied the causes of the rapid growth in South Korea and found that the externality effects of exports were a catalyst and that there was also increasing returns to scale during this rapid growth. Finally, Levin and Raut (1997) showed that education has a complementary relation with exports.

In addition to the above studies of export-oriented growth, some studies have considered the direct effect of openness, the import of technology, policy and FDI on economic growth. In the case of openness, which is a variable that considers the effects of exports and imports together, Edwards (1998) used nine existing openness indexes in order to analyze data on 93 developing countries and found that these indexes played a role in total factor productivity growth. Obstfeld and Rogoff (1996) also found that total factor productivity can be a requisite for production and thus that openness induces growth; however, they did not directly use an economic growth variable.

Regarding imports and the imitation of technology, Kumar and Russell (2002) showed that although advanced countries grew as they moved the frontiers of productivity, latecomers grew as they developed technologies in a direction from low productivity to high productivity, namely to the frontier. In other words, while advanced countries lead technology development, latecomers grow as they imitate technologies developed by advanced countries and conduct technological catch-up. Kuznets (1955) considered that policy choices to solve specific situations such as an economic crisis or an oil shock should analyze growth factors not steady time series factors. In the case of income inequality, Levin and Raut (1997) analyzed the relation between growth and income inequality and found that income inequality does not induce growth, but vice versa. UNCTAD (1999) claimed that FDI can have a positive or a negative effect according to analysis equations; however, there were mostly significant results in the causality analysis. For instance, De Gregorio (1992) found that FDI has more than three times the effectiveness of domestic investment and Kundan (2010) showed that FDI had a significant effect on economic growth. However, Durham (2004) claimed that FDI does not have a direct effect, but does have an effect on raising national absorptive capability.

The above studies show that export-led economic growth and control variables such as the import of raw materials and the FDI of advanced countries can be complementary. In addition, some studies have used several individual variables. The majority of the findings show that exports, especially based on securing insufficient capital (FDI), the import of raw materials and the introduction of technology, have an aggressive influence on the economic growth of latecomers. However, most studies failed to show this economic growth in relation to that of advanced countries.

Second, previous studies of the convergence and divergence of latecomers and advanced countries can be divided into those focusing on the growth function and those focusing on the actual proof such as the World System. In the case of the former, few studies have directly compared nations and most have assumed that the growth function follows Balanced Growth (Baumol 1986; Mankiw et al. 1992). In order for them to do so, although externality, internality or other various functions were applied, they did not review the actual organic growth correlation between nations. By contrast, the World System approach, which divides nation groups using actual data and reviews convergence and divergence between groups, seems to be closer to the present study in terms of the described growth tendency. In this regard, Horowitz (1966) and Odum (1971) claimed that increasing economic output made countries choose between various courses of development and thus it was connected to divergence between countries. Peacock et al. (1988) showed that, in the case of dividing countries into core (advanced countries), semiperiphery (latecomers) and periphery (underdeveloped countries) in the World System, there was convergence within groups and divergence between groups.[6] However, these studies used Theil's T, which can measure the division level of the production of nation groups (Peacock et al. 1988), and thus they could not directly indicate a growth course and a growth level of each nation and a growth level of each advanced country.

The present study, which reviews the merits of these two groups of previous studies, will first determine the growth principles of latecomers and then assess whether they can narrow the gap between themselves and advanced countries (convergence) by maintaining their rapid growth or fail to narrow (divergence) by experiencing slow growth.

7.3 Hypotheses and Empirical Model

First, a nation group termed latecomers undergoing rapid growth was selected in light of recent growth rates. We then extracted related factors from the principles of the economic growth of latecomers focusing on exports based on the literature review and applied these to the data on this group for analysis. The present study finally compared this with the growth speeds of advanced countries to see how this subordinative growth relationship would reflect on actual growth.

[6] Representative studies in this line of research include Frank (1966, 1967), Dos Santos (1970), Amin (1976), Cardoso and Faletto (1979) and Arrighi and Drangel (1986).

7.3.1 Hypotheses

H1. Exports, openness and the introduction of technology have a positive effect on the economic growth of latecomers undergoing rapid growth.
H2. The growth speeds of latecomers undergoing rapid growth are similar but not higher to the growth speeds of advanced countries.
H3. First-generation latecomers that have experienced rapid growth in the past will not surpass the economic growth speeds of advanced countries and experience slower growth as their economic scales expand.

Through Hypothesis 1, we aim to test whether the rapid growth (or growth) of latecomers is dependent on advanced countries. In other words, do latecomers import production resources including capital and technology from advanced countries and achieve economic growth by exporting goods produced with these resources? As the trading scale expands, openness widens and the introduction of technology induces economic growth. Through Hypothesis 2, we aim to test whether latecomers undergoing rapid growth that are dependent on advanced countries can keep pace with advanced countries in light of this subordinative relationship, namely can they achieve a similar growth speed, but never overtake them? If Hypotheses 1 and 2 are determined, the growth pattern and its limitation of latecomers dependent on advanced countries can be clarified. Lastly, through Hypothesis 3, we aim to obtain the implications of the future growth of rapidly growing countries, which can hardly be measured in rapidly growing countries now.

7.3.2 Data Selection

The data used in this study were collected from various international agencies such as the United Nations. First, in order to extract latecomers undergoing rapid growth, we used the data on Maddison (2009) on per capita GDP in 1990 International Geary–Khamis dollars. Second, in order to find out the principles of economic growth on how latecomers were developed, we used Maddison GDP data on latecomers undergoing rapid growth together with annual data (1970–2008) for each variable. The information on exports and imports were derived from the IMF's *Direction of trade statistics yearbook* (IMF 2009), while the FDI and technology indexes were obtained from the World Bank's *World Development Indicators* and *Global Development Finance*. Openness data were derived from *Penn World Table 6.3* (Heston et al. 2009). All variables were converted into 1990 US dollars.

The method of selecting latecomers undergoing rapid growth was as follows. We selected countries that had experienced 3.5 % or above average annual growth for 5 years (2004–2008) excluding countries in Africa and oil-producing countries. The reason we used an average of 5 years was to control for cycle effects according to business circulations and to remove the short-term effects of business circulations

(Schumpeter 1939). As a result, the number of countries sampled was 27.[7] The variables used in the study are shown in the table in Appendix 1. In particular, time series data on some sample countries were limited since data on six countries of the old Soviet Union were effective only after their independence; thus, just 16 cases were finally collected and used for the analysis.

7.3.3 Determination of the Principles of Growth of Rapidly Growing Countries

In order to find out the principles of growth of latecomers undergoing rapid growth, the study applied the time series multivariate and bivariate Granger causality test or vector error correction model test. Before the Granger causality test, the unit root test and cointegrating test were used. By reviewing whether the F value was bigger than was the critical F value based on the test results, we selected the significance level and decided whether or not to dismiss the null hypothesis. If the calculated F value was higher than was the critical value, the null hypothesis was dismissed. The unit root test determines whether time series data contains the unit root, namely they are nonstationary. Otherwise, the Granger causality test can be applied if time series data are stationary. For the unit root test, the augmented Dickey–Fuller test was used. The cointegration test reviews the long-term relation between variables of series. In the case of nonstationary data, by using the error correction model (ECM) according to cointegration, long-term causality can be confirmed (Miller and Russek 1990).

One dependent variable and three independent variables were used for the analysis. Per capita GDP (pGDP) was used as the dependent variable and manufacturing goods export (Exp), Openness (Opn) and Technology dependency (Tech) were used as independent variables. In order to find out the relation between manufacturing goods export and growth, a multivariate method was used, and thus ores and metal import (Imp_1) or fuel import (Imp_2) and FDI (Fdi) variables were added.[8] The reason why this study used these variables is to assess whether the economic growth of latecomers is affected by importing insufficient resources and raw materials, manufacturing or assembling and exporting finished products. In particular, if capital is the most important growth factor, FDI can supplement insufficient domestic capital. To test the dependency of Openness and Technology, a bivariate analysis was used since it shows the degree of trade of the whole society.

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[7] Armenia, Belarus, Latvia, Kazakhstan, Russia, Lithuania, Slovakia, Bulgaria, Poland, Slovenia, Croatia, Bosnia-Herzegovina, Hungary, Greece, Finland, Venezuela, Uruguay, Argentina, Chile, Cambodia, China, India, Malaysia, Vietnam, Thailand, Turkey, South Korea.

[8] Owing to difficulties collecting data on some countries, we used total exports and total imports. Since most of these countries have small economies, we did not anticipate big differences between the export goods of manufacturing and import goods of raw materials (Esfahani 1991).

For Technology, license royalty (Tech_1) and technical cooperation grants (Tech_2) were further used. All these variables were calculated as 1990 US dollars and applied to the analysis.

The equations of the unit root test (Eq. 7.1) and augmented Dickey–Fuller test (Eq. 7.2) were as follows ($\alpha =$ constant, $\beta =$ coefficient of time trend, $\rho =$ lag order, instead of pGDP value, Exp, Opn, Tech and Fdi were also repeatedly tested):

$$\Delta pGDP_t = \alpha + \beta t + \gamma pGDP_{t-1} + \delta_1 \Delta pGDP_{t-1} \cdots + \delta_p \Delta pGDP_{t-p} + \varepsilon_t \tag{7.1}$$

$$DF_t = \frac{\gamma}{SE(\gamma)} \tag{7.2}$$

The Granger causality test (when a specific information set is given) predicts whether X causes Y and whether the Y value is better than the previous one using previous and present X values. The multivariate Granger causality test for the equations used in this study was derived from following procedures (in the case of the bivariate analysis, X was substituted with Opn and Tech):

$$pGDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} Exp_{t-i} + \sum_{j=1}^{n} \alpha_{21j} Imp_{t-j} + \sum_{j'=1}^{n} \alpha_{22j'} Fdi_{t-j'} + \sum_{k=1}^{n} \alpha_{3k} pGDP_{t-k} + \varepsilon_{1t} \tag{7.3}$$

$$Exp_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} Exp_{t-i} + \sum_{j=1}^{n} \beta_{21j} Imp_{t-j} + \sum_{j'=1}^{n} \beta_{22j'} Fdi_{t-j'} + \sum_{k=1}^{n} \beta_{3k} pGDP_{t-k} + \varepsilon_{2t} \tag{7.4}$$

$$Imp_t = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i} Exp_{t-i} + \sum_{j=1}^{n} \gamma_{21j} Imp_{t-j} + \sum_{j'=1}^{n} \gamma_{22j'} Fdi_{t-j'} + \sum_{k=1}^{n} \gamma_{3k} pGDP_{t-k} + \varepsilon_{3t} \tag{7.5-1}$$

$$Fdi_t = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i} Exp_{t-i} + \sum_{j=1}^{n} \gamma_{21j} Fdi_{t-j} + \sum_{j'=1}^{n} \gamma_{22j'} Imp_{t-j'} + \sum_{k=1}^{n} \gamma_{3k} pGDP_{t-k} + \varepsilon_{3t} \tag{7.5-2}$$

$$F = \frac{(RSS_r - RSS_u)/m}{(RSS_u)/(n-k)} \tag{7.6}$$

Granger causality can be accepted or rejected through the F value derived according to the above relation. However, a major premise of the Granger causality test is the stationary or non-stationary of a variable. If a variable is non-stationary, the acceptance or rejection of causality cannot be carried out. As a complementary measure, the study used the vector error correction test in the form of the cointegration test with which causality can be accepted or rejected under a long-term equilibrium (Miller and Russek 1990; Islam 1998). As below, when lag length = 1, $\Delta pGDP_t$ which is derived by deducing $pGDP_{t-1}$ from $pGDP_t$ (Eq. 7.7) is as Eq. 7.8. From Eq. 7.8, we can determine that the non-stationary series Exp, pGDP, Imp and Fdi have the stationary error term, ν_t on a long-term basis. Nonzero error ν_t was made by a past decision of an agent (Ericsson 1992) and to correct this error, an ECM as in Eq. 7.10 can be analogized. If we apply the F test to Eq. 7.11, which was derived from Eq. 7.10, we can understand the Granger causality between them[9]:

$$pGDP_t = \alpha_0 + \alpha_{11} pGDP_{t-i} + \alpha_{20} Exp_t + \alpha_{21} Exp_{t-i} + \alpha_{301} Imp_t + \alpha_{311} Imp_{t-i} + \alpha_{302} Fdi_t + \alpha_{312} Fdi_{t-i} + \varepsilon_{1t} \quad (7.7)$$

$$\Delta pGDP_t = \alpha_0 + \alpha_1 \Delta Exp_t + \alpha_{21} \Delta Imp_t + \alpha_{22} \Delta Fdi_t + \alpha_3 \left(pGDP_{t-1} - \beta_1 Exp_{t-i} + \gamma_{11} Imp_{t-i} + \gamma_{12} Fdi_{t-i}\right) + \varepsilon_{1t} \quad (7.8)$$

$$pGDP_t = \beta_1 Exp_t + \gamma_{11} Imp_t + \gamma_{12} Fdi_t + \nu_t \qquad \nu_t \tilde{\ } IN\left(0, \sigma^2\right) \quad (7.9)$$

$$\Delta pGDP_t = \alpha_0 + \alpha_1 \Delta Exp_t + \alpha_{21} \Delta Imp_t + \alpha_{22} \Delta Fdi_t + \alpha_3 \nu_{t-1} + \varepsilon_{1t} \quad (7.10)$$

$$\Delta pGDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta Exp_{t-i} + \sum_{j=1}^{n} \alpha_{21j} \Delta Imp_{t-j} + \sum_{j'=1}^{n} \alpha_{22j'} \Delta Fdi_{t-j'} + \alpha_3 \nu_{t-1} + \varepsilon_{1t} \quad (7.11)$$

Whether or not to apply the vector error correction model test was decided by the cointegrating rank in the cointegration test; when the rank was 1, the ECM was applied. Johansen statistics ϕ_i was used as a cointegration determinant (Johansen 1988; Johansen and Juselius 1990).

7.3.4 The Economic Growth Speeds of Advanced Countries and Latecomers Undergoing Rapid Growth

In order to find out the effect of the growth along these principles compared with actual growth, the study compared the economic growth speeds of latecomers with

[9] Equations regarding ΔExp_t ΔImp_t, ΔFdi_t were omitted. Through Eqs. 7.4, 7.5 and 7.10, these can easily be analogized.

that of a specific advanced country (i.e. the US[10]). In order to compensate for the gap in per capita GDP between the US and the latecomers sample, the study moved the per capita GDP of the US vertically to fit it for a term when its economic growth speed was similar to that of the latecomers group. In order to confirm this fit, the Intraclass Correlation Coefficient (ICC) was used. The ICC is an index that is used to measure similarity between objects and that has a maximum value of +1 (Kish 1965; Ahmed et al. 2001). Since the point of time when an advanced country and latecomers exchanged influences and grew is identical, in order to compare economic growth speeds in the same time period, the study moved per capita GDP of the US vertically. Because this only shows the increase or decrease in per capita GDP at a specific point of time (1-year basis) regardless of the existing per capita GDP level, it is appropriate for comparing directly changes in economic growth in the selected year.

Lastly, we reviewed whether the growth rates of advanced countries that had experienced rapid growth in the past remained high until now. Because latecomers undergoing rapid growth have only just started growing rapidly, it is impossible to predict whether they will maintain this growth rate in the future. Therefore, the study assessed countries that started industrialization later than the US and succeeded in economic development at an early stage. In order to do this, the study again used Maddison data. To avoid potential fluctuations and to capture the level of economic growth during rapid growth, we divided the increase in per capita GDP by 1,000 dollars

7.4 Analytical Results

Table 7.1 shows the per capita GDP for 2008 and average per capita GDP over 5 years for the 25 studied countries. As shown in Table 7.1, the high growth rate countries were mostly developing nations because dynamically growing latecomers have more chances to achieve relatively high growth rates compared with advanced countries, which have tended to plateau earlier. Another reason is that the growth rate is overinflated, as discussed previously.

[10] The reason why data on the US were used as an indicator of advanced countries is that the US held the number 1 per capita GDP in the world spot 44 times in 88 years since 1920 (including 23 times in the past 30 years). Countries that showed a higher per capita GDP than that, if we exclude city-state types with small populations (Switzerland, New Zealand) and oil-producing countries (Qatar, Kuwait, UAE), included Denmark (four times), England (five times) and the Netherlands (twice). Even these countries can only surpass the US during economic shocks. Maddison data were used as before.

