Evan Lau
Biagio Simonetti
Irwan Trinugroho
Lee Ming Tan *Editors*

Economics and Finance Readings

Selected Papers from Asia-Pacific Conference on Economics & Finance, 2019

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Preface

This publication contains eight papers that were presented at the 2019 Asia-Pacific Conference on Economics and Finance (APEF 2019), organized by East Asia Research and supported by Universiti Malaysia Sarawak (UNIMAS) and Loughborough University, held on 25–26 July 2019 in Singapore at the Grand Copthorne Waterfront.

This year's theme focused on how the US-China trade war is affecting the world economy. APEF 2019 achieved the objective of bringing together leading scholars, students, and practitioners from overseas to Singapore for an academic exchange. The program consisted of an opening speech by Dr. Evan Lau, Associate Professor, UNIMAS, and a keynote speech by Dr. Steven Cochrane, Chief APAC Economist, Moody's Analytics, and Dr. Kai-Hong Tee, Loughborough University, UK. We have received close to 200 abstracts and accepted 44 full papers to be presented at the conference. A total of 60 registered delegates attended APEF 2019 from the following countries: Australia, China, France, India, Japan, Lebanon, Macao, Malaysia, Mexico, Norway, the Philippines, Norway, Singapore, Republic of Korea, the United Kingdom, the United States, and Vietnam.

APEF 2020 will be held in Furama RiverFront, Singapore, on 29–30 July 2021, with the theme "International Capital Flows and Foreign Investment." I welcome you to this conference and look forward to your participation.

With warmest regards,

Kota Samarahan, Malaysia — Evan Lau

East Asia Research (EAR)

Established in Singapore in 2015, East Asia Research (EAR) envisions to be the gateway to improving lives and enhancing productivity in Asia through promoting cross-geographical exchange of ideas and knowledge in various faculties. This will be achieved through the dissemination of knowledge from the Asia-focused research conferences and publications by EAR.

EAR academic conferences provide a meaningful platform for researchers, post-graduates, academicians, and industry practitioners to share unique insights and drive innovation. This is a great opportunity for expanding contact networks beyond a singular field and kick-starting a strategic collaboration. Such partnership can bridge the resources and expertise of multiple disciplines to spearhead pioneer movements, giving rise to breakthroughs in long-standing issues.

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About the Editors

Evan Lau serves as Associate Professor and Managing Editor for *International Journal of Business and Society* (IJBS) in the Faculty of Economics and Business, Universiti Malaysia Sarawak (UNIMAS). He was the Deputy Dean for Research and Postgraduate at the Faculty of Economics and Business from 2016 to 2017 and the Director of the Centre for Business, Economics, and Finance Forecasting (BEFfore), UNIMAS, from 2013 to 2016. He was Visiting Scholar at the Faculty of Economics, University of Cambridge, from October 2013 to April 2014 and Visiting Professor in the Universitas Sebelas Maret from June to July 2019. He speaks at numerous international conferences in countries like Indonesia, UAE, Sri Lanka, Italy, and Malaysia. Besides, he is also an active academic workshop instructor. He provides lectures, consultations, and supervisions to students, and received positive evaluations from both undergraduates and postgraduates. As of today, his journal article publications stand at 94. He has 67 postgraduate students under his supervision. As an active researcher, he has been awarded a total of 27 research grants. He was listed among the top 10% economists in Malaysia in 2008 and the top 12% in Asia in 2012 by the Research Papers in Economics (RePEc) database and is among the highly cited authors in UNIMAS. Apart from the academia journey, he joined number of running events and enjoys travelling around the world.

Biagio Simonetti received his PhD in Computational Statistics. He is Associate Professor in Statistics at the Università degli Studi del Sannio and also Professor in Statistics and Statistics for Business. His research interests focus on multivariate statistical methods with particular attention to correspondence analysis applied to problem of the evaluation of the customer satisfaction. He serves on the program and organizing committees of conferences in the field of multivariate methods and decision theory. He is the Author of more than 40 conference and high-impact factor journal papers published in various journals such as *Journal of Multivariate*

Analysis; *Journal of Applied Statistics*; *Communications in Statistics* – Theory and Methods; *Journal of Statistical Planning and Inference*; *International Business Review*; and *European Management Journal*. He is the coordinator of several international projects.