Table 7.1 Per capita GDP for 2008 and average per capita GDP for 5 years for the 25 selected countries

Country	2008 GDP per capita (1990 Int. GK$)	Average growth rate (%) (2004–2008)
Cambodia	2,482	13.30
Armenia	11,630	11.18
Belarus	12,607	9.87
Latvia	14,816	8.43
Venezuela	10,596	8.26
Kazakhstan	11,245	7.69
Uruguay	9,893	7.50
Russian Federation	9,111	7.27
Slovakia	12,925	7.03
Lithuania	11,342	7.02
Argentina	10,995	7.01
Bulgaria	8,886	6.95
China	6,725	6.73
India	2,975	6.64
Vietnam	2,970	6.50
Poland	10,160	5.28
Slovenia	18,170	4.89
Turkey	8,066	4.45
Croatia	8,904	4.16
Bosnia	7,274	4.10
Thailand	8,750	3.91
South Korea	19,614	3.85
Malaysia	10,292	3.80
Chile	13,185	3.73
Greece	16,362	3.52

7.4.1 Testing the Growth Principles of High Growth Rate Developing Countries

In order to test the growth principles of latecomers that have high growth rates, we categorized each of the studied 25 countries into three categories (Export, Openness and Introduction of technology) and applied bivariate/multivariate Granger tests and ECM analysis (see Table 7.2). In the case of Export, we applied ECM analysis to eight countries among 25 (in the case of cointegrating relation rank = 1). Regarding Openness, we applied the ECM test to five countries among 22 (three countries with insufficient data were omitted). Regarding Introduction of technology, we applied ECM analysis to five countries among 23. In the case of Export only, we applied multivariate tests using the additional variables of the import of raw materials and FDI (import of capital). Although the time period of analysis was 37 years, we sometimes encountered insufficient data because of the short post-independence histories of countries in Eastern Europe and the former Soviet Union (Table 7.3).

Table 7.2 Bivariate/multivariate granger test and ECM analysis result of selected 25 countries

						Standard granger test					
						Bivariate		Multivariate		ECM	
Country	X variable	Obs.	ADF test statistic	Trace statistic (r ≤ r*)	Number of cointegrating relations (r)	Y = f (X) X → Y	X = f (Y) Y → X	Y = f(X,Z) X → Y	X = f(Y,Z) Y → X	Y = f(X) Y = f (X,Z,ν) X → Y	X = f(Y) X = f (Y,Z,ν) Y → X
Asia											
Cambodia	Export	26	−4.217***	17.563	0	3.189*	15.555***	(−)0.263	6.854***		
	Openness	36	−4.780***	14.781	0	0.034	(−)0.010				
	Technology	37	−5.343***	32.801	0	(−)0.017	0.348				
China	Export	23	−5.962	0.7065*	1	0.0000	(−)0.985	0.001	2.478	5.20**	0.83
	Openness	37	−7.575***	10.673	0	6.321**	(−)4.512**				
	Technology	28	−4.927***	0.2796*	0	4.863**	0.299				
India	Export	37	−5.165***	13.800	0	7.621***	2.795*	6.901***	1.671		
	Openness	36	−4.201***	2.5473*	1	21.086***	3.410*			(−)0.92	(−)0.63
	Technology[b]	31	−4974***	0.6813*	1	3.129*	0.418			2.6	0.11
Malaysia	Export	37	−3.678***	32.329	0	9.160***	(−)6.456**	16.167***	(−)5.427**		
	Openness	36	−5.096***	40.004	0	0.184	0.004				
	Technology	37	−5.793***	33.916	0	(−)0.193	(−)3.901**				
South Korea	Export[a]	37	−2.880**	0.2825*	1	0.192	0.733	16.403***	0.164	6.04*	7.09*
	Openness	36	−5.531***	25.233	0	3.227*	0.894	–	–		
	Technology[b]	31	−4.946***	52.828	0	0.569	0.194	–	–		
Thailand	Export[a]	37	−3.635***	3.5338*	1	(−)0.107	4.155**	3.456*	1.659	(−)1.66	1.312***
	Openness	36	−5.597***	34.776	0	(−)0.027	0.264	–	–		
	Technology	37	−5.935***	23.996	0	1.169	(−)0.223	–	–		
Turkey	Export	27	−3.740**	3.5954*	1	4.510**	0.007	0.792	1.444	(−)3.48	(−)1.49
	Openness	36	−5.065***	32.413	0	0.001	0.008	–	–		
	Technology	37	−4.171***	21.978	0	5.446**	1.106	–	–		
Vietnam	Export	26	−3.692***	13.621	0	1.254	(−)0.888	0.138	(−)0.631		
	Openness	36	−4.317***	1.3298*	1	2.135	2.460	–	–	(−)7.62***	(−)1.44
	Technology	37	−7.772***	28.540	0	–	1.964	–	–		

South America												
Argentina	Export[a]	37	−6.167***	22.154	0		8.371***	(−)0.017	5.730**	0.001		
	Openness	36	−7.667***	27.877	0		4.0135**	(−)1.076	–	–		
	Technology[b]	31	−3.679***	19.298	0		0.126	0.021	–	–		
Chile	Export[a]	37	−3.557***	17.055	0		4.724**	(−)0.222	1.330	(−)0.333		
	Openness	36	−4.550***	33.204	0		0.857	(−)0.524	–	–		
	Technology	37	−5.670***	24.648	0		5.250**	0.093	–	–		
Uruguay	Export	37	−2.908**	21.593	0		3.025*	0.022	2.212	(−)0.065		
	Openness	36	−6.216***	25.425	0		2.125	(−)			19.305***	–
–												
	Technology[b]	15	−8.732***	2.1548*	1		0.452	(−)1.486	–	–	(−)0.30	(−)4.33**
Venezuela	Export	37	−5.367***	34.321	0		2.533	0.997	3.828**	0.212		
	Openness	37	−2.867**	27.126	0		3.259*	0.560	–	–		
	Technology	37	−7.665***	34.322	0		(−)0.298	(−)0.071	–	–		
Furope, USSR												
Bosnia	Export[a]	15	−4.236***	35.701	0		3.219**	(−)0.5168	2.481	(−)0.063		
	Technology	15	−5.539***	0.235	1		-	(−)2.293	–	(−)0.048	–	8.36**
Bulgaria	Export	28	−3.586**	8.753	0		2.245	0.982	0.353	0.912		
	Openness	28	−3.628**	13.017*	0		5.923**	1.490	7.058***	5.346		
	Technology	15				−.6.283***	23.915	0	(−)1.483	0.066	(−)1.064	0.489
Croatia	Export	16	−3.702**	9.455	0		1.006	0.107	2.122	(−)0.000		
	Openness	17	−7.807***	2.177	1		0.068	1.239			2.34	(−)0.52
	Technology[b]	16	−4.028***	2.993	1		(−)0.478	0.391	(−)0.473	0.101	(−)12.41***	7.62*
Poland	Export	19	−3.936***	18.920	0		0.791	4.760**	3.812*	2.490		
	Openness	18	−3.998***	8.7613	0		(−)0.200	2.704*	0.024	1.642		
	Technology[b]	15	−3.162**	14.137*	0		1.713	0.456	(−)1.988	0.869		
Slovakia	Export[a]	19	−4.501***	2.878*	1		3.392*	(−)1.019	5.387**	(−)0.933	(−)0.16	(−)0.84
	Openness	18	−4.226***	7.989	0		6.054**	(−)1.314	3.587*	(−)1.199		
	Technology[b]	15	−1.516	14.771	0		9.961***	0.044	12.961***	(−)0.489		
Slovenia	Export	17	−3.220**	11.710	0		0.570	0.279	(−)0.016	(−)0.000		
	Openness	18	−2.610*	3.504	1		1.056	18.933***			3.66	(−)8.84**
	Technology[b]	17	−3.433***	8.315	0		0.664	20.686***	1.003	1.414		

(continued)

Table 7.2 (continued)

Country	X variable	Obs.	ADF test statistic	Trace statistic (r ≤ r*)	Number of cointegrating relations (r)	Standard granger test: Bivariate Y = f (X) X → Y	X = f (Y) Y → X	Multivariate Y = f(X,Z) X → Y	X = f(Y,Z) Y → X	ECM Y = f(X) Y = f (X,Z,ν) X → Y	X = f(Y) X = f (Y,Z,ν) Y → X
F. USSR											
Armenia	Export[a]	16		21.447	0	0.748	(−)1.709	0.656	(−)	11.393***	
	Openness	15	−5.509***	11.992*	0	(−)0.151	0.0347				
	Technology	16	−4.457***	12.763*	0	0.324	(−)3.277*				
Belarus	Export	16	−2.540	8.257*	0	(−)0.255	0.568	10.162***	0.026		
	Openness	14	−3.551***	9.848*	0	(−)				10.26***	3.094
Kazakhstan	Export[a]	16	−3.240**	13.935*	0	5.993**	0.394	10.797***	(−)0.002		
	Openness	15	−4.124***	9.199*	0	4.807**	(−)0.120				
	Technology	16	−5.950***	23.133	0	1.673	(−)			8.412***	
Latvia	Export[a]	16	−4.782***	27.118	0	2.9760*	(−)0.119	0.574	(−)0.285		
	Openness	15	−4.147	5.443	0	(−)0.157	4.267**				
Lithuania	Export[a]	16	−4.933***	0.140*	1	2.483	0.076	0.913	(−)	8.732***	6.68*
(−)2.25											
	Openness	15	−5.079***	10.845*	0	4.41**	0.677				
	Technology[b]	16	−4.551***	2.170*	1	0.712	1.069			(−)2.50	(−)15.60***
Russia	Export[a]	16	−3.931**	27.822	0	8.564***	0.218	85.364***	1.311		
	Openness	15	−2.793*	1.251*	1	0.236	(−)0.978			2.71	(−)0.74
	Technology[b]	15	−4.379***	3.696	1	(−)0.038	0.486			0.35	0.23
Other											
Greece	Export	37	−3.170*	2.419*	1	0.163	8.073***	1.059	2.960*	6.42*	0.47
	Openness	36	−4.439***	28.561	0	(−)2.044	3.963**	–	–		
	Technology[b]	28	−4.025***	1.885*	1	0.003	8.699***	–	–	(−)5.72	(−)0.67

ADF augmented Dickey–Fuller test
[a]As an export variable, total exports is used. In other cases, manufacturers exports is used
[b]As a technology variable, technical cooperation grants is used. In other cases, license royalty is used
*Significant at 10% level; **Significant at 5% level; ***Significant at 1% level

Table 7.3 Industrialization time, overtaking time and matching growth speed period of the selected 25 countries

Country	Industrialization time	Overtaking time	Matching growth speed period
Cambodia	2002	–	–
China	1978	1984	1999–2008
India	1947	1990	–
Malaysia	1957	1960	1988–1997
Vietnam	1994	1994	1994–2008
Thailand	1961	1964	1986–1997
Turkey	1930	1965	2001–2008
South Korea	1962	1962	1983–2008
Venezuela	1922	1922	2002–2008
Uruguay	1870	–	2000–2008
Argentina	1870	–	1871–2008
Chile	1850	–	1990–2008
Slovakia	–	–	1993–2008
Bulgaria	1927	1950	1997–2008
Poland	1929	1950	1993–2008
Slovenia	–	–	1993–2008
Croatia	–	–	1994–2008
Bosnia	1993	1993	1994–2008
Armenia	–	–	1993–2008
Belarus	–	–	1995–2008
Latvia	–	–	1993–2008
Kazakhstan	–	–	1998–2008
Russia	–	–	1996–2008
Lithuania	–	–	1994–2008
Greece	1890	1962	1990–2008

The results of the Granger causality analysis were as follows. In the case of Export, 20 countries among 25 showed significant growth-led causality and another four (Vietnam, Bulgaria, Croatia and Armenia) showed a positive causality even though the significance level was low. These results show a much higher causality compared with previous findings. In Jung and Marshall's (1985) study, only four countries among 37 showed significance, while in Hsiao's (1987) study, only Hong Kong among four East Asian countries showed a significant causality based on data from 1950–1981 to 1960–1987, respectively. In Bahmani-Oskooee and Alse's (1993) study that used data on 1973–1988, all nine developing countries showed significant causal relations, similar to the present study. The results of the present study are also in line with the findings of Riezman et al. (1996) and Islam (1998).

By contrast, the results for Openness and Introduction of technology were milder. In the case of Openness, causality could be found in nine countries among 22, while 17 countries showed positive but not significant causal relations. In the case of Introduction of technology, 5 countries among 23 showed significant and positive relations and 11 countries showed positive relations. In other words, because Openness includes both exports and imports compared with GDP, export-led growth (through the import of raw materials and capital) has a closer relationship with the growth of latecomers.

The results of the ECM test were as follows. Because we aimed to derive the long-term relationships between countries and variables that had rank = 1 relations, in the case of Export, all eight countries showed significant positive relations. This result is in line with Islam (1998) and Biswal and Dhawan (1998). In the case of Openness, ECM analysis showed that one country among five had a significant result and the remaining four countries showed positive test values even though the significance level was low. In the case of Introduction of technology, all five countries showed significant relations.

The presented results suggest the following findings. First, for the Export variable, both multivariate analysis and bivariate analysis showed significant positive results in most cases. In particular, since a one-directional relation from export to economic growth was derived in most cases, we could confirm hypothesis that exports rather than interactive causality lead to economic growth. In the case of the Openness and Introduction of technology variables, even though there were fewer significant countries compared with Export, they were mildly supported in most cases, too. Thus, Hypothesis 1 is supported.

Latecomers with high growth rates have a tendency to be more dependent on exports. In previous studies, even though developing countries were selected, many analyses were carried out with regional ranges without any specific basis. Since this study filtered countries (e.g. specific countries such as oil-producing ones were dismissed) based on high growth rates and used exports in the manufacturing field as an export indicator, it might have better reflected the principles of national development of industrial nations. Furthermore, this study used relatively recent data compared with previous studies. Since it analyzed all country-level data until 2008, export-led economic growth might have been better explained.

7.4.2 Comparison Between the Growth of the US and of Developing Countries

The results of the ICC analysis are as follows. First, we assessed whether latecomers could keep pace with advanced countries by moving the per capita GDP curve of advanced countries (using the US as a proxy) in order to determine the correspondence degree.

In Table 7.3, overtaking time means the point at which the growth rate of a country overtook that of the US and matching growth speed period means when the growth speed of a country kept a similar pace to that of the US.[11] As shown in

[11] Take-off time, defined in this study, means when rapid growth starts upon repeating industrialization. Rapid growth is when, upon moving to a post-industrial revolution growth curve of previous advanced countries (the US) horizontally to a period of industrial revolution of latecomers, shows similar growth speeds and then the latter starts to rise over the growth curve of the US. In Fig. 1, it is the point where the other countries begin to show faster growth speeds compared with the blue curve. The matching period of growth is when a latecomer grows at a similar speed to that of the US.

Table 7.4 ICCs of the selected 25 countries' growth speeds and US growth speed during the matching period

Country	Matching period	ICC	Significance
Cambodia	–	–	–
China	1999–2008	0.97	0.00
India	–		
Malaysia	1988–1997	0.93	0.00
South Korea	1983–2008	0.97	0.00
Thailand	1986–1997	0.93	0.00
Turkey	2001–2008	0.91	0.00
Vietnam	1994–2008	–	–
Argentina	1871–2008	–	–
Chile	1990–2008	0.89	0.00
Uruguay	2000–2008	0.51	0.00
Venezuela	2002–2008	0.87	0.00
Bosnia	1994–2008	0.85	0.00
Bulgaria	1997–2008	0.83	0.00
Croatia	1994–2008	–	–
Poland	1993–2008	–	–
Slovakia	1993–2008	0.71	0.00
Slovenia	1993–2008	0.95	0.00
Armenia	1993–2008	0.81	0.00
Belarus	1995–2008	0.87	0.00
Kazakhstan	1998–2008	0.89	0.00
Latvia	1993–2008	0.88	0.00
Lithuania	1994–2008	0.80	0.00
Russia	1996–2008	0.57	0.00
Greece	1990–2008	0.76	0.00

Table 7.3, 19 countries among 25 latecomers that show high growth rates recently matched the growth speed of the US. All six countries (Poland, Croatia, Argentina, Cambodia, India, Vietnam) that did not match the growth speed of the US clearly showed lower growth speeds. In other words, even though a country grows at a high growth speed, if its per capita GDP is low, it cannot reach the growth increase of the US through a low growth rate. This again reminds us of the overinflated growth rate phenomenon. Next, we determined how similar these growths were through statistical analysis (see Table 7.4).

The closer to one is the ICC value is, the higher is the correspondence degree between the two graphs. Table 7.4 shows that all 19 countries showed higher than 99 % significance except for Russia (0.57) and that all countries showed a higher than 0.8 correspondence degree (except for Slovakia (0.71) and Greece (0.76)). Thus, we can confirm that this matching phenomenon of growth actually indicates a high correspondence degree.

Figure 7.1 shows the industrialization times, overtaking times and the matching growth periods of eight Asian countries. As shown, since the economic scale of Cambodia is small even though it has a high growth rate, its growth speed is very

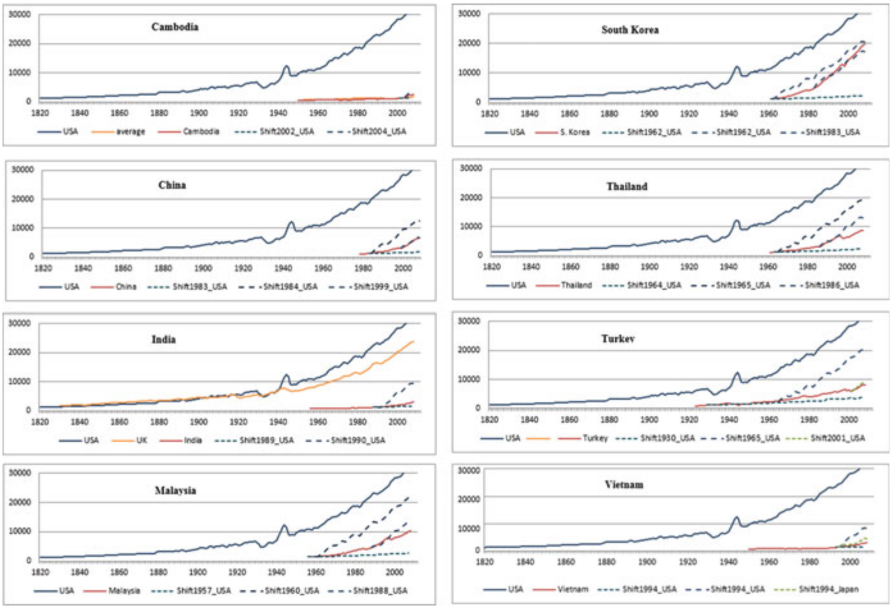

Fig. 7.1 Eight Asian countries' industrialization times and overtaking times

slow and it has no matching growth period. Table 7.5 explains the policy issues related to the industrialization of these countries.

According to Table 7.5, we find that the speed matching periods mostly began when there were promotion policies for heavy industry, which achieved economic growth by exporting products. Furthermore, even countries that showed matching growth speeds did not overtake the US. Although they grew at similar speeds to that of the US, they only approached gradually and upwardly, but never surpassed it. Latecomers grow by imitating the technologies of advanced countries, producing industrial goods through importing capital and exporting to markets of advanced countries. These principles of growth show the limits that latecomers can reach despite rapid growth rates. Thus, Hypothesis 2 is supported.

7.4.3 Limitations of the Catch-Up of Developing Countries

Table 7.6 shows the countries that display matching growth speeds with the US (some of these are now classified as advanced countries). However, none of these countries has ever caught up with the US.

Table 7.5 Eight Asian countries' industrialization policy issues

Country	Major policy change and time of industrialization
Cambodia	2002: Industrialization started when the country's GDP reached 1250
	No overtaking and matching growth speed period—since industrialization, Cambodia has not grown significantly
China	1978: Industrialization reform began
	1984: China started its open policy and economic innovation
	1999: The Chinese economy enters the growth speed matching period. Economic policy is centred on restructuring towards heavy industries
India	1947: India gains independence in 1947 and starts a 5-year plan for economic development from 1951
	1990: India enforces an open economic policy by implementing its 'New Economic Policy'
	No speed matching period—India's economic growth fails to match the speed of the US economy
Malaysia	1957: Consistent enforcement of the 'Malaysia Plan' and import substitution industrialization
	1960: Switched to export-oriented industrialization
	1988: New Economy Policy (1971–1990)
South Korea	1962: Industrialization
	1962: The first 5-year plan for economic development
	1983: The country's industry policy is directed towards heavy industries
Thailand	1961: Socio-economic development plan
	1964: Overtaking time
	1986: FDI from Japan, South Korea and Taiwan
Turkey	1930: Atatürk's innovation
	1965: Overtaking time
	2001: Speed matching period starts
Vietnam	1994: The country's GDP reaches 1200 for the first time
	1994: Overtaking time
	No speed matching with the US but it matches the speed of Japan

Figure 7.2 graphically represents the maximum growth rate for the specific per capita GDP region of each country.[12] The Fig. 7.2 shows that the higher per capita GDP a country achieves as it grows, the less its relative growth rate becomes. This also shows the overinflated growth rate well. Although economic growth in industrial societies is accelerating, the growth rate is dropping because the rate of the increase compared with the previous per capita GDP level has decreased.

First, Fig. 7.2 confirms that, for the maximum growth rate of each per capita GDP region, the growth rate of the US forms the highest outlier. This phenomenon can be interpreted as follows. First-generation countries that chased the US at an early stage enjoyed high growth rates at first. However, as their per capita GDP

[12] Figure 7.2 was derived by dividing the pGDP of each country per section by $1,000 (e.g. $2,001 ~ $3,000, $3,001 ~ $4,000 etc.) and making a graph of the growth rate of the year when the maximum growth rate shows up in each section. For instance, the US showed a maximum growth rate of 3.3 % in 1999 among the sections of pGDP $27,001 ~ $28,000.

Table 7.6 Analysis of speed matching times

Group	1940–1949	1950–1959	1980–1989	1990–1999	2000–2008	Average Growth Rate (2004–2008) (%)
The former Soviet Union				Armenia (1993)		11.87
				Belarus (1995)		10.37
				Kazakhstan (1998)		8.03
				Latvia (1993)		9.00
				Lithuania (1994)		7.29
				Russia (1996)		7.54
South America				Chile (1990)		3.80
					Uruguay (2000)	7.81
					Venezuela (2002)	8.69
Eastern Europe				Bulgaria (1997)		7.20
				Hungary (1998)		3.16
				Bosnia (1994)		4.19
				Slovenia (1993)		5.02
				Slovakia (1993)		7.29

North America				Canada(1992)		1.56
Asia					Turkey (2001)	4.46
			South Korea (1983)			3.93
		Japan (1951)				1.59
			Taiwan (1982)			3.83
				China (1999)		6.97
			Thailand (1986–1997)			4.93
			Malaysia (1988–1997)			6.84
Western Europe				Greece (1990)		3.58
				Spain (1993)		2.93
		Austria (1953)				2.66
	Belgium(1946–1985)					2.21
	Denmark(1946–1985)					1.30
	Finland(1946–1990)					3.16
	France(1940–1985)					1.25
		Germany (1950–1985)				1.74

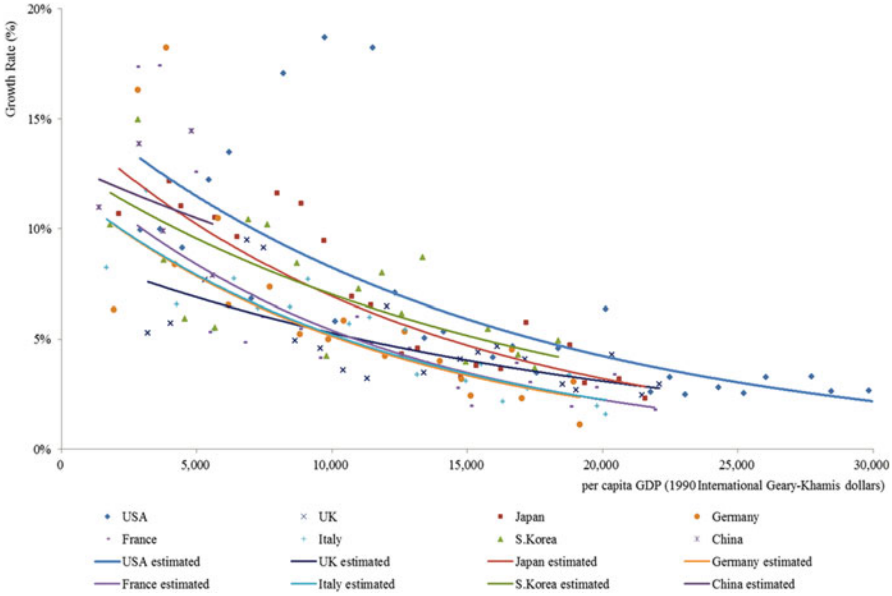

Fig. 7.2 Growth rate versus pGDP of advanced countries

levels increased, eventually their growth rates slowed down just as US rates did. This shows that when we forecast the futures of rapidly growing countries such as China, it is not historically accurate to calculate growth on the assumption that growth rates are fixed. Second, the Fig. 7.2 confirms that despite predictions that first-generation latecomers will overtake the US, they have not. For example, Japan and Germany once enjoyed postwar high growth rates because of the inherent characteristics of latecomers; however, their per capita GDP levels have remained less than that of the US until this day. Thus, Hypothesis 3 is supported.

7.5 Conclusion

The growth of latecomers that show rapid growth in the same period has a significant relation with ‘advanced country factors’ such as exports, openness and the introduction of technology. However, despite the similarity between the growth speeds of latecomers and those of advanced countries, the former cannot overtake the latter. First-generation latecomers that enjoyed rapid growth in the past such as Japan and Germany eventually failed to overtake the economic growth speed of the US since growth rate drops relatively as economic scale enlarges. Thus, it is impossible for today’s rapidly growing countries such as China to overtake the US.

Nevertheless, hasty predictions that latecomers that display high growth rates will soon surpass advanced countries with low growth rates are rampant for various reasons. These reasons include praising the successful economic growth of poorer developing countries, protecting the industries of advanced countries against latecomers and punishing latecomers' trade surpluses by swaying public opinion. However, correct predictions on the future economic growth of latecomers with high growth rates and advanced countries with low growth rates would provide very important viewpoints for peace and prosperity.

The fact that the economic growth of latecomers with high growth rates is dependent on advanced countries means that latecomers cannot narrow the gap in per capita GDP between advanced countries and themselves. In other words, they cannot overtake, but can only keep pace with advanced countries. The higher the per capita GDP level of rapidly growing latecomers becomes through economic growth, the lower their growth rates fall. Thus, as long as the industrial society system exists, the relationship between advanced countries who were industrialized earlier and latecomers who were industrialized later will probably remain forever as a leader and a follower. This study proves that under the general market economy system latecomers with high growth rates can never overtake advanced countries with low growth rates.

Appendix 1 Variables for Analysis

Variables		Description (converted to 1990 US$)	Data source
Per Capita GDP	pGDP	GDP per capita	Historical statistics of the world economy: 1–2008 AD 2009 (Maddison)
Export	Exp_1	Manufacturers export	World development indicators 2009 (World Bank)
	Exp_2	Total export (goods and services)	World development indicators 2009 (World Bank)
Openness	Opn	Openness in current prices[a]	Penn world table 6.3 2009 (University of Pennsylvania)
Technology	Tech_1	Royalty and license fees, payments	World development indicators 2010 (World Bank)
	Tech_2	Technical cooperation grants	Global development finance 2010 (World Bank)
Import	Imp_1	Ores and metals imports	World development indicators 2009 (World Bank)
	Imp_2	Fuel imports	World development indicators 2009 (World Bank)
FDI	Fdi	FDI, net inflow	World development indicators 2009 (World Bank)

[a]Exports plus imports divided by GDP is the total trade as a percentage of GDP. The export and import figures are in national currencies from the World Bank and United Nations data archives

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Chapter 8
War, Peace and Economic Growth: The Phoenix Factor Reexamined

Tai-Yoo Kim, Gicheol Jeong, and Jongsu Lee

Abstract The effect that war has on the economy has long been investigated. However the results of investigations do not provide conclusive answers. The 'War destruction view' argues that war has a negative effect as war distorts the economy and destruct resources. The 'War construction view' argues that war has a positive effect as war improves efficiency in economy and facilitates technological innovation by destroying the existing political structures and economic facilities. We propose a new and promising explanation of what happens to the economy following war: the course of the postwar economy is a consequence of the industrial technology accumulated and the cultivation of engineers during the war. We investigate this explanation for nations involved in World War II during the period 1950–1960 by utilizing econometric models. We find that the technological strength and industrial production capability that a nation accumulated during the war is an important factor for economic growth.

Keywords War destruction • War construction • Peace • Economic growth, phoenix factor • Curse of postwar • JEL Classification Numbers: F43; H56; N40; O43

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8.1 Introduction

All human conflicts and disputes have some basic triggers that culminate in war. Economic factors are one such trigger, in that resources are limited and the desire to increase them is great. Plausibly, the underlying cause of war is always the desire for dominance and the frustration of desire, which usually boils down to a frustration of the desire to possess certain goods. Peaceful methods of producing and allocating goods have changed many times in the course of human civilization, from the primitive society of hunters and gatherers, to agricultural society, to industrial society. However, the use of force to secure goods is a constant factor throughout human history. We now review, in brief, how this manifests itself in agricultural and industrial societies.

In agricultural society, land and labor are the factors used in production. Rich farmland and pastures are essential for agricultural production. Agricultural production, in turn, is essential for feeding the existing population and supporting population growth, which in turn is essential for maintaining competitiveness with other peoples. Thus, for reasons of survival, peoples that did not have these key resources turned to war to obtain them, and peoples that had them already turned to war for expansion. In addition, war could be used to plunder final goods to resolve food shortages. The most typical examples are the war for conquest by the northern kingdoms of China, such as Mongolia, which forced China to construct the Great Wall, and the Roman wars for securing granaries and a supply of slave labor.

In the commercial economy of agricultural society, the value of existing products increased through the transport and sale of products from production centers (where the products were plentiful) to regions where consumers were willing to pay a higher price because the products were scarce. The trading of products requires a market as well as a transport route. Wars between countries that had commercial economies were perpetrated to secure commercial supremacy or transport routes. Famous wars of this type occurred during the Age of Great Voyages between Spain, the Netherlands, France, and England over the command of the Atlantic, as well as the Battle of Lepanto between the Ottoman Turks (Turkey) and the Holy Alliance of Europe over the commercial supremacy of the Mediterranean.

Industrial society is based on the manufacturing sector, which uses a factory system, and incorporates a system of expansive reproduction. This system forms a virtuous cycle: the garnering of profits through the production and sales of products, the development of new products through the accumulation of capital and technology, and the creation of new demand. This expansive reproduction system requires more and more production elements and larger markets over time. Industrialized countries started wars to secure both elements of production and new markets in which to sell their products. Wars between advanced industrial nations, such as the Franco-Prussian War over the iron and coal mines in the Alsace-Lorraine region, were often started in order to claim colonies that acted both as supply centers for raw materials for the nations and as markets for the home country's goods. From the two world wars to the recent Gulf War, the basis of war in industrial society has remained consistent.

In the end, regardless of whether society is agricultural or industrial, mankind has used war to secure desired goods, while paying scant attention to the massacre and destruction involved. Yet might there not be another way? Why *did* war become the ultimate choice of action over other alternatives?

We think the answer is as follows. First, resources are limited. All production, whether it is agricultural or industrial, uses physical resources, such as capital, labor, energy, raw materials, and environmental resources. These resources are limited in supply. Second, the desire of man is unlimited. We start from a desire for basic necessities, such as food, clothes, and a place to live. When these basic requirements are met, we desire luxury goods and products to improve our health and increase longevity. Throughout history, the conflicts and disputes of mankind, which may be construed in essence as a clash between the two contradictory forces of limited resources and unlimited wants, have ultimately led to war.

An analysis of the effect that war has on economic growth helps us to see how we might create prosperity without war. The study presented herein provides insight into the causes of war in agricultural and industrial societies, how these causes may differ or be avoided in the post-industrial society that is currently being developed, the effect that war has on economic growth, and how prosperity might be achieved without war.

Previous studies on the relationship between war and post-war economy can be categorized according to the view they present on the influence that war has had upon the post-war economy. The 'War destruction view' argues that war has a negative effect as war distorts the economy and destruct resources. The 'War construction view' argues that war has a positive effect as war improves efficiency in economy and facilitates technological innovation by destroying the existing political structure and economy. However the results of investigations do not provide conclusive answers. This suggests that appealing to wartime destruction, either economic or political, cannot be a major explanation for post-war economic growth.

Herein, we propose a new and promising explanation of what happens to the economy following a war: the course of the postwar economy is a consequence of the technological strength and industrial production capability accumulated (or not) during the war. This hypothesis can explain economic revival in the presence of destruction, as in the case of Germany, simple growth in its absence, as in the case of the US.

Nations that go to war spare no expense to gain victory or protect their territories. The nation's capacities are heavily concentrated on research and development, and on expanding production facilities to produce war supplies and take advantage of new research advances in weaponry and detection technology. State-driven R&D and production activities directly determine the victory or loss in war in an industrial society. A byproduct of this drive to win the war is that countries improve their economic and technological capabilities. These capabilities include the development of advanced technology and the training of skilled engineers. In comparison with the US, Germany and Japan, which lost the war, were less developed industrial countries. However, they quickly became advanced industrial countries, even outpacing the economies of victorious countries, such as England and France. England and France were dominant technological powers in the early phases of the Industrial Revolution. During World War II, they heavily outsourced the production of war supplies to the US, whereas Germany and Japan produced all of their supplies domestically. Interestingly, the US, Germany, and Japan formed the top three postwar economic powers, respectively, in proportion to the level of domestic wartime industrial production.

The remainder of the paper is organized as follows. First, we examine the previous literature on the impact of war on the postwar economy according to the 'War Construction view' and the 'War Destruction view', and, through a review of the literature, present material that alludes to the importance of technology for the course of the postwar economy. Second, we (a) analyze empirical data on the countries that were defeated during World War II, to determine why some countries experience postwar growth while others do not, and (b) present the results. Finally, we draw out the implications of our results for research and development policy.

8.2 Previous Literature on Postwar Economic Growth

The effect that war has on the economy has long been a major interest in economics and economic history. The results of investigations of these issues are mixed: it has been found some countries that engaged in war experienced economic recession afterwards, whereas others made economic advances, with defeated nations making an even faster economic recovery than victorious ones.