Irwan Trinugroho is Associate Professor of Finance at the Faculty of Economics and Business, Universitas Sebelas Maret (FEB UNS), Indonesia. He was the UNS best lecturer in 2015 and 2018 as well as UNS best scholar in 2015 and 2016. He has published a number of papers in reputable journals including the *Journal of Financial Stability*, *Global Finance Journal*, *Research in International Business and Finance*, *Borsa Istanbul Review*, *Economics Bulletin*, *Emerging Markets Finance and Trade*, *Singapore Economic Review*, and *Journal of Asia Business Studies*. He is the editor in chief of *International Journal of Governance and Financial Intermediation* and serves as the Managing Editor of the *International Journal of Economic Policy in Emerging Economies* and as editorial board member in some journals such as *Eurasian Economic Review*, *Journal of Asia Business Studies*, *International Journal of Economics and Management*, *International Journal of Monetary Economics and Finance*, and *International Journal of Education Economics and Development*. Currently, he is the Vice President for Program and International Affairs of the Indonesian Finance Association (IFA).

Lee Ming Tan is the Founder of East Asia Research. He obtained his Master of Applied Finance from the University of Adelaide. He is deeply interested in how humans function and react with each other. An insight into how people's minds think and how they work together is invaluable in just about every field. Outside of work, he enjoys outdoor activities and occasional computer games.

Chapter 1
The China-US Trade Imbalance: Evaluating Remedial Macroeconomic Measures

Anthony J. Makin

Abstract This paper addresses the most contentious issue in China-United States economic relations, their bilateral trade imbalance. After highlighting key features of the trading relationship, a straightforward international macroeconomic framework is introduced to analyze the main influences on the external imbalance. From an output-expenditure perspective, it examines real exchange rate valuation, the effects of tariffs and subsidies, higher Chinese consumption, and increased foreign direct investment. It concludes that protectionist measures are ineffective in reducing the trade imbalance and negatively affect macroeconomic welfare, broadly defined, in both countries. Meanwhile, real exchange rate adjustment, increased Chinese private consumption, and relaxation by China of restrictions on US foreign investment would all contribute to balancing the external accounts, with lower Chinese saving and more US FDI in China also improving macroeconomic welfare in both countries.

Keywords China-US trade imbalance · Real exchange rate · Protection · Consumption · FDI

JEL Codes F32 · F33 · F43

1 Introduction

While the United States is the world's largest economy, China is the world's largest exporter and replaced the United States as the world's largest manufacturing nation a decade ago. Since then, the China-US trade imbalance has been the key source of economic tension between the two superpowers, stretching back to concerns raised by the Bush and Obama administrations. Members of the European Union have had

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similar concerns about their trade imbalances with China. Yet, policy debate on this issue has centered on the nature of bilateral export and import flows, to the neglect of macroeconomic factors influencing those flows, which this paper aims to redress.

In the United States, since the turn of the century, the demise of manufacturing firms unable to compete against low-priced Chinese imports has repeatedly sparked calls for retaliatory action by the US government against China. Given the impact exchange rates have on international competitiveness and trade flows, the value of the CNY/$US exchange rate has also been raised in the ongoing China-US dialogue on the trade imbalance. From the mid-2000s, the US government has pressed China to revalue its currency on the grounds that its undervalued currency boosted the competitiveness of China's manufacturing sector and contributed to the bilateral trade imbalance. For related discussion, see Congressional Research Service (2008).

While the CNY/$US exchange rate has strengthened significantly over the past decade, somewhat paradoxically, China's trade deficit with the United States has continued to widen from a deficit of near $80 billion in 2000 to close to $400 billion in 2018. Under the Trump administration, direct action has been taken to reduce this trade imbalance by imposing tariffs on Chinese imports to the United States, beginning with tariffs on steel and aluminum and extended to solar panels and household appliances. China has retaliated by imposing tariffs on American chemicals, coal, medical equipment, and soybeans. These protectionist measures directly affect the targeted industries but also have macroeconomic effects, as evidenced from the escalation of US tariffs during the Great Depression (see Crucini and Kahn 1996).