The 'War Destruction view' postulates that war has a negative effect on postwar economic growth. There are two bases for this view.

The *first basis* is that war distorts the economy negatively and exogenously. Thorp (1941) analyzed the economic trends of powerful nations, including the US, England, Germany, and Russia, during the course of war between the late seventeenth century and World War I, and found that economies generally boomed in the beginning of wars but stagnated they were over. He argues that the massive consumption of materials during war increased government spending in the beginning, sparking growth in war industries, causing inflation, and eventually resulted in an economic boom. However, this government demand decreased rapidly after the end of war, which led to recession. Wright (1943) analyzed wars that the US engaged in, from the Revolutionary War to World War I, and concluded that war harms long-term productivity. He argued that a post-war recession causes a reduction of capital goods and hampers the efficient distribution of resources, thus decreasing long-term productivity. It has also been held that the increased government spending for war causes a reduction in other public spending, which has a negative effect on the postwar economy. Higgs (2004) analyzed the trends of capital invested in the US, before, during, and after World War II (1942–1945), and concluded that the scale of pure public investment made during the war period was close to that during the Great Depression. He argued that the success of public investment is determined in the market and depends on the utilization of capital goods. Government investment that is supported through the tax system is less efficient, because it lacks a mechanism to determine success and failure. Higgs insisted that the state-driven investment that occurs during wartime distorts industrial and regional developments, because it is concentrated into producing war facilities and weapons that become useless during peacetime, with the effect remaining even after the war.

The *second basis* for the ‘War Destruction view’ is that the destruction of human and material resources during war has a negative effect on postwar economic growth. It is clear that this phenomenon occurs in civil wars in underdeveloped nations. Kang and Meernik (2005) analyzed the effect of war on postwar economic recovery in underdeveloped nations that experienced civil war between 1965 and 1997, excluding OECD member nations. They found that the longer the war lasted and the greater the destruction, the greater was the negative effect on economic growth. Their explanation for this result was that underdeveloped countries have poor facilities and systems without the capabilities to incorporate new technologies, which render them less capable of resuming economic development after war. It has also been shown that the destruction that occurs during war affects not only countries that are directly involved in the war, but also neighboring countries. Murdoch and Sandler (2002) argued that civil war has a negative effect on the economic growth of neighboring countries in addition to the countries involved because of the uncertainty of economic activities and the general reduction in trade that is caused by destruction in the countries that are at war.

The ‘War Construction view’ argues that war has a positive effect on economic growth. The pioneering work was by Organski and Kugler (1977). They analyzed how much the economic status after the First and Second World Wars deviated from economic growth trends before the war periods. They found that defeated nations underwent greater economic recession than victorious nations immediately after war, but achieved faster economic recovery and eventually resumed their full prewar rates of economic development more quickly than victorious nations. Organski and Kugler likened the cases of defeated nations that recovered quickly from the ruins of war to the phoenix that rises from the ashes, and named this postwar resurrection ‘the Phoenix Factor’. However, although the authors found quantitative evidence for the existence of the Phoenix Factor, they did not identify its cause. Later studies attempted to find factors that could explain why the ‘Phoenix Factor’ occurs. Olson (1982) argued that the ‘Phoenix Factor’ is caused by the destruction of political structures. The groups that control the economic distribution of resources throughout the country, such as the labor unions, cartels, or financial cliques, prosper in a stable society. However, these groups hamper economic growth. Their destruction in defeated nations, for example the dissolution of cartels in Germany and of financial cliques in Japan following World War II, enabled the smooth distribution of resources throughout the respective nations, which became a major driving force behind fast economic growth. Olson (1982) also argued that the reason the US, which achieved victory without suffering major destruction of its facilities, could achieve continuous economic growth after the war period and maintain the highest level of development, was that the US maintained higher technological strengths than other countries. These technological strengths enabled continuous economic growth, regardless of factors affecting political stability.

Some studies suggested that the ‘Phoenix Factor’ is caused by economic destruction. Kugler and Arbetman (1989) analyzed the effect of the political and economic destruction on postwar economic growth. They found evidence that economic destruction has a positive effect on postwar economic growth, but that political devastation has no effect. Their explanation of this positive effect was that when the industrial facilities with old technologies, which were destroyed by war, were rebuilt after the war, the latest technology was used for the machinery, which increased production capacity.

8.3 Interests of this Study

It is evident from the foregoing that some studies find the effect of war on the postwar economy to be negative (Kang and Meernik 2005; Thorp 1941), whereas others find it to be positive (Kugler and Arbetman 1989; Olson 1982; Organski and Kugler 1977). Faced with these conflicting results, two responses are possible: either (i) take the view that there will always be some unpredictable external circumstance that renders it impossible to determine in advance whether the effect of war on the postwar economy will be positive or negative, or (ii) take the view that there is some underlying, as yet unidentified, factor that can be used to explain why war sometimes yields positive, and other times negative, effects. In this paper, we pursue the second line of thinking.

We hold that the particular technological strengths and industrial production capability that a nation accumulates during war determine whether there will be positive, negative, or no postwar growth. That the accumulation of technological strengths may be an important factor has already been suggested, albeit indirectly, in the literature. For example, Olson (1982) mentions that the technological strength of the US is an exception to his argument that political destruction is the cause of the 'Phoenix Factor'. Kugler and Arbetman (1989) note the introduction of new technology due to the destruction of industrial facilities. Abramovitz (1986) explains the prolonged manifestation of the accumulation of technological strength during war in the economy by appeal to social capabilities. Economic growth requires nations to not only accumulate technology, but also to effectively industrialize it. Countries in Europe that were turned to ruins during World War II displayed fast economic growth after the war because they had accumulated technologies during the war that they had no motivation to develop before. The reason that Abramovitz suggests for the lag between the accumulation of technology and economic growth is that these countries could not instantly commercialize the technology, because existing industrial facilities had been destroyed. The US did not experience direct damage from war, so it could immediately introduce the new technology into existing production facilities.

This study provides evidence that the technological strengths and industrial production capability accumulated during war are the efficient cause of the 'Phoenix Factor'. This new view can explain the results of previous studies. Using data on economic growth for the period following World War II, we will address the following research questions:

1. Does the technological strengths and industrial production capability that a nation accumulates during war have a significant impact on post-war economic growth?
2. How does the destruction experienced during war affect postwar economic growth?

To answer these questions, we use empirical models based on growth theory. Although there is not a well-specified model capable of analyzing the relationship between war and economic growth, an approach in the empirical growth literature can be applied to the empirical analysis of war and economic growth (Barro and Lee 1994; Koubi 2005).

8.4 Empirical Analysis

We conducted an empirical analysis of the effect of World War II, a war of industrialized nations, on the postwar economic growth of these nations. The first step in the analysis was to determine which countries to include and place them into relevant categories. We defined three analysis sample sets into which countries affected by World War II could be placed, using as a basis the previous literature on World War II. Each set was then partitioned into a treatment group and a control group to identify the effect of World War II. Our three sample sets were:

1. World War II Actors
2. World War II Winners/Losers
3. World War II Industrial Powerhouses

The first set, World War II Actors were those countries that participated. Countries that were categorized as actors in previous studies by Organski and Kugler (1977), Smolny (2000), and Clodfelter (2002) were categorized as actors in our study. However, we dropped the countries that were under the control of communists during or after the war for two reasons: (i) insufficient data exists about these countries' post-war economic growth paths, and (ii) it is difficult to compare the centrally planned economies of these countries with the market economies of other countries.

The second sample set comprised countries that participated in the war and divided them into Winners and Losers. Winners were defined as the nations that, according to Organski and Kugler (1977), retained all their territories or expanded them immediately after the war. The remainder of the countries was classed as Losers.

The last sample set defined as Industrial Powerhouses. We classified the actors according to whether they have technological strength and industrial production capability during the war. However, it was difficult to identify a quantitative indicator of technological strength, especially for the study period. The development and production of weapons, armored vehicles, bombers or reconnaissance aircraft may be good proxy indicators for technological strength, and Harrison (1998) gave war production data (i.e., as rifles, carbines, guns, mortars, tanks, combat aircraft and etc.) for each country from 1942 to 1944. However Harrison (1998) covered only six great powers' data, we cannot consider Harrison's data in our model because of data availability. Therefore, we selected electricity and iron ore production, which are virtually only available data for the period, as proxy

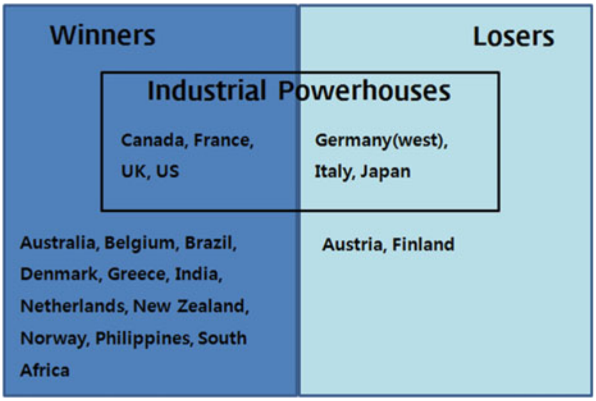

Fig. 8.1 Final sample of countries used in the analysis

indicators of technological strength and industrial production capability before the Second World War. It can be justified considering that switches from steam power to electric power for driving machinery took place between 1880 and 1930, and it led to the golden age of productivity growth from 1913 to 1972 (Gordon 2000). Since iron and steel are the most basic industrial materials since the Industrial Revolution, Wallace (1971) used crude iron production and crude steel production to reflect changing technology. Therefore, as pointed out by Spiezio (1990), Iron/steel production and energy consumption are useful indicators of the relative economic strength of countries or the relative development of a country's underlying industrial base (Spiezio 1990).

The countries that generated 10,000 GW/h or more and also produced 2,000,000 metric tons or higher of iron ore between 1936 and 1945 were defined as Industrial Powerhouses. The data are taken from Mitchell (1980).

The countries that were finally included in the empirical analysis for the study are represented in a Venn diagram, as in Fig. 8.1.

The regression model that was used in this study is based on the Barro regression model, which is widely used for cross-country growth regression:

$$\frac{\ln(y_i(t)) - \ln(y_i(0))}{t} = \alpha \ln(y_i(0)) + \beta X_i + \gamma Z_i + \varepsilon_i \tag{8.1}$$

The Barro regression model in Eq. 8.1 has been used as the baseline for much of growth econometrics (Durlauf et al. 2005). It was also used by Barro and Lee (1994), Koubi (2005), and Kang and Meernik (2005) to examine the relationship between war and postwar economic growth. Ray (2003) and (2005) discuss several issues related with construction of multivariate models that address analysis of international war.

In Eq. 8.1, the left-hand side represents the growth rate of per-capita GDP between our initial year 0 and year t. The variable $y_i(t)$ represents the per capita GDP of country i at year t, while the right-hand side contains variables that influence the economic growth rate. The vector X_i contains the determinant factors of economic growth suggested in the Solow growth model, and the vector Z_i contains determinant factors that are not suggested in Solow's original theory but are still relevant to economic growth. We analyze empirically the effect of the major Solow determinants of economic growth, as well as the effect of other major variables on economic growth, through estimations of Eq. 8.1.

Our vector Z_i can include war-related variables to enable the effect of war on economic growth to be analyzed. For example, Koubi (2005) included in Z_i the number of war casualties and the length of participation in war. Barro and Lee (1994) also included in Z_i whether the country participated in the war and the length of the participation in war. We base our regressions on Eq. 8.1, but want to examine the effects of World War II between years t and $t + k$. To do so, we rewrite Eq. 8.1 as

$$r(t, t+k) = \alpha \times X(t, t+k) + \beta \times W + \varepsilon(t, t+k) \tag{8.2}$$

In this new equation, $r(t,\ t + k)$ is the dependent variable, which represents the average growth rate over a period of k years after World War II that begins t years after the end of the war in 1945.

Our explanatory variable of interest is W, which reflects the effect of war on economic growth. W contains indicators for the technological strength during the war period, as represented in Fig. 8.1, and war characteristics. Following Koubi (2005), we defined two war characteristics as follows: severity, measured either by the number of total battle deaths per population (denoted by BDP) or the total military dead of all causes per population (denoted by TDP).

We also include, in the vector X, the standard major variables that are used in the literature on economic growth. These capture the accumulation of material and human capital, convergence factors, and the inefficiency of government. The variables we consider in X are (i) the ratio of real gross domestic investment to GDP, denoted by I/Y; (ii) the ratio of real government consumption to GDP, denoted by G/Y; (iii) a variable for educational attainment, average years of secondary schooling in the total population, denoted by SST; and (iv) initial per capita GDP.

The effect of major variables for economic growth that are discussed theoretically in Solow's model can be examined empirically by estimating the marginal effects of X in Eq. 8.1. The study also estimates the effect of war on postwar economic growth in marginal effects of W.

The 20 countries listed in Table 8.1 were used as analysis samples and the period from 1950 to 1960 was chosen as the target period. The data were obtained from Penn-World Table Version 5.6 (PWT 5.6), which was compiled by Summers and Heston (1991), and Barro and Lee (2010). The average growth rate over a particular period was calculated using the PWT 5.6 variable "Real GDP per capita (RGDPCH); Chain Index, 1985 international prices". The initial per capita GDP was obtained from the PWT 5.6 variable "Real GDP per capita (RGDPL); Laspeyres index, 1985 international prices". I/Y was obtained from the PWT 5.6 variable "Real Investment share of GDP (%) (I), 1985 international prices" divided by 100. G/Y was obtained from the PWT 5.6 variable "Real Government share of GDP (%) (G), 1985 international prices" divided by 100.

Table 8.1 Estimation results

	Model 1				Model 2			
Variable	Coefficient	Std. error	t-statistic	Prob.	Coefficient	Std. error	t-statistic	Prob.
Constant	0.1204	0.0174	6.9150	0.0000	0.1494	0.0216	6.9300	0.0000
Dummy, 1955–1960	0.1177	0.0176	6.6760	0.0000	0.1469	0.0218	6.7410	0.0000
Ln(GDP)	−0.0111	0.0027	−4.1240	0.0000	−0.0151	0.0033	−4.5880	0.0000
I/Y	0.0005	0.0003	1.7170	0.0859	0.0007	0.0004	1.7270	0.0841
G/Y	−0.0009	0.0005	−1.8810	0.0599	−0.0010	0.0006	−1.6090	0.1076
SST	−0.0074	0.0021	−3.5790	0.0003	−0.0060	0.0026	−2.3100	0.0209
Industrial powerhouses	0.0143	0.0029	4.9990	0.0000	0.0190	0.0036	5.3270	0.0000
TDP	0.0009	0.0001	9.7590	0.0000				
BDP					0.0009	0.0001	7.3480	0.0000
R^2	0.9141				0.8958			
(period, number of obs.)	(1950–1955, 20)				(1950–1955, 20)			
	0.4782				0.3392			
	(1955–1960, 20)				(1955–1960, 20)			

The average years of secondary schooling in the total population was obtained from Barro and Lee (2010). The number of battle deaths and the number of total military dead of all causes were obtained from Clodfelter (2002). BDP and TDP were calculated by using the population in 1939, which was obtained from Population Statistics.[1]

We estimated Eq. 8.2 using the seemingly-unrelated regression (SUR) model as previously used by Barro and Lee (1994). The definitions of the dependent variables and explanatory variables used in the analysis are as follows.

The SUR analysis divided our sample period into two 5-year periods: 1950–1955 and 1955–1960. The dependent variables were the growth rates of real per capita GDP over each of the 5-year periods. We used average values over each period for the ratio of real government consumption to GDP and the ratio of real gross domestic investment to GDP. For initial per capita GDP and schooling data, we used the 1950 and 1955 values, depending on the period.

To determine the effect of participation in war, dummy variables representing industrial powerhouses and variable representing war characteristics were included in the SUR model. Two of models, which included differing war characteristics variables, were analyzed. The results of these estimations are summarized in Table 8.1. We discuss the results below.

First, the estimation results related to the major economic variables match those of the general empirical analysis of economic growth (Barro and Lee 1994), except for the initial level of secondary education. As seen in the estimation results, a country's initial income Ln(GDP) has a negative effect on economic growth, which supports conditional income convergence. Physical capital (I/Y) had a positive effect on economic growth, whereas government spending (G/Y) had a negative effect.

Countries that were Industrial Powerhouses experienced greater postwar economic growth than those that were not. We included a dummy for Industrial Powerhouses in Model, to examine the influence of technology in war. As seen in the estimation results, Industrial Powerhouses experienced greater postwar economic growth rates than other actors. The estimation results provide answers to our first research question: Does the technological strengths and industrial production capability that a nation accumulates during war have a significant impact on post-war economic growth? Our results suggest that the technological strengths and industrial production capability accumulated during war does have a positive impact on post-war economic growth.

The estimation results of war characteristics provide an answer to the second research question: How does the destruction experienced during war affect postwar economic growth? Our results suggest that the destruction of war had a positive effect on postwar economic growth. The actors in World War II suffered many military and civilian casualties. These phenomena affected postwar growth adversely. Koubi (2005) viewed severity, duration, and intensity as the major variables of war, using the number of battle deaths as a measure of severity, the

[1] http://www.populstat.info

length of participation in war as a measure of duration, and the number of battle deaths per month of war as a measure of intensity. He then used these variables to represent the effect of destruction in war.

In this regard, the BDP and TDP variables can be regarded as representing the effect of destruction by war. Accordingly, the positive coefficients of BDP and TDP variables can be interpreted as indicating that the destruction suffered by actors in World War II had a positive effect on postwar economic growth. The estimation results are relevant to Koubi's (2005) findings and consistent with the 'war construction view'.

8.5 Discussion and Conclusions

The Phoenix is consumed by fire and rises anew from the ashes every 500 years. Humankind creates and accumulates goods by learning and exploiting the laws of nature to its own advantage. Civilization is advanced to the extent that humankind can overcome the destruction of war and the pain of killing with the courage to rebuild society and live amicably together. On some views, this process of destruction and rebuilding is a necessary part of human existence, in that war is a mechanism by which the ecosystem purifies itself in the face of pollution caused by overpopulation. If this is true, war is the cost of the continued existence of human civilization. The myth of the phoenix may thus be interpreted as follows: human civilization is cyclic, and the destruction of war is the necessary precursor of a new beginning.

Dreams of peace and prosperity characterize each new beginning. Yet the methods that are used to fulfill these dreams are often Janus-faced. On the one hand, the marvels of modern industry and technology have improved the standards of living of the masses immeasurably, through mass production and a constant flow of breakthroughs. Never has the life of individuals in industrial nations been so comfortable: accommodation is comfortable, diseases have been conquered, surgical techniques have improved, personal transport is available to all, entertainment is available at the press of a button, and every aspect of work has been made easier through a vast array of appliances. Yet on the other hand, these same marvels (a) come at great cost and (b) are often misused for harm rather than benefit. As a result of the constant desire for the easy life, for the next best thing, and to maintain supremacy over one's neighbors, which are desires that are fuelled by governments and corporations in their insatiable quest for economic growth rather than the simple contentment of the people, the Earth is, with ever-increasing speed, being stripped of her resources. The natural environment is being destroyed and the full disastrous consequences of this are not yet known. Resources are becoming scarce and there is no way to replace them quickly enough. Thus, humankind is creating more pain for itself. She is creating an uninhabitable world and one in which war is an inevitable consequence of the desire to maintain living standards in the face of diminishing resources. In addition, industry and technology are used to create ever more powerful weapons of destruction. The destructive force of weapons has long ago exceeded the level at which they could destroy the entire human civilization. The future is grim.

In light of the foregoing, the study of war and peace has ceased to be a luxury of the denizens of the ivory tower. It has become a matter of the very survival of our species. If we continue to destroy our ecosystem, there will come a time when the phoenix can no longer rise from the ashes of war; humans will simply vanish from the Earth. A way must be found to avoid war. One way of achieving this goal is to examine the history of humankind and see how war could have been avoided. This is far from being an easy task, because, in direct contrast to the goal of showing how war may be avoided, there seems to be an easy path to showing that war is an inevitable consequence of our economic choices, as follows.

The characteristics of the agricultural economy in a pure agricultural society ensure that production decelerates and growth slows (Kim et al. 2010a). The output decreases successively compared to input, and the farm has no incentives for surplus production beyond the levels required for survival. Even if a central planner forces increased production, marginal productivity tends toward zero, and the desires of the state or the ruler for greater wealth and power can only be satiated by wresting more farmland and manpower from others, and this in turn can only be achieved by war. In the commercial economy of an agricultural society, the creation of goods can accelerate in the short term through expansive reinvestment, but demand will eventually become stagnant because agricultural products have little elasticity with respect to the demand for them. Wars will continue, now intended to deprive trade routes and commercial supremacy from competing nations. War in an agricultural society is a negative sum game, because the whole of mankind is made worse off by it.

The characteristics of an industrial society are that short-term production decreases successively, while the creation of goods and economic growth accelerates (Kim et al. 2010b). The geometric increase of output compared to input acts as the incentive for entrepreneurs and capitalists to pursue more production. That is the reason why an industrialized society requires increasing production and occupying larger markets. Yet increasing production requires ever greater access to raw materials and sources of energy. These resources are limited and when a country's desire for resources exceeds its own capacity to supply them, they will need to be acquired from other areas. The result is war. As the need to access larger markets exceeds the boundaries of the country that is producing the goods, it will search elsewhere. Other countries will be searching for markets in the same extended area. In order to secure the markets, they will go to war. Given the assumed ever-present desire for economic growth, such wars and the accompanying destruction and loss of life are inevitable.

Yet such was the affluence and prosperity of the Western World due to the diffusion of industrial material civilization and the capitalist economic system after the war periods that the sanguinary memory of war was erased. There were indeed organizational contradictions, such as the gap between the haves and have-nots and the North–south divide. However, the diffusion of mass production and consumption of industrial capitalist society clearly showed the potential of war in an industrial society to become a 'long-term potential positive sum game' in terms of the economy. It is against this background of viewing war in these terms that it was conceptually possible for the War Construction view to be formulated. Previously, the War Destruction view had been predominant. The results of recent studies by numerous researchers support this hypothesis.

This paper was designed to look for the possibility of minimizing social costs, and pursuing warless peace and prosperity in the future by investigating the causes and effects of the 'War Construction view' more thoroughly. The results of our study show that a major cause of the Phoenix Factor is the technological strengths and industrial production capability that a nation accumulates on an enormous scale within a short period of time. This occurs through the mobilization of all available capacities within a country, such as finance, human resources, and institutional support, for war-related industries. What we call the accumulation of technological strengths and industrial production capability comprises the overall accumulation of industrial and technological capacities at the state level, including the innovation of science and technology through research and development; the diffusion of technology and improvement of management efficiency through the maximization of industrial production; and the research, technology, and industrial manpower cultivated in the course of the accumulation. Those countries that accumulate technological strengths and industrial production capability experience strong postwar economic growth, whereas those that do not accumulate technology do not experience postwar economic growth.

As communism eventually fell due to organizational contradictions, and the Cold War between the US and the Soviet Union ended, there emerged optimism over the demise of the threat of a nuclear third world war. However, as long as there is the contrast between industrial capitalism's unique expansion-oriented reproduction system and the limited global resource base, then conflicts are always possible, much like the calm of a dormant volcano before an eruption. Serious studies about war and economic growth in the future knowledge-based society, based on a correct understanding of war and economic growth, are required not only for personal security and happiness but also for the continuance and advancement of human civilization.

In the beginning of the knowledge-based society, the digital economy based on ICT previews a type of economic growth rate accelerating faster than an industrial society (Kim et al. 2009). This must represent the trend of economic growth in the knowledge-based society, powered by futuristic advanced new technologies, such as BT and NT. Predictions can only be made about a future society that has not yet matured, and there are concerns about the trials and errors of the human civilization based on such predictions. However, the future can bring even greater disasters if mankind is unprepared for it. The mission of modern times is to search for new hope and a way out of this potentially gloomy future scarred by information asymmetry, an increasing divide between the haves and have-nots, the depletion of resources, and the destruction of the ecological environment and global warming.

The knowledge-based society will be led by intellectual productive elements, such as information and technology, rather than material productive elements, such as resources and energy. If so, humankind can maintain its expansive reproduction by concentrating efforts on international cooperation in domestic R&D instead of fighting to steal limited material resources from abroad. Market demand will also expand multi-dimensionally along anti-aging and life-extending technologies, culture, art, hobbies, and entertainment. This expansion goes beyond the food of the agricultural society and the living necessities of the industrial society. When market demand becomes diversified and grows multi-dimensionally, it will be possible to promote complementary cooperation without exclusive competition or conflict. This would be completed through distributing R&D through the international division of labor to supply products or services for different demands through a wide variety of companies and countries.

The results of this study show that the accumulation of technological strengths and industrial production capability required to stage war caused rapid post-war economic growth in industrial societies, regardless of the preceding mass destruction and slaughter. However, it also suggests the possibility that humankind can continue with economic growth and prosperity in peace, without war, if there are international orders and treaties. These orders and treaties would ensure companies and countries concentrate on R&D and the production of products and services in their specialized fields by mobilizing all capacities they have in a knowledge-based society, in which there will be less need for conflict over productive elements and market dominance. The attempt to explain greater phenomena for the future based on past conclusions made in the social sciences, where many hypotheses cannot be proven through experiments, may be considered hasty or immature. However, this springs from the hope that the intellects of the world who share hopes of peace and prosperity for humankind.

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Chapter 9
The Relationship Among Stock Markets, Banks, Economic Growth, and Industry Development

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Abstract Most previous studies examining the effect of financial and stock market development on economic growth did not consider the different levels of economic development, assuming that the effect is same at all stages of economic development. Thus, previous literature is unable to sufficiently explain the recent economic crisis caused by the excessive development of financial markets in developed economies. This study analyzes the effect of financial and stock market development on economic growth considering countries' varying levels of development, using a dynamic panel generalized method of moments on a panel data for 94 countries from 1976 to 2005. The results show that for high-income countries, the effect of financial and stock market development on economic growth is negative. However, if such countries develop their financial markets with their manufacturing industries, the effect becomes positive. This study presents policy recommendations emphasizing the significance of combining financial development with real economic development.

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Keywords Financial market • Stock market • Economic growth • Industry development • Dynamic panel generalized method of moments • JEL Classification Numbers: C12; G10; O40

9.1 Introduction

Research on the relationship between economic growth and financial and stock market development including those by Bagehot (1873), Gurley and Shaw (1955), and Schumpeter (1911), focuses on theoretical and empirical analysis from a macroeconomic perspective. According to Schumpeter (1911), the functions of the financial and stock markets, which include mobilizing savings, evaluating projects, managing risk, monitoring managers, and facilitating transactions and technological innovation, are essential to economic growth. To analyze the relationship between economic growth and the development of financial and stock markets, previous studies have conducted case studies from economic historian and quantitative analyses from macroeconomists.

Over the last 20 years, many researchers have similarly analyzed the effect of finance and stock market development on economic growth. For instance, Pagano (1993) states that the financial markets' roles including linking savings and investments, and funneling investment to more productive industries, yields a positive impact on economic growth. In addition, Rousseau and Wachtel (2000) emphasize that previous researchers analyze economic growth without considering the effect of stock markets and mentioned the importance of stock market on analysis of economic growth. The stock market, theoretically, has two different effects: First, the stock market has a positive effect on economic growth because it transfers surplus to long-term capital markets by encouraging investments and influx of capital; Second, the stock market could interrupt savings activities because it focuses on providing higher returns, additional liquidity, and real capital.

Most previous studies mainly show a positive effect of financial and stock markets on economic growth. However, these studies overlook the potential negative effects of the excessive development of financial and stock markets, and thus are unable to explain the recent global financial crisis. For instance, excessive development of financial markets through the liberalization of banking and other similar methods could cause excessive risk-taking and consequently, a financial crisis (Bonfiglioli and Mendicino 2004; Kaminsky and Reinhart 1999; Lartey and Farka 2011; Ranciere et al. 2006). Meanwhile, the liquidity of the stock market does not necessarily provide accurate and timely information on companies, and excessive development of the stock market can potentially reduce the rate of savings, thereby negatively affecting the economy (Devereux and Smith 1994; Mayer 1988; Morck et al. 1990a, b; Shleifer and Summers 1988; Stiglitz 1985, 1993). Moreover, according to Ranciere et al. (2008), there is a positive correlation between financial market development and the probability of a crisis, that is, the more developed a financial market is, the higher the possibility of a crisis.

While it is clear that financial and stock market development can have positive effects on economic growth as evidenced by the growth during the 1980s and

1990s, excessive development of these markets can also have potentially negative effects on economic growth. It is possible that the effects of financial and stock market development on economic growth differ depending on the stage of country development. This study tests this theory using a statistical model and through the following two hypotheses which propose the potentially negative effects of excessive risk-taking and information asymmetry in financial and stock markets:

H1: In a highly developed country, an overdeveloped financial market has a negative effect on economic growth. However, if the country develops its financial market alongside its manufacturing industry as in a real economy, this effect becomes positive.

H2: In a highly developed country, an overdeveloped stock market development has a negative effect on economic growth. However, if the country develops its stock market alongside its manufacturing industry as in a real economy, this effect becomes positive.

This study empirically analyzes a panel data for 94 countries from 1976 to 2005 using the dynamic panel GMM[1] to determine the effect of financial and stock market development on economic growth. Based on the results, policy suggestions are provided for achieving positive effects of financial and stock market development on economic growth.

This paper is organized as follows. Section 9.2 reviews previous literature on the relationship between economic growth and financial and stock market development, and presents how our study aims to contribute to the current body of research. Section 9.3 discusses the dynamic panel GMM model and panel data used in this study. Section 9.4 presents the estimation results on the effect of financial and stock market development on economic growth, and conducts hypothetical tests examining the effects of combining financial and stock market development with real economic development. Lastly, Sect. 9.5 presents the conclusion and policy implications in this study.

9.2 Literature Review

Over the last 20 years, numerous studies have examined the impact of role of financial and stock markets on economic growth from a macroeconomic perspective. According to Ang (2008), previous research analyzes the effect of financial and stock market development on economic growth or analyzes the causality between economic growth and development of financial and stock markets. In addition, Ang (2008) cites these studies' lack of focus on developing countries. Our review of existing literature focuses on the relationship between financial market and economic growth, that between stock market and economic growth, and that among the financial market, stock market, and economic growth.

Previous research on the relationship between the financial market and economic growth generally fall under those that analyze the effect of financial market

[1] Generalized method of moments.

development on economic growth (Fernandez and Galetovic 1994; King and Levine 1993), and those that analyze the causality between the two (Ang and Mckibbin 2007; Demetriades and Hussein 1996; Jung 1986; Rousseau 2003). Both groups of studies have been criticized by Ang (2008) for not taking into consideration the countries' different levels of development. For instance, while previous studies show a positive effect of financial market development on economic growth, they analyze the average impact of financial market development on economic growth without considering the potential differences between developing and developed economies. Meanwhile, while the studies on causality show that financial market development leads to economic growth and vice versa, they also have limitations in considering the differences between developing and developed countries in their sample.

Previous studies regarding the relationship between stock market and economic growth show mixed results. On the one hand are those that claim that stock market development has a positive effect on economic growth because stock market encourages the liquidity of capital and funnels capital to companies (Bencivenga et al. 1995; Greenwood and Smith 1997; Holmstrom and Tirole 1993; Kyle 1984; Levine 1991; Obstfeld 1994). On the other hand are those that claim that the stock market has a negative effect on growth because stock market promotes asymmetric information on companies and contributes to the reduction in savings (Devereux and Smith 1994; Mayer 1988; Morch et al. 1990a, b; Shleifer and Summers 1988; Stiglitz 1985, 1993). In an attempt to shed light on these conflicting theories, subsequent empirical researches were conducted (Atje and Jovanovic 1993; Bencivenga et al. 1995; Harris 1997; Jo 2002; Levine and Zervos 1996), which mainly found a positive relationship between stock market and economic growth. With the exception of Harris (1997), however, these studies only consider the average effect of stock market development on economic growth without considering the countries' different levels of economic development.

Existing research on the relationship among the financial market, stock market, and economic growth also produces varied results, which can be classified into three main categories: some studies reveal a positive effect of both financial and stock markets on economic growth (Beck and Levine 2004; Levine and Zervos 1996, 1998; Rousseau and Wachtel 1998, 2000; Wachtel and Rousseau 1995); some find that only the stock market positively impacts economic growth (Tang 2006); and others show that the financial market has a negative impact on economic growth (Naceur and Ghazouani 2007; Saci et al. 2009). The latter group of studies, however, only focuses either on developing countries or those in the MENA[2] region. It is possible, then, that the negative effect of financial markets finds in these studies stems from the underdeveloped and/or unregulated financial markets in these regions, and that different effects may be found depending on a country's level of economic development.

To test whether the effect of financial and stock market development on economic growth indeed differs based on the countries' levels of development, Rioja and Valev

[2] Middle East and North Africa.

(2004a) analyze data from 74 countries using dynamic panel GMM. They find that low levels of financial market development has an insignificant on economic growth; that mid-level financial market development has significant, positive effects on economic growth; and that high levels of financial market development has a positive, albeit smaller, positive effect on economic growth, showing that the positive effect of financial markets increases up to a certain threshold. Owing to data limitations, however, they did not examine the effects of the stock market.

This study aims to contribute to the existing body of literature by analyzing the effects of both financial and stock market development on economic growth while also considering the countries' levels of development. In addition, this study also tests whether excessive development of financial and stock markets negatively impacts economic growth using two hypotheses: Developing the financial market alongside a country's manufacturing industry as in a real economy will have a positive effect on the economy; likewise, developing the stock market alongside a country's manufacturing industry as in a real economy will also have a positive effect on the economy.