The China-US trade imbalance has routinely been interpreted as the difference between export and import flows between the two countries, with protectionist measures aimed directly at influencing these flows. However, trade imbalances are also macroeconomic phenomena, reflecting discrepancies between an economy's output, or aggregate supply, and its expenditure, or aggregate demand, as highlighted by Alexander's (1952) absorption approach. In what follows, this much neglected perspective provides a novel basis for examining the interrelationship between the China-US trade imbalance, the CNY-$US real exchange rate, and the macroeconomic impact of policy measures, including subsidies, tariffs, countertariffs, increased Chinese consumption, and increased foreign investment flows.

The remainder of the chapter is structured as follows: Section 2 summarizes recent trends in Chinese and US growth, bilateral balance of payment trends, and protectionist measures. Section 3 advances a simple international macroeconomic framework based on the output-expenditure distinction. Section 4 adapts this framework to analyze how discrepant economic growth, exchange rate management, protectionism, higher Chinese consumption, and higher US foreign direct investment in China influence the trade imbalance and macroeconomic welfare. Section 5 concludes the paper and draws policy implications, emphasizing that a protectionist response is not only an ineffective means of reducing the trade imbalance but also reduces macroeconomic welfare in both countries.

2 Bilateral Trade, Exchange Rate, and Balance of Payment Trends

China's transition to an economic superpower arose from persistently high economic growth rates that began in the early 1980s at rates three to four times those of its trading partners, the United States being the most significant. See Fig. 1.1.

Exports have been a major contributor to China's stellar economic growth, combined with foreign direct investment (FDI) in electronics and manufacturing, enhanced domestic labor mobility, improved education, high domestic saving, entrepreneurship, and positive investment conditions for the private sector. See World Bank (2012) for related discussion.

Based on the proportion of exports and imports to its GDP, China is a highly open economy in terms of goods and, to a much lesser extent, service flows. As a share of GDP, China's exports plus imports of goods and services are around 75%, well above comparable ratios for the United States and major advanced economy export nations Japan and Germany. Yet, China is relatively closed financially with heavy restrictions on short-term international capital flows, although has encouraged selective foreign direct investment in certain sectors, subject to conditions governing intellectual property rights. In view of the extensive capital controls in place, recorded capital flows have, therefore, been mostly in the form of foreign direct inward and outward investment (FDI) and purchase of US government debt instruments.

The wider China-US trade surplus and corresponding US trade deficit, depicted in Fig. 1.2, have been the most notable aspect of China's international trade since the turn of the century. The US trade deficit grew strongly after China joined the WTO in

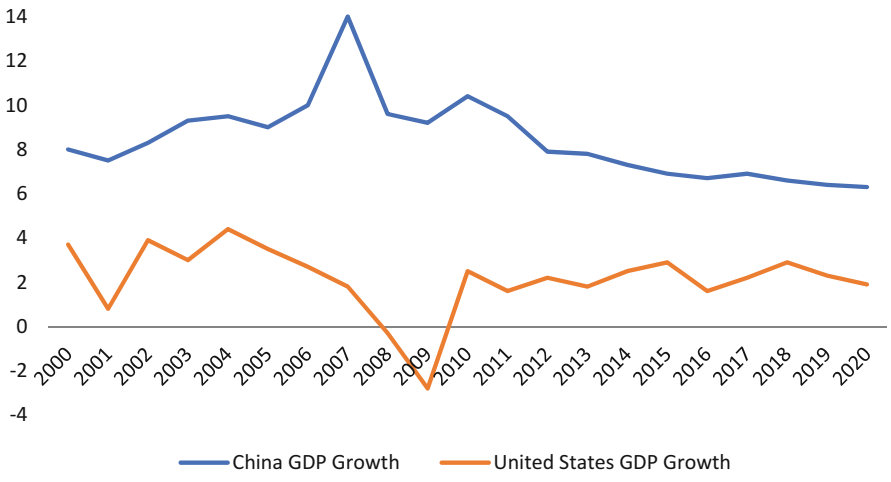

Fig. 1.1 GDP growth (%): China and the United States, 2000–2018. (Source: Based on IMF data)