9.3 Methodology and Data

9.3.1 Model

This study uses the dynamic panel GMM method to analyze the effect of financial and stock market development on economic growth. The dynamic panel GMM method, developed by Arellano and Bond (1991), considers the endogeneity of the data. In this method, y_{it}, F_{it}, and X_{it} represent the logarithm of real per capital GDP for country i at time t, the development index of the financial markets, and that of the stock markets as dependent and explanatory variables, respectively. The impact of financial and stock market development on economic growth is therefore defined as:

$$y_{it} = \beta_1 y_{it-1} + \beta_2 F_{it} + \beta_3 X_{it} + u_i + \varepsilon_{it} \tag{9.1}$$

In Eq. 9.1, u_i and ε_{it} represent the unobserved country-level effects and the error term, respectively. Based on the structure of Eq. 9.1, the lagged dependent variable, y_{it-1}, which defines the logarithm of real per capital GDP for country i at time (t-1), is correlated with u_i, causing an endogeneity problem, which is turn results in inconsistent estimators. To overcome the endogeneity problem from the unobserved country-level effects, u_i, the first difference for Eq. 9.1 is conducted, resulting in the following Eq. 9.2:

$$y_{it} - y_{it-1} = \beta_1 (y_{it-1} - y_{it-2}) + \beta_2 (F_{it} - F_{it-1}) + \beta_3 (X_{it} - X_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) \tag{9.2}$$

However, after removing the endogeneity problem from the unobserved country-level effect, u_i, a correlation between the lagged dependent variable, y_{it-1}, and ε_{it-1} arises, in addition to a potential correlation between the explanation variables, F_{it} and X_{it}. To overcome these problems, instrumental variables need to be defined. To this end, this study assumes that there is no serial correlation between error terms, and no correlation between the lagged explanatory variables and future error terms. Thereafter, the lagged explanation variables can be used as instrument variables. Thus, moment conditions which use lagged explanation variables as instrument variables are shown in the following Eq. 9.3:

$$
\begin{aligned}
&E[y_{it-k}(\varepsilon_{it} - \varepsilon_{it-1})] = 0\,for\ k \geq 2, t = 3, \ldots, T \\
&E[F_{it-k}(\varepsilon_{it} - \varepsilon_{it-1})] = 0\,for\ k \geq 2, t = 3, \ldots, T \\
&E[X_{it-k}(\varepsilon_{it} - \varepsilon_{it-1})] = 0\,for\ k \geq 2, t = 3, \ldots, T
\end{aligned}
\tag{9.3}
$$

Additional moment conditions are also defined because the explanatory variables in the first difference equation can be used as instrument variables:

$$
\begin{aligned}
&E\left[(y_{it-1} - y_{it-2})\left(u_i + \varepsilon_{it}\right)\right] = 0 \\
&E\left[(F_{it-1} - F_{it-2})\left(u_i + \varepsilon_{it}\right)\right] = 0 \\
&E\left[(X_{it-1} - X_{it-2})\left(u_i + \varepsilon_{it}\right)\right] = 0
\end{aligned}
\tag{9.4}
$$

Thus, the dynamic panel GMM estimator is determined by using the moment condition equations specified in Eqs. 9.3 and 9.4. This study uses the Sargan test to evaluate the validity of the instrumental variables. Because this study aims to analyze the effect of financial and stock market development on economic growth considering the different levels of development, we classify the sample of countries into low-, middle-, and high-income groups using the income group criteria of the World Bank database, which are defined by the relationship among various economic variables such as GNI per capita and well-being measurements such as property rate and infant mortality rate.[3]

This study defines low-, middle-, and high-level of economic development using two dummy variables: MI is 1 if a country is in the middle income group, and 0 otherwise; and HI is 1 if a country is in the high income group, and 0 otherwise. We then describe the effect of financial and stock market development on economic growth considering the countries' income levels as:

$$
y_{it} = \beta_1 y_{it-1} + \beta_2 F_{it} + \beta_{21} MI \times F_{it} + \beta_{22} HI \times F_{it} + \beta_3 X_{it} + u_i + \varepsilon_{it} \tag{9.5}
$$

where β_2 is the effect of financial market development on economic growth in low-income countries, $\beta_2 + \beta_{21}$ is the effect in middle income countries, and $\beta_2 + \beta_{22}$ is the effect in high income countries. The effect of stock market development on economic growth in each income groups is analyzed in a similar manner.

[3] Further details on the World Bank country classification are available at http://data.worldbank.org/about/country-classifications.

9.3.2 Data

This study uses the development index of the financial and stock markets proposed by Beck et al. (2009). The variables “private credit,” “commercial versus central bank,” and “liquid liabilities,” defined by King and Levine (1993) are used as development indices of the financial market. Private credit indicates the distribution of domestic assets, and is defined by the ratio of credit allocated to the private sector by the financial system. In short, this index represents the ratio of nonfinancial private sector credit to total domestic credit. Commercial versus central bank is an index showing the relative importance of commercial banks compared to central banks, and is defined by the ratio of commercial bank assets to total financial assets. Because most theoretical models assume that a commercial bank has better risk management and potential returns than a central bank, commercial versus central bank is used as an index of financial market development (King and Levine 1993). Last, liquid liabilities is an index for “financial depth,” and is defined by the ratio of liquid liabilities of a financial system to GDP.

“Total market capitalization (MCAP),” “volume of trading activity (VT),” and “turnover ratio, (TURNOVER)” proposed by Beck and Levine (2004) and Rousseau and Wachtel (2000), are commonly-used stock market development indices. Total market capitalization is defined as the ratio of total value of shares in all stock markets to GDP. Volume of trading activity is defined as the ratio of the value of domestic shares traded in domestic exchanges to GDP. Turnover ratio represents liquidity relative to the total size of the stock market, and is defined as the ratio of the value of domestic shares traded in domestic exchanges to the total value of shares in all stock markets.

This study uses commercial versus central bank (BANK) as a financial market development index, which has been widely used in previous empirical studies. In addition, since volume of trading activity (VT) cannot measure the liquidity of stock market (Beck and Levine 2004), and total market capitalization (MCAP) is not a proper development index (Levine and Zervos 1998), we use turnover ratio (TURNOVER) as a stock market development index.

According to Rousseau and Wachtel (2000), additional payoffs occur if less productive capital is funneled into more innovative and high-quality projects in the long-term capital market. Following Rousseau and Wachtel (2000), this study also uses GDP per capita as a dependent variable, the data for which is derived from the Penn World Table database.

As control variables, this study uses the ratio of government spending to GDP (GOV), real gross domestic income (INCOME), average years of total schooling (EDU), the ratio of trade to GDP (TRADE), and average inflation rate (INFLATION). This study’s panel data set includes the above-mentioned variables, that is, it uses an unbalanced panel data set for 94 countries from 1976 to 2005 in the empirical analysis.

To analyze the effect of financial and stock market development on economic growth considering the countries’ development level, this study divides the 94 countries into 3 subgroups: low-, middle-, and high-income countries. Although

Table 9.1 Country groups according to income levels

Low-income group	Middle-income group		High-income group	
Bangladesh	Argentina	Latvia	Australia	Singapore
Cote d'Ivoire	Armenia	Lithuania	Austria	Slovenia
Ghana	Barbados	Malaysia	Bahrain	Spain
India	Bolivia	Mauritius	Belgium	Sweden
Kenya	Brazil	Mexico	Canada	Switzerland
Kyrgyz Rep.	Bulgaria	Morocco	Cyprus	UK
Malawi	Chile	Namibia	Denmark	UAE
Moldova	China	Panama	Finland	USA
Mongolia	Colombia	Peru	France	
Nepal	Costa Rica	Philippines	Germany	
Pakistan	Croatia	Poland	Greece	
Tanzania	Czech Rep.	Romania	Iceland	
Zambia	Ecuador	Russian Fed.	Ireland	
Zimbabwe	Egypt	Slovak Republic	Israel	
	El Salvador	South Africa	Italy	
	Estonia	Sri Lanka	Japan	
	Fiji	Swaziland	Korea, Rep.	
	Guatemala	Thailand	Kuwait	
	Hungary	Trinidad and Tobago	Luxembourg	
	Indonesia	Tunisia	Malta	
	Iran, Islamic Rep.	Turkey	Netherlands	
	Jamaica	Ukraine	New Zealand	
	Jordan	Uruguay	Norway	
	Kazakhstan	Venezuela, RB	Portugal	

Source: World Bank Database

Rioja and Valev (2004b) also adopt a similar grouping approach in their empirical analysis, they evenly divide the countries into three subgroups using subjective classification criteria. In contrast, to eliminate any subjectivity, this study uses the income group classification criteria of the Work Bank database mentioned earlier, which is determined from the relationship between economic variables such as GNI per capita, and well-being measures such as property rate and infant mortality rate. Table 9.1 presents the grouping of the 94 countries in our sample using World Bank's classification criteria.

To analyze the effect of financial and stock market development on economic growth considering the countries' stage of development, we first need to demonstrate that the three income-based subgroups are positively related to financial market development, stock market development, and economic growth. The average values for GDP, Bank, MCAP, and VT for each subgroup are calculated to determine whether this income-based subgrouping accurately represents the economic growth, financial market development, and stock market development at the different stage of economic development (Table 9.2).

Table 9.2 shows that the higher a country's income level is, the greater its economic growth (GDP), financial market development (BANK), and stock market development (MACP, VT). These results are consistent with those of Rioja and Valev (2004b), who evenly divide their sample into three income-based subgroups. This study can therefore proceed to analyze the effects of financial and stock market

Table 9.2 GDP level, financial market development, and stock market development for country subgroups

	Low income	Middle income	High income
	Average		
GDP	6.42	22.33	70.89
BANK	0.72	0.86	0.96
MCAP	0.13	0.28	0.61
VT	0.07	0.09	0.41

development on economic growth considering the countries' income levels using the dynamic panel method on an unbalanced panel data set, as well as test the two hypotheses identified earlier in this study.

9.4 Results

9.4.1 Effect of Financial Market Development on Economic Growth at Each Level of Economic Development

Before analyzing the effect of financial market development on economic growth for each level of economic development (B) using Eq. 9.5, the average effect of financial market development is first analyzed without considering the different economic development levels (A). Table 9.3 presents the results of the analysis using dynamic panel GMM.

The results of the Sargan test validate both analyses A and B. The results of analysis A show that the effect of financial market development on economic growth is positive on average, consistent with those of previous researches by Beck and Levine (2004), King and Levine (1993), Levine and Zervos (1996, 1998), and Rioja and Valev (2004a, b). Meanwhile, the results of analysis B show that financial market development has a negative effect on economic growth in low-income countries (β_1), consistent with the findings of Naceur and Ghazouani (2007); This negative effect in low-income countries may be due to the underdeveloped financial and banking system in those countries. Meanwhile, a significantly positive effect of financial market development was found in middle-income countries ($\beta_1 + \beta_2$). Last, a significantly negative effect was found in high-income countries ($\beta_1 + \beta_3$). Thus, the results of this study support the negative effect of excessive development of financial markets mentioned in previous research by Bonfiglioli and Mendicino (2004), Kaminsky and Reinhart (1999), Lartey and Farka (2011) and Ranciere et al. (2006).

9.4.2 Effect of Stock Market Development on Economic Growth at Each Level of Economic Development

Using the same process outlined in pervious section, this section analyzes the effect of stock market development on economic growth considering the countries' levels

Table 9.3 Estimation results for the effects of financial market development

Variables	A[a]	B[b]
ln y_{it-1}	0.823** (0.004)	0.808** (0.004)
BANK	0.023** (0.006)	−0.076** (0.019)
BANK × MI	–	0.132** (0.029)
BANK × HI	–	−0.061** (0.026)
INFLATION	−0.00001** (0.000002)	−0.00001** (0.000004)
EDU	−0.021** (0.001)	−0.021** (0.001)
GOV	−0.0008** (0.0001)	−0.0002** (0.0001)
INCOME	0.00001** (0.0000002)	0.00001** (0.0000002)
TRADE	−0.00004** (0.000024)	−0.0001** (0.00001)
Constant	0.600** (0.014)	0.671** (0.013)
Observations	1,140	1,140

Notes: *Significant at 10 % level; **Significant at 5 % level
[a]Analysis without considering various levels of economic development
[b]Analysis considering various levels of economic development

of development. First, the average effect of stock market development on economic growth (A') is analyzed without considering the different levels of economic development, followed by the analysis considering the different levels of development (B'). Table 9.4 presents the results from the dynamic panel GMM method.

The results of the Sargan test validate both analyses A' and B'. The results of analysis A' show that the average effect of stock market development on economic growth is significantly negative, consistent with the theoretical literature by Devereux and Smith (1994), Mayer (1988), Morch et al. (1990a, b), Shleifer and Summers (1988), and Stiglitz (1985, 1993). However, since these estimation results pertain to the average effect across all countries in the sample, we cannot claim that there is no positive effect of stock market development on economic growth. Therefore, the countries' different levels of development must be taken into consideration, as was done in analysis B'. The results of this analysis show that stock market development has a negative effect on economic growth in both low- and high-income countries (β_1, $\beta_1 + \beta_3$), but a positive effect on middle-income countries ($\beta_1 + \beta_2$), showing that underdeveloped or overdeveloped stock markets such as those in low- and high-income countries negatively impact economic growth, but that sufficiently developed stock markets such as those in middle-income countries positively impact economic growth. In addition, the significantly negative effect found in high-income countries is a main contributor to the negative average effect on economic growth.

The results of the analysis in previous and this section suggest policy implications for achieving positive effects of financial and stock market development on economic growth, especially in high-income countries. These potential implications are further tested in following section, using the two hypotheses identified earlier in the introduction.

Table 9.4 Estimation results of the effects of stock market development

Variables	A'[a]	B'[b]
ln y_{it-1}	0.820** (0.005)	0.827** (0.001)
TURNOVER	−0.005** (0.0004)	−0.013** (0.002)
TURNOVER × MI	–	0.013** (0.002)
TURNOVER × HI	–	−0.009** (0.004)
INFLATION	−0.00001** (0.000001)	−0.00001** (0.000002)
EDU	−0.020** (0.0006)	−0.019** (0.0004)
GOV	−0.0008** (0.00008)	−0.0005** (0.00008)
INCOME	0.00001** (0.0000002)	0.00001** (0.0000004)
TRADE	−0.00008** (0.00002)	−0.00007** (0.00002)
Constant	0.617** (0.021)	0.575** (0.024)
Observations	1,140	1,140

Notes: *Significant at 10 % level; **Significant at 5 % level
[a]Analysis without considering various levels of economic development
[b]Analysis considering various levels of economic development

9.4.3 Financial and Stock Market Development Alongside Industry Development

This section tests the two hypotheses (H1 and H2) identified earlier, which propose that financial and stock markets positively affect economic growth if they are developed alongside the industries in the economy. If the financial and stock markets are functioning properly by investing in higher productivity industries and increasing the liquidity of capital, they facilitate economic performance and therefore, economic growth. This study examines this theory on high-income countries, which have been shown to be negatively affected by financial and stock market development in our previous analysis.

To test the effect of financial and stock market development on economic growth in high-income countries when these markets are developed alongside the real economy, this study uses the following Eq. 9.6:

$$y_{it} = \beta_1 y_{it-1} + \beta_2 HIF_{it} + \beta_3 HIF_{it} \times Manufacture_{it} + \beta_4 X_{it} + u_i + \varepsilon_{it} \qquad (9.6)$$

where, *HIF* represents the financial and stock market development indices in high-income countries; and *Manufacture* is the index of real economy and is determined by the value-added share of the manufacturing industry in GDP. Partially differentiating Eq. 9.6 by *HIF*, we derive the following Eq. 9.7:

$$\frac{\partial y_{it}}{\partial HIF_{it}} = \beta_2 + \beta_3 Manufacture_{it} \qquad (9.7)$$

where β_3 is the effect of financial and stock market development alongside the real economy (*Manufacture*). Table 9.5 presents the results from the dynamic panel GMM method.

Table 9.5 Estimation results for the impact of financial and stock market development alongside industry development

Variables	Financial market	Stock market
ln y_{it-1}	0.762** (0.030)	0.796** (0.057)
BANK	−0.051** (0.027)	–
BANK × Manufacture	0.011** (0.001)	–
TURNOVER	–	−0.049 (0.034)
TURNOVER × Manufacture	–	0.0016 (0.0014)
INFLATION	0.0002 (0.0004)	0.0003 (0.0005)
EDU	−0.0017 (0.0016)	0.0007 (0.0043)
GOV	−0.0038** (0.0005)	−0.0030 (0.0054)
INCOME	0.000007** (0.0000009)	0.000004** (0.000002)
TRADE	−0.0017** (0.0002)	−0.0004* (0.00025)
Constant	0.852** (0.121)	0.823** (0.175)
Observations	367	367

Notes: *Significant at 10 % level; **Significant at 5 % level

The results of the Sargan test validate the analyses for both the financial and stock markets. The results show that when financial markets are developed with the real economy, they positively and significantly impact economic growth in high-income countries. However, the results show that when stock markets are developed with the real economy, it positively but insignificantly impacts economic growth in high-income countries. In short, H1 can be reasonably accepted based on the results of the study, but H2 cannot. This suggests that policy makers in countries with overdeveloped financial markets should develop these markets alongside real economic industries such as manufacturing, in order to realize positive effects on growth.

9.5 Conclusion and Discussion

This study analyzes the effect of financial and stock market development on economic growth considering the different levels of economic development, using a panel data on 94 countries for the period 1976–2005. The results show that the average effect of financial market development on economic growth is positive, consistent those of previous studies. When the different country income levels are considered, however, this effect becomes negative in underdeveloped and overdeveloped financial markets in low- and high-income countries, respectively. This effect remains positive only for middle-income countries. Meanwhile, the results show that the average effect of stock market development on economic growth is negative, mainly attributed to the significantly negative effect found for high-income countries. Similar to financial market development, stock market development negative affects low- and high-income countries but positively affects middle-income countries.

This study further examines the impact of overdeveloped financial and stock markets on the economic growth of high-income economies by testing two hypotheses. The results show that financial markets, even if overly developed, can positively impact economic growth when developed alongside the real economy. This suggests important policy implications for middle-income countries working to become developed countries, as they are more sensitive to the effects of financial and stock market development. For instance, the overdevelopment of the financial and stock markets in Ireland, which did not consider the real economy, has led to an economy crisis. Thus, middle-income countries should formulate financial market policies that consider real economic industries in order to realize sustainable economic growth.

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Chapter 10
The Necessity of a New Industrial Classification Based on Value-Creation Behavior

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Abstract In the mid-twentieth century, Fisher (1939) and Clark (1940) classified industry into primary, secondary, and tertiary production, which served as the basis of the International Standard Industrial Classification. However, some have criticized Fisher and Clark's classification as too simple to account for the heterogeneity in tertiary production (i.e., the service industry). By using EU KLEMS and Organisation of Economic Co-operation and Development data, we suggest a new industrial classification based on value-creation behavior that helps explain economic development. In the new paradigm, industry is divided into value-creation sectors composed of base and extended value as well as transferred value industries comprised of production support service, private service, and public service components. The new industrial classification can inform an efficient industrial policy designed to accelerate economic growth.

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10.1 Introduction

Fisher (1939) and Clark (1940) (hereafter, Fisher-Clark) classified industry into primary, secondary, and tertiary production, which served as the basic standard for understanding and analyzing industrial structure that later became the International Standard Industrial Classification (ISIC). Most countries have adopted ISIC as a national classification, and it is widely used in "classifying data according to kind of economic activity in the fields of economic and social statistics, such as for statistics on national accounts, demography of enterprises, employment and others" (United Nations 2008, p. 3). However, some have criticized Fisher-Clark's classification as too simple to account for the characteristics of each industry. Specifically, they argue that, because of the heterogeneity inherent in it, tertiary production (i.e., the service industry) needs to be reclassified (Katouzian 1970; Scharpf 1990; Singelmann 1978). For example, two service industries that provide output to manufacturers or consumers exhibit different characteristics, such as, among variances, productivity growth level and the proportion of intermediate goods.

To overcome the heterogeneity issue, alternative classifications have been proposed based on criteria such as labor structure change, productivity growth, and relationship with the production sector, among others (Baumol et al. 1985; Scharpf 1990; Singelmann 1978). However, only a few authors have considered the contribution to economic development as a main criterion of classification and analyzed the industry sectors that positively affect economic growth. Discussion of industrial classification with regard to a national economic development is warranted, and we suggest a new classification of industries based on value creation, which can be used to inform the industrial policies that help develop a national economy.

To accomplish our reclassification goal, we applied two different methods: comparative analysis of total factor productivity (TFP) growth and cluster analysis. For each industry, we calculated the growth rate of TFP and the intermediate sales ratio. We then calculated Domar weights for each industry (Domar 1961; Hulten 1978). With these results, we computed the contribution level of each industry to the aggregate TFP growth. We collected and used EU KLEMS and Organisation for Economic Co-operation and Development (OECD) input-output data of selected-country sectors from 1980 to 2005. Then, using three factors from the first analysis, we conducted hierarchical cluster analysis to classify the industries.

From the results of the TFP analysis, we found that the contributions of the manufacturing and communication industries to TFP growth increased during the study periods, but those of service sectors, in general, had decreased. However, each sector shows different levels and trends during that period. The cluster analysis illustrates that communication and distribution services can be separated from the other service sectors. The former group of sectors has a greater relationship to value creation sectors and the latter is more closely related to value transferring sectors. The results look similar to those of Baumol (1967) and Baumol et al. (1985), but we claim more developed results related to recent data.

Following the Introduction, previous literature is surveyed in Sect. 10.2, and data description and empirical results from the data are introduced in Sects. 10.3 and 10.4, respectively. We cautiously propose a new taxonomy of industry in and discuss policy implications in Sect. 10.5.

10.2 Previous Literature

The purpose of this research is classifying industries by contribution of economic growth and proposing a new taxonomy. In this section, we survey previous literature related to classifying productive industries from early periods. Then, we offer some literature pointing out the problems of previous industrial classifications.

To classify the industries by the degree of contribution to economic growth, one must consider celebrated economists' ideas of which industries are productive. To justify a new categorization of industries, Hill (1999) summarized the work from famous economists and decided that the proper order for productivity is as follows: tangible goods, intangible goods, and service sectors. Hill's initial discussion from A. Smith is similar to that which we present. Smith (1776) believed goods made by productive labor can be stored and exchangeable, but unproductive labor (i.e., work from those in the service industry) cannot create long-lasting exchangeable goods. Smith noted that real quantity of industry, the number of productive hands, is related to capital formation, while unproductive labor is not. However, J. B. Say (1803) argued against Smith, stating that it is inappropriate to consider service workers (e.g., a physician) as unproductive. Rather, Say called services *immaterial products*. Yet, J. S. Mill (1848) defended Smith's distinction by arguing that physicians and lawyers do not produce wealth but rather produce utility. A. Marshall (1890) more specifically defined material goods as "consist[ing] of useful material things, and of all rights to hold, or use, or derive benefits from material things, or to receive them at a future time. Thus they include the physical gifts of nature, land and water, air and climate; the products of agriculture, mining, fishing, and manufacture; buildings, machinery, and implements; mortgages and other bonds; shares in public and private companies, all kinds of monopolies, patent-rights, copyrights; also rights of way and other rights of usage" (p. 54). Marshall defined non-material goods, in characteristics related to human activity, as "fall[ing] into two classes. One consists of his own qualities and faculties for action and for enjoyment; such for instance as business ability, professional skill, or the faculty of deriving recreation from reading or music. All these lie within himself and are called internal. The second class are called external because they consist of relations beneficial to him with other people. Such, for instance, were the labour dues and personal services of various kinds which the ruling classes used to require from their serfs and other dependents" (pp. 54–55). By addressing the concepts of transferable and nontransferable goods, Marshall made the following classification (Fig. 10.1):

Marshall said that wealth of man is composed of material goods that are transferable and "immaterial goods, which belong to him, are external to him, and serve

Fig. 10.1 Classification of goods (Marshall 1890)

$$\text{Goods are}\begin{cases}\text{external}\begin{cases}\text{material}\begin{cases}\text{transferable}\\ \text{non}-\text{transferable}\end{cases}\\ \text{personal}\begin{cases}\text{transferable}\\ \text{non}-\text{transferable}\end{cases}\end{cases}\\ \text{internal}-\text{personal}-\text{non}-\text{transferable}\end{cases}$$

directly as the means of enabling him to acquire material goods" (p. 57). In addition, Marshall defined *value* as the power of purchasing other goods. From the above arguments, one finds abundant opinions, given since the dawn of economic studies, about which industries are productive and can be considered contributors to national wealth.

Among the research recently conducted, Baumol's study relates to the discussion of productivity growth. Baumol (1967) shows the reason for industrial structure changes and the impact of them on economic growth. Baumol assumes an environment characterized by a technologically progressive sector with very high productivity growth rates (i.e., manufacturing) and stagnant sectors with relatively low productivity growth rates (e.g., service industry); comparable labor incomes characterize both types of sectors. Baumol shows that, in theory, unit cost in a stagnant sector increases more rapidly than that in a progressive sector (*cost disease*). As a result, if demand elasticity for the stagnant sector is high, the stagnant sector will vanish, but if demand elasticity is low, such as when the output ratio of stagnant-progressive sectors is high or government supports the industry, it will experience enlarged labor share. When labor shifts to the stagnant sector from the progressive sector, the overall economic growth will slow down (called *growth disease*). Therefore, Baumol predicts that as labor share of a service industry suffering from cost disease increases, the overall economic growth of a nation will be slow. A few years later, Baumol et al. (1985) added an *asymptotic stagnant sector* to the model. The new service sector is defined by high productivity and includes industries such as communications and broadcasting, trade, real estate, and business services. In this research, Baumol showed empirical results, using TV broadcasting and electronic computation that are consistent with the Baumol theory.

Nordhaus (2008) found that Baumol's predications have come to fruition in the United States (however, the real output share of a stagnant sector is constant by an empirical analysis when data on gross domestic product of each industry in United States, as published by the Department of Commerce, Bureau of Economic Analysis, are used). In particular, Nordhaus found that growth disease problems are caused by an increase of nominal output shares of a stagnant sector. Hartwig (2011) verified Baumol's ideas with a similar method, but by using EU KLEMS data. Hartwig found, similar to Nordhaus, with U.S. data in EU KLEMS, which European Union (EU) countries also suffer from growth disease. However, some studies show different results. Oulton (2001) pointed out that Baumol assumes that both progressive and stagnant sectors produce final output and argued that if one of them produces intermediate goods for the other sector's production, the overall economy growth may not decelerate despite the increased share of the low productivity industry. Oulton verified the idea with data from the United Kingdom (U.K). The U.K. finance sector has a relatively low (but larger than zero) TFP growth rate,

Table 10.1 Relationships of previous studies and current classifications

Sub-sectors (ISIC rev. 4)	Fisher-Clark (1939, 1940)	Singelmann (1978)	Baumol et al. (1985)	Scharpf (1990)
Agriculture and mining	Primary	Extractive	Progressive	Production
Manufacturing	Secondary	Transformative	Progressive	Production
Electricity and energy supply				
Construction				
Wholesale and retail trade	Tertiary	Distributive	Progressive	Consumer
Transport, storage, and communication		Distributive	Progressive	Production
Finance and insurance		Producer service	Stagnant	Production
Real estate, rental, and business services		Producer service	Progressive	Production
Hotel and restaurants		Social and personal services	Stagnant	Consumer
Social and personal services (public administration and defense, education, health, private services)		Social and personal services	Stagnant	Consumer

Notes: In the case of Baumol et al. (1985), we classified activities not included in stagnant sectors as belonging to progressive sectors (Kim and Choi 2010)

and per Baumol's prediction, its share has increased. However, despite the poor growth of the finance sector, Oulton found that its expansion contributes to the national aggregate TFP growth because a high ratio of intermediate goods produced by the finance sector is used as input by industries with higher TFP growth rates.

By considering the role of human capital formation, Pugno (2006) extends the scope of service industries that positively affect economic growth from the business service sector, such as finance, education, health care, cultural service, and others. Similarly, on one hand, Vincenti (2007) argued that an enlarged service sector may lead to an economic growth rate under the endogenous model in which positive network effects on manufacturing and the learning-by-doing effect are considered. On the other hand, Sasaki (2007) argued that expansion of service sector shares, which produce final and intermediate goods, while increasing short-term growth rates, will slow the aggregate growth rate in the long-term.

In addition, several researchers suggested a new taxonomy of industry based on considerations of industrial structure changes (Baumol et al. 1985; Scharpf 1990; Singelmann 1978). Kim and Choi (2010) compared other industrial classifications as shown in Table 10.1. Singelmann (1978) divided similar economic activities by labor structure changes caused by economic growth. Baumol et al. (1985) grouped industries as progressive or stagnant per productivity growth. Scharpf (1990) differentiated industries based on their relationships with the production sector. With a similar purpose, Park and Chan (1989) divided the service industries into distribution, producer, personal, and social sectors based on the relationship between each service sector and manufacturing sector. Based on survey data, Evangelista (2000) classified the service industries into technology users, science and technology based, interactive and IT based, technical consultancy, and post and telecommunications industries by the degree of innovation.

10.3 Data Description

In this research, we mainly used the EU KLEMS (March 2008 release) database, which is a useful source for comparing various countries' industries. The EU KLEMS data cover a number of European countries and other nations including the United States, Japan, and Korea, providing data by year from 1970 to 2005 on 71 subcategorized industries. Among other data, it provides information on gross value added; labor input and labor productivity; and the contribution of labor, capital, and other factors to growth. However, this type of classification makes difficult the identification of general industry characteristics. The EU KLEMS database also provides additional industry aggregations, which further classifies these 71 industries into seven sectors such as: electrical machinery; post and communication (EMPC); manufacturing, excluding electrical (MEE); other goods producing industries (OGPI); distribution services (DS); finance and business services (FBS); personal and social services (PSS); and non-market services (NMS) as shown in Table 10.2 and is considered most fit for the purpose of this study. To find characteristics of seven sectors for our analysis, we used several

Table 10.2 EU KLEMS additional industry aggregations classification

Sector	Included industries
Electrical machinery, post and communication (EMPC)	Electrical and optical equipment/post and telecommunications
Manufacturing, excluding electrical (MEE)	Consumer manufacturing/Food products, beverages and tobacco/Textiles, textile products, leather and footwear/Manufacturing nec; recycling/Intermediate manufacturing/Wood and products of wood and cork/Pulp, paper, paper products, printing and publishing/Coke, refined petroleum products, and nuclear fuel/Chemicals and chemical products/Rubber and plastics products/Other non-metallic mineral products/Basic metals and fabricated metal products/Investment goods, excluding high-tech/Machinery, nec/Transport equipment
Other goods producing industries (OGPI)	Mining and quarrying/Electricity, gas and water supply/Construction/Agriculture, hunting, forestry, and fishing
Distribution services (DS)	Trade/Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel/Wholesale trade and commission trade, except of motor vehicles and motorcycles/Retail trade, except of motor vehicles and motorcycles; repair of household goods/Transport and storage
Finance and business services (FBS)	Financial intermediation/Renting of machinery & equipment and other business activities
Personal and social services (PSS)	Hotels and restaurants/Other community, social and personal services/Private households with employed persons
Non-market services (NMS)	Public administration, education and health/Public administration and defense; compulsory social security/Education/Health and social work/Real estate activities

possible indices, such as TFP growth, intermediate sales ratio, and aggregate TFP growth contribution.

In addition, we used the input-output table of the OECD database in this research because it classifies industries into 48 categories and provides information for 1995, 2000, and 2005 for most of the countries that the EU KLEMS database covers. OECD provides information for industry output, value added, intermediate inputs and consumption, final demands, and so on. The relationship between the 48 categories of OECD input-output table and the seven sectors of EU KLEMS data are described in the Appendix.

10.4 Results

10.4.1 Comparative Analysis Based on EU KLEMS Classification Data

In this chapter, general characteristics of industries across the countries are analyzed. Table 10.3 shows country-specific mean values and standard deviations (SDs) of average TFP growth rate. The first two columns refer to the mean values and SDs of 13 countries from 1980 to 2005 and from 1980 to 1995, respectively, and the third column lists mean values and SDs of 20 countries from 1995 to 2005. Because the study aims to examine the trends of each industry sector in the countries, a simple mean value is used instead of a weighted average of GDP. Although there are differences in the concrete measures depending on the period concerned, the size of TFP growth rate follows the order of EMPC > MEE > OGPI > DS > NMS > FBS > PSS (between 1995 and 2005 only the FBS growth rate becomes higher than that of NMS), and EMPC, MEE, OGPI, and DS have a positive TFP growth rate, while NMS, FBS, and PSS have a negative TFP

Table 10.3 Average total factor productivity growth rates (standard deviation)

Sector	1980–2005[a]	1980–1995[a]	1995–2005[b]
Electrical machinery, post and communication (EMPC)	4.2 (2.6)	3.6 (2.3)	4.8 (3.9)
Manufacturing, excluding electrical (MEE)	1.5 (1.2)	1.9 (1.0)	1.2 (1.3)
Other goods producing industries (OGPI)	1.3 (1.2)	1.7 (1.6)	0.6 (1.3)
Distribution services (DS)	1.2 (1.0)	1.3 (1.1)	0.6 (1.4)
Finance and business services (FBS)	−0.3 (0.9)	−0.7 (1.3)	−0.1 (1.1)
Personal and social services (PSS)	−0.9 (1.1)	−1.0 (1.7)	−1.0 (1.3)
Non-market services (NMS)	−0.2 (0.6)	0.0 (0.6)	−0.6 (1.2)

[a]Austria (data from 1982 and later), Australia, Belgium, Denmark, Finland, France, Germany, Great Britain, Italy, Japan, Korea, Netherlands, and the United States

[b]Austria, Australia, Belgium, Czechoslovakia, Denmark, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, Japan, Korea, Luxemburg, Netherlands, Portugal, Slovenia, Sweden, and the United States

growth rate. In other words, the EMPC, MEE, OGPI, and DS sectors accelerate economic growth, while the others do not.