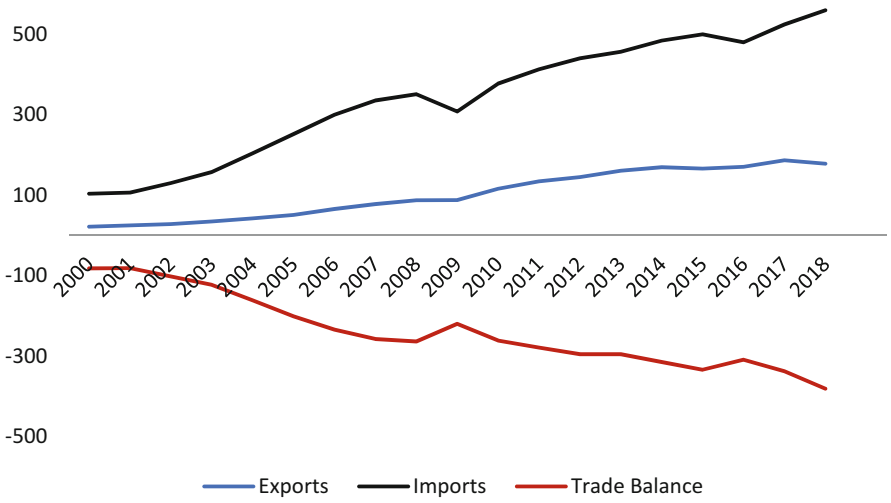

Fig. 1.2 US-China trade: Exports, imports, and trade deficit, 2000–2018. (Source: Based on US Census Bureau data)

2001, although China's export capability began expanding at least a decade earlier, assisted by China's plentiful low-cost and more mobile workforce that provided a competitive edge for a burgeoning manufacturing sector.

Figure 1.2 reveals that US imports from China rose relatively quickly from 2002 until 2008. During the 2008–2010 Global Financial Crisis (GFC), US imports from China fell sharply though soon recovered their upward climb. Bilateral trade in goods dominates trade in services and attracts the most attention. US merchandise imports from China, mainly in the form of computers, phones, electronics, other electrical equipment, machinery, metals, furniture, apparel, and footwear, are over three times the value of US merchandise exports to China, mainly commercial aircraft, electronics, chemicals, oil and gas, soybeans, and motor vehicles.

2.1 Exchange Rate Management

After a lengthy period of explicitly pegging against the $US, China's exchange rate system changed in 2005 to set its value against a basket of currencies in which the US dollar still predominates (see Das 2019). The CNY/$US exchange rate subsequently appreciated from over 8 yuan to the dollar and has ranged between 6 and 7 yuan to the dollar since the Global Financial Crisis.

Given the importance of the $US in China's effective exchange rate index, and the absence of major differences in price level behavior, movement in the nominal

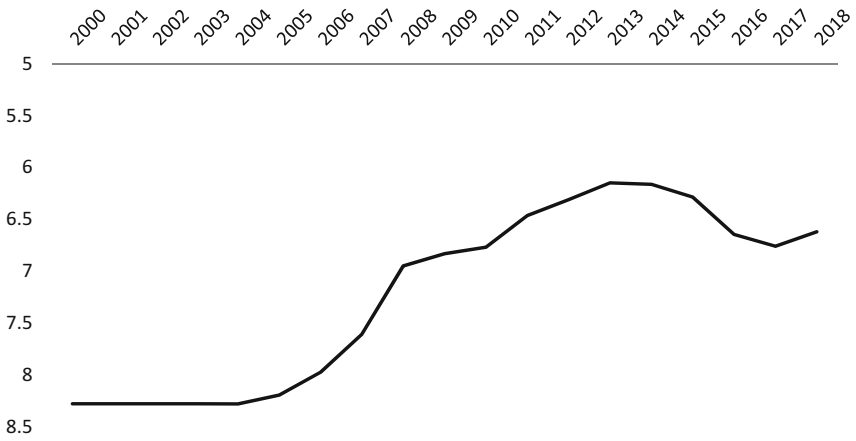

Fig. 1.3a Chinese Yuan – US dollar exchange rate, 2000–2018. (Source: Based on BIS data)

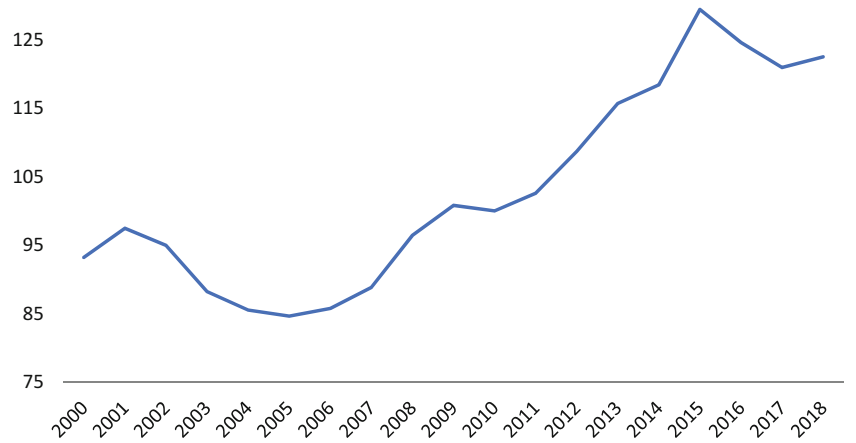

Fig. 1.3b Chinese real exchange rate, 2000–2018. (Source: Based on BIS data)

bilateral exchange rate is largely mirrored in the behavior of China's real exchange rate over this time. See Figs. 1.3a and 1.3b.

In the absence of a fully developed financial system, China's exchange rate system provides a measure of financial stability and an anchor for monetary policy, though contrasts with relatively more flexible exchange rate regimes adopted by most developing and emerging economies with which many industrial economies trade.

By running sizeable trade and current account surpluses since the turn of the century, China's exchange rate settings against the US dollar have enabled its central bank, the People's Bank of China, to accumulate large holdings of foreign exchange

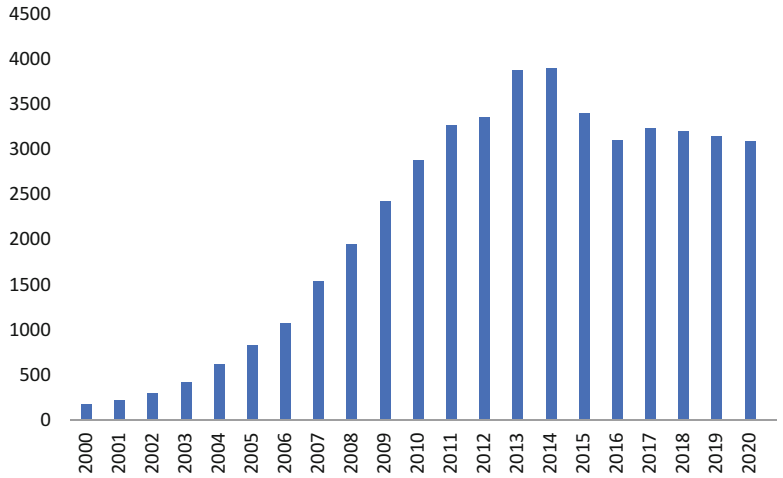

Fig. 1.4 China's gross foreign exchange reserves 2000–2020 ($US billion). (Source: Based on IMF data)

reserves. These peaked at close to $4 trillion in 2014 falling to around $3.0 trillion more recently, still the highest $US reserves of any economy in the world. See Fig. 1.4.