To calculate the level of contribution to the aggregate TFP growth when each sector's gross output is different, we needed the weighted sum of each sector's TFP growth. By the calculation used in Oulton (2001), under an unbalanced growth model where productivity growth, $\hat{q}_i$, is different across industry i, aggregate TFP growth, $\hat{q}$, and Domar weight (Domar 1961; Hulten 1978), w_{Domar}, are represented as Eqs. 10.1 and 10.2, respectively.

$$\hat{q} = \sum_{i=1}^{n} \left(w_{Domar,i} \times \hat{q}_i \right) \tag{10.1}$$

$$\begin{aligned} w_{Domar,i} &= \frac{\text{gross output of } i}{\text{Total final output}} \\ &= \frac{\text{Intermediate sales of } i}{\text{Total final output}} + \frac{\text{Final sales of } i}{\text{Total final output}} \end{aligned} \tag{10.2}$$

In other words, as intermediate sales increase, the Domar weight increases the aggregate TFP growth rate (when the TFP growth rate is positive). However, because an increase of final sales of i also increases the total final output, effect of increased final sales on the Domar weight is ambiguous.

Table 10.4 summarizes the results of the analysis for 1995, 2000, and 2005. The first column shows the intermediate sales against gross output of the seven industries classified by EU KLEMS. To measure the intermediate sales ratio, we used the input-output table of the OECD database. The analysis of countries with productivity data included in the EU KLEMS database from 1980 and later revealed that the intermediate sales ratio of the FBS sector was close to 80 %, while that of the PSS and NMS sectors was approximately 35 % and 15 %, respectively. That is, FBS is likely to have a relatively large Domar weight for its final output share, and the impact of its TFP growth on the aggregate TFP growth will be relatively large.

The second column shows the mean Domar weight calculated by Eq. 10.2 While the Domar weight, representing share of industry, tended to decrease in MEE and OGPI sectors, it increased in FBS and PSS industries from 1995 to 2005. That is, the impact of MEE and OGPI on the aggregate TFP growth decreases, while that of FBS and PSS increases over time.

The third column shows mean value of the individual sectors' contribution to aggregate TFP growth, which was calculated by substituting the country-specific TFP growth rate by sector and the results of Domar weight in Eq. 10.1. The contributions to aggregate TFP growth of countries are arranged in descending: MEE, OGPI, EMPC, DS, NMS, FBS, and PSS. Between 1995 and 2005, the contributions of EMPC, MEE, and OGPI increased, but those of DS, FBS, PSS, and NMS decreased.

Table 10.4 Summary of the analysis results

Sector	% Intermediate sales–gross output ratio (standard deviation)			Domar weight			% Total factor production growth contribution		
	1995[a]	2000 [a]	2005 [a]	1995	2000	2005	1995	2000	2005
Electrical machinery, post and communication (EMPC)	66.6 (0.09)	68.8 (0.10)	68.5 (0.12)	0.095 (0.021)	0.120 (0.045)	0.102 (0.037)	27.5 (0.14)	33.6 (0.17)	33.8 (0.20)
Manufacturing, excluding electrical (MEE)	64.0 (0.04)	64.5 (0.05)	62.5 (0.10)	0.535 (0.098)	0.522 (0.117)	0.486 (0.128)	59.0 (0.53)	62.9 (0.68)	71.8 (0.94)
Other goods producing industries (OGPI)	53.0 (0.13)	55.2 (0.12)	58.6 (0.12)	0.273 (0.062)	0.259 (0.060)	0.256 (0.074)	43.8 (0.82)	49.3 (1.06)	71.8 (1.83)
Distribution services (DS)	42.2 (0.06)	42.8 (0.08)	43.7 (0.07)	0.317 (0.055)	0.331 (0.062)	0.322 (0.057)	15.7 (0.33)	13.9 (0.39)	12.4 (0.49)
Finance and business services (FBS)	75.6 (0.08)	78.7 (0.10)	77.5 (0.08)	0.233 (0.053)	0.275 (0.070)	0.282 (0.072)	−12.4 (0.34)	−18.8 (0.47)	−27.8 (0.74)
Personal and social services (PSS)	30.0 (0.10)	35.8 (0.15)	35.5 (0.15)	0.122 (0.030)	0.127 (0.030)	0.127 (0.034)	−25.8 (0.57)	−32.0 (0.77)	−47.2 (1.29)
Non-market services (NMS)	13.3 (0.05)	14.0 (0.05)	15.0 (0.04)	0.382 (0.040)	0.379 (0.030)	0.394 (0.031)	−7.8 (0.24)	−9.0 (0.29)	−14.7 (0.47)

[a] Austria (the OECD input-output tables for 1994, 2001, and 2004 were used), Australia, Belgium, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Spain, the United Kingdom, and the United States

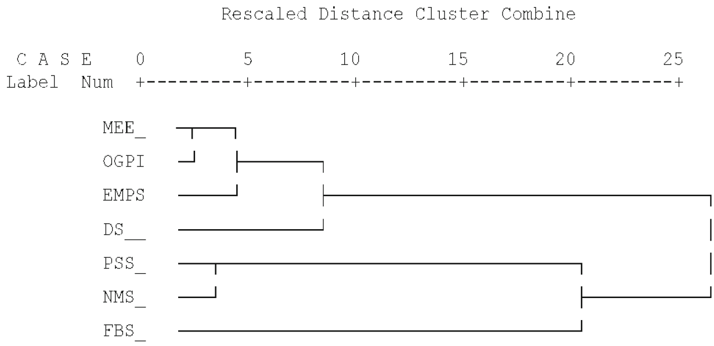

Fig. 10.2 Dendrogram of seven sectors

10.4.2 New Taxonomy of Industry Based on Value Creation

To know how the seven sectors are classified depending on TFP growth rate, intermediate sales–gross output ratio, and aggregate TFP growth contribution as indicators of industrial characteristics, we carried out Hierarchical Cluster Analysis with SPSS 16.0 and the results are shown as a dendrogram in Fig. 10.2. In a broad sense, MEE, OGPI, EMPC, and DS have a higher TFP growth rate, and PSS, NMS, and FBS have a lower TFP growth rate. MEE, OGPI, and EMPC show a higher intermediate sales ratio and aggregate TFP growth contribution, and DS has a relatively low intermediate sales ratio and contribution. The latter, PSS, NMS, and FBS, are grouped into FBS with a high intermediate sales ratio and PSS and NMS with a lower intermediate sales ratio.

Basically, these differences reflect the type and manner of value created. MEE, OGPI, EMPC, and DS sectors, with high TFP growth rates, appear to create value directly, and PSS, NMS, and FBS are transferred value industries, which redistribute generated value. Value-creation industries are classified into two types: Base value industries, such as MEE and OGPI, create items from nothing; extended value industries, such as DS, increase generated value. Transferred value industries are divided into FBS, PSS, and NMS depending on the subject and the object of transfer. Because the actual wealth of a country is based on value-creation industries, among others, an industry classification standard is necessary to categorize value-creation industries and their counterparts to explain the economic growth or generate polices for economic growth. Discussions that follow define industries classified by value creation and transfer type in a new way.

10.4.2.1 Value-Creation Industries

Value-creation industry refers to an industry in which systematic, accumulated, and repeatable originals become transaction targets. *Originals* means the objects with owners and economic value. Originals can, in turn, be divided into material goods as well as excludable and non-rival immaterial goods. Material goods generally indicate commodities known to be tangible, whereas excludable and non-rival immaterial goods, as mentioned by Romer (1990), refer to the objects upon which one can award ownership, technically or legally, as intangible knowledge; examples include technology or design. The capabilities of barbers, doctors, lawyers, musicians, or professors are embodied in their bodies and not typically non-rival; thus, these may not be included in the originals mentioned here. However, recorded music pieces or filmed lectures broadcast on TV or the Internet have excludable and non-rival qualities, and they are thus considered originals. They may be similar to the intangible goods described by Hill (1999), and the number of products falling under this category and their economic effects has expanded, such as digital media. The originals, the core of value creation, encompass concepts related to outputs such game software, performance, and hamburger recipes, as well as tangible goods.

However, industries with originals that are subject to transaction may not always reflect value creation. Because we aim to suggest an industrial classification that can contribute to greater understanding of economic growth, we consider value-creation industries to include only those with transaction objects of the originals that can be systematic, accumulated and repeatable. The qualities of being systematic, accumulated, and repeatable make expansive reproduction possible and are absolutely needed to accomplish the accelerated economic development of industrial society. For example, handicrafts and works of art are original creations, but not systematic; they cannot be reproduced on a large scale so are not considered value-creation industries. However, the hamburger recipe is an original when it makes capital accumulation possible through systematically repeated production; for example, it may be the basis of a franchise, such as McDonalds, with expansive reproduction around the world, and is thus part of the value-creation industry.

Value-creation industries satisfying the aforementioned characteristics will create value through originals and contribute to capital accumulation through expansive reproduction, thus playing a role in accelerating economic growth. Value-creation industries can be divided into the base value industry that makes originals on their own and the extended value industry that improves the value of manufactured originals.

10.4.2.2 Base Value Industries

Base value industry refers to the sectors that produce originals that are systematic, accumulated, and repeated and include most of the primary and secondary sectors that produce tangible goods according to the Fisher-Clark classification. In addition to them, even among the tertiary sectors previously classified as service industries, those producing originals corresponding to standards of value-creation industries, as mentioned above, such as software, entertainment, and restaurant sectors, may be regarded as base-value industries.

The base value industry is similar to the progressive sector suggested by Baumol (1967) because labor is utilized, not as an end product, but as a tool, and the possibility of its capital accumulation, innovation, and economy of scale are similar to those of a base-value industry. Also in terms of classification, it is similar to that of this study, because it helps better explain economic growth than other classifications. On one hand, Baumol divides the sectors into high-productivity and low-productivity sectors and classifies the former as progressive. However, *high* and *low* are relative concepts and their meanings can vary depending on the time period. On the other hand, value creation is an absolute concept unlikely to change with the passage of time. For instance, while Baumol thought of the software industry as stagnant due to its low productivity, we classify it as a base value industry producing originals with a systematic, accumulated, and repeatable nature. The originals produced from the base value industry become the source of national wealth, and national economic scope may be measured by the value of the originals created from the base value industry.

10.4.2.3 Extended Value Industries

The reason for not limiting the definition of value-creation industries to those producing systematic, accumulated, and repeatable originals, but including those creating transaction objects is that extended value industries may increase value without directly producing originals. Extended value industries provide the originals produced from the base value industry for a location or time with higher consumer efficiency, thus further increasing the value of originals. In this aspect, distribution and other commercial activities as well as the networking industry that transmit material goods are generally included in the extended-value industry category. Even though extended value industries do not directly create originals, but simply add value, they make extended re-investment possible and promote accelerated economic development through expansive reproduction; hence, they play a crucial role as part of the value-creation industry.

10.4.2.4 Transferred Value Industries

Systematic, accumulated, and repeatable originals are not considered transaction objects of transferred value industries; that is, these industries do not create originals and enhance value in the same way as value-creation industries, but they play a role in transferring or distributing the value created. The transferred value industry is similar to Baumol's stagnant sector and the labor associated with it is usually an end product. Therefore, these sector productivities are low and their expansive reproduction is difficult to achieve. Furthermore, they cannot increase net wealth because they do not create real value. Transferred value industries can be divided into the production support services that are highly related to value-creation industries as well as the private and public services that are not.

10.4.2.5 Production Support Service Industries

Production support-service industries directly support the activities of value creation among the transferred value industries and include finance, law, advertising, and consulting, and so on. For example, in the automobile industry, production support services do not directly create value in the same way as the base value industry creating the originals (autos) or the extended value industries that sell/export the originals (autos), but they provide the funding necessary to operate auto manufacturing factories, provide legal services related to sales contracts, and consult for the improvement of productivity. Production support-service industries receive partial transfer of value created in the form of profits through production; therefore, these are considered part of the transferred value industry.

10.4.2.6 Private Service Industries

Private service industries, among the transferred value sector, provide the custom-built services for the efficient improvement of individuals and include beauty treatment, art, medical treatment, and legal defense. Finance or legal services as well as financing or legal counseling for enterprises, which help create value, are part of the production support-service sector, whereas loaning or legally defending a person is included in the private service sector.

10.4.2.7 Public Service Industries

The main agent of public service industry operations is a national government and the outputs include education and national defense services. Private and public service industries represent a simple reproduction industry in which improvement in productivity and net wealth is very difficult to achieve, but in most cases, these services are necessary to secure the quality of life for citizens, regardless of the level of short-term economic growth.

According to the data offer by EU KLEMS, the MEE and OGPI, which include most primary and manufacturing industries, are related to the base value industry, DS is related to the extended value industry, FBS is related to the production support service industry, PSS is related to the private service industry, and NMS is related to the public service industry. The EMPC, a rapidly growing industry, includes electrical machinery as well as post and communication, is matched with the base value industry and the extended value industry, respectively.

10.5 Discussion

In this study, by using the data of productivity in Europe, Japan, Korea, and the United States provided by EU KLEMS and OECD input-output data, we analyzed TFP growth rate, intermediate sales, and the aggregate TFP growth contribution for the industries divided into seven sectors. In addition, we re-grouped those seven sectors through clustering and suggested a new classification system on the basis of the value creation of each group.

In conclusion, the entire industry can be divided into (a) industries creating value and (b) those that redistribute the value produced, called transferred value sectors. In turn, value-creation industries can be divided into base value industries that directly generate value and extended value industries that extend the created value. Transferred value industries can be divided into production support services and private/public services, which show varying degree of connection with industry. Our finding that the distribution and networking industries are generally considered part of the service industry due to the extended value they bring distinguishes this research from past efforts. However, because the current industry classification is not based on the type of value created. The characteristics of the base value, extended value, and transferred value industries cannot be shown without fundamentally modifying the system. Even though various kinds of restaurants are equally classified as one category, some of them may belong to a value-creation industry and others may belong to a transferred value industry according to the standards of this study.

Even with limitations, the results of this study clearly offer various suggestions in determining the directions of industry policies for economic growth. For instance, base value with high TFP growth and aggregate TFP growth contributions is very beneficial to economic growth, but its Domar weight is gradually reduced with the passage of time (Table 10.4). This shows that Baumol's growth disease takes place and governmental support for the value-creation industry is necessary to speed up economic growth. In contrast, Oulton (2001) claimed that production services with a high intermediate sales ratio can lead to economic growth in spite of a low TFP growth rate, but the analysis shows a minus in TFP growth rate of production support services. The Domar weight is high while TFP growth is low, which negatively impacts aggregate TFP growth. To improve this outcome, the weight of production support services needs to be lower or an effort must be made to enhance TFP growth of production support services.

Appendix

Sector matching between 48 sectors in the OECD input-output table and 7 sectors in the EU KLEM classification

EU KLEMS classification	OECD input-output table classification
Electrical machinery, post and communication (EMPC)	17 Office, accounting & computing machinery
	18 Electrical machinery & apparatus, nec
	19 Radio, television & communication equipment
	20 Medical, precision & optical instruments
	37 Post & telecommunications

(continued)

(continued)

EU KLEMS classification	OECD input-output table classification
Manufacturing, excluding electrical (MEE)	4 Food products, beverages and tobacco
	5 Textiles, textile products, leather and footwear
	6 Wood and products of wood and cork
	7 Pulp, paper, paper products, printing and publishing
	8 Coke, refined petroleum products and nuclear fuel
	9 Chemicals excluding pharmaceuticals
	10 Pharmaceuticals
	11 Rubber & plastics products
	12 Other non-metallic mineral products
	13 Iron & steel
	14 Non-ferrous metals
	15 Fabricated metal products, except machinery & equipment
	16 Machinery & equipment, nec
	21 Motor vehicles, trailers & semi-trailers
	22 Building & repairing of ships & boats
	23 Aircraft & spacecraft
	24 Railroad equipment & transport equip nec.
	25 Manufacturing nec; recycling (including furniture)
Other goods producing industries (OGPI)	1 Agriculture, hunting, forestry and fishing
	2 Mining and quarrying (energy)
	3 Mining and quarrying (non-energy)
	26 Production, collection and distribution of electricity
	27 Manufacture of gas; distribution of gaseous fuels through mains
	28 Steam and hot water supply
	29 Collection, purification and distribution of water
	30 Construction
Distribution services (DS)	31 Wholesale & retail trade; repairs
	33 Land transport; transport via pipelines
	34 Water transport
	35 Air transport
	36 Supporting and auxiliary transport activities; activities of travel agencies
Finance and business services (FBS)	38 Finance & insurance
	40 Renting of machinery & equipment
	41 Computer & related activities
	42 Research & development
	43 Other Business Activities
Personal and social services (PSS)	32 Hotels & restaurants
	47 Other community, social & personal services
	48 Private households with employed persons & extra-territorial organizations & bodies
Non-market services (NMS)	39 Real estate activities
	44 Public administration & defense; compulsory social security
	45 Education
	46 Health & social work

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