There are several approaches to evaluating whether any country's exchange rate is appropriately valued. For instance, there is the Fundamental Equilibrium Exchange Rate (FEER) pioneered by Williamson (1993) which calculates real exchange rate values consistent with macroeconomic equilibrium. According to the FEER perspective, China's exchange rate was significantly undervalued in the early 2000s but revalued substantially against the US dollar from 2005 (Cline and Williamson 2012). Other studies focusing on the relationship between China's exchange rate and its international trade flows include inter alia, Goldstein and Lardy (2009), Frankel and Wei (2007), and (Zhang 2001) which employ a range of different theoretical and estimation techniques.

With the above as background, we now model the interrelationship between aggregate expenditure and national income levels in both countries, the CNY/$US real exchange rate, and the China-US trade imbalance. A basic framework is first developed, before examining the impact of a range of policy options on both the trade balance and macroeconomic welfare, defined broadly with reference to national income and private consumption (as an indicator of the standard of living).

3 The China-US Trade Imbalance: An International Macroeconomic Framework

This section advances a two-country international macroeconomic framework for examining the China-US trade imbalance centered on respective national output, national expenditure flows, and the real exchange rate. Inspired by Alexander's (1952) absorption approach, it assumes the two economies only trade with each other and that the bilateral trade imbalance reflects discrepancies between their respective aggregate outputs and aggregate expenditures. By changing competitiveness, the real exchange rate directly affects these aggregates and hence the trade balance.

China's real bilateral exchange rate with the United States is defined as

$$R = {}^{eP^C}/_{P^{US}} \tag{1.1}$$

where e is the nominal *CNY/$US* exchange rate, P^C is China's domestic price level, and P^{US} is the US price level. Given little difference in price level behavior of China and the US post GFC, nominal exchange rate variation mostly accounts for short-term real exchange rate fluctuation. The US real exchange rate is defined as the reciprocal of *R*.

A rise (fall) in the real exchange rate, R, for China (US) denotes a real depreciation (appreciation) and improved (worsened) competitiveness. The weaker (stronger) the real exchange rate, the greater the supply (demand) of goods and services. In sum, total output (expenditure) includes exports (imports) of goods and services and so is positively (negatively) related to competitiveness.

Aggregate output functions for both economies are specified as

$$AO^C = AO\left(R(e); \varsigma, L^C, K^C, L^C, T^C\right) \tag{1.2}$$

$$AO^{US} = AO\left(R(e); L^{US}, K^{US}, L^{US}, T^{US}\right) \tag{1.3}$$

where *L*, *K*, and *T* are the factor inputs labor, capital, and technology used to produce national outputs and ς is Chinese government subsidies.

Exchange rate depreciation improves competitiveness, encouraging short run production and increased exports of goods and services (see Sarno and Taylor 2002; Feenstra and Taylor 2015). Hence, an upward (downward) sloping aggregate output schedule AO^C (AO^{US}) for China (United States) can be drawn in real exchange rate-output space, as shown in the left (right) panel of Fig. 1.5.

On the aggregate expenditure side,

$$AE^C = AE\left(R(e); C^C, I^C\right) \tag{1.4}$$

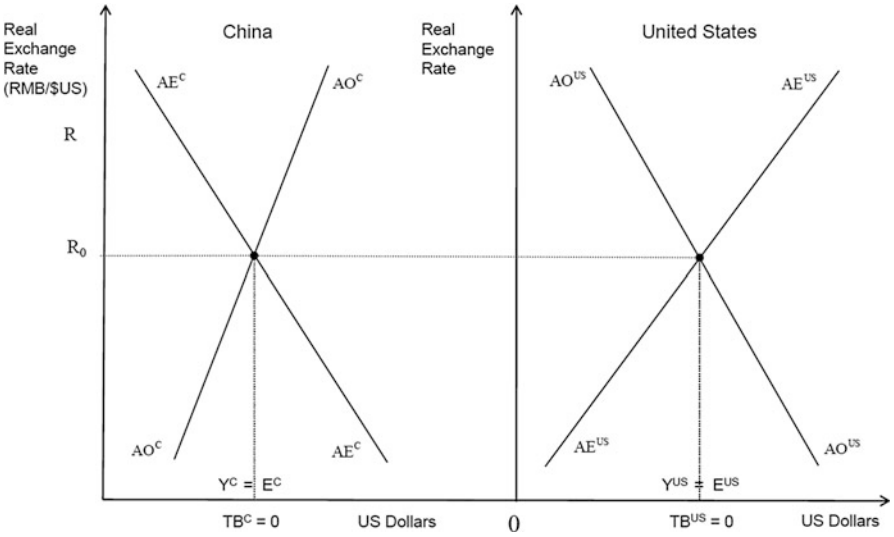

Fig. 1.5 Output, expenditure, and real exchange rate: A two-country framework

$$AE^{US} = AE\left(R(e); \tau, C^{US}, I^{US}\right) \tag{1.5}$$

where AE is expenditure by resident entities on goods and services including imports, or absorption, C is private and public consumption, and I is private and public investment and τ is US tariffs on Chinese imports.

With absorption defined as $C + I = AE$, and as $C + I + X - M = AO$, the trade imbalance, $(X - M)$,is the output-expenditure difference, such that

$$AO - AE = AO - (C + I) = X - M \tag{1.6}$$

Hence for China and the United States,

$$AO^C - AE^C = \left(AO^C - C^C\right) - I^C = \left(S^C - I^C\right) = TS^C \tag{1.7}$$

$$AE^{US} - AO^{US} = I^{US} - \left(AO^{US} - C^{US}\right) = \left(I^{US} - S^{US}\right) = TD^{US} \tag{1.8}$$

$$TS^C = TD^{US} \tag{1.9}$$

where S is national saving, TS is the trade surplus, and TD is the counterpart US trade deficit. Moreover, because a trade surplus must be matched by net outward foreign investment and a trade deficit by net inward foreign investment,

$$TS^C = -NFI^C = TD^{US} = NFI^{US} \tag{1.10}$$

where NFI is net foreign investment.

The US real bilateral exchange rate is the inverse of China's, so that depreciation of the CNY is an appreciation of the $US. Hence, as shown in the left (right) panel of Fig. 1.5, a downward (upward) sloping aggregate expenditure schedule AE (AE∗) for China (US) can be drawn in exchange rate-expenditure space. In other words, the output-expenditure schedules for China in the left panel have the opposite slopes to those for the United States in the right panel. The trade accounts of China and the United States balance when aggregate supply and demand schedules intersect in both panels at real exchange rate, R.

When China has a trade surplus, this reflects its excess production over expenditure, matched by a US trade deficit conveying its excess expenditure over production. Output-expenditure differences manifest not only as trade imbalances but also as excess demand or supply of foreign currency, in this case $US. In the absence of capital flows, the real exchange rate equilibrates national output and national expenditure ensuring a balanced trade account.

4 Policy Options for Reducing the Trade Imbalance

With these foundations, we can examine several policy options for addressing the China-US trade imbalance, including real exchange rate adjustment, protectionist measures, increased (reduced) Chinese (US) consumption, and increased foreign inward (outward) direct investment to China (from the United States).

Consider first, however, China's rapid development relative to the United States up until the 2008–2009 Global Financial Crisis as depicted earlier in Fig. 1.1. As conveyed in Fig. 1.6, rapid expansion of low-cost manufacturing for export resulted in China's, mainly manufacturing, output growing at a multiple of US growth. Hence, China's AO schedule in the left panel of

Figure 1.6 shifts rightward, as does the US AE schedule in the right panel, reflecting increased consumption of cheap Chinese-made manufactures by US households and firms. In other words, output in China outpacing its expenditure equates to additional exports from China to the United States, which corresponds to higher imports to the United States from China reflecting US expenditure outpacing its production.

4.1 Real Exchange Rate Adjustment

Other things equal, China's relatively stronger economic growth and exports strengthen China's exchange rate in real terms from R_0 to R_1 and weaken the $US accordingly. Abstracting from FDI flows, with a fully flexible nominal CNY/$US exchange rate, the real exchange rate also appreciates, ensuring the bilateral trade account eventually balances.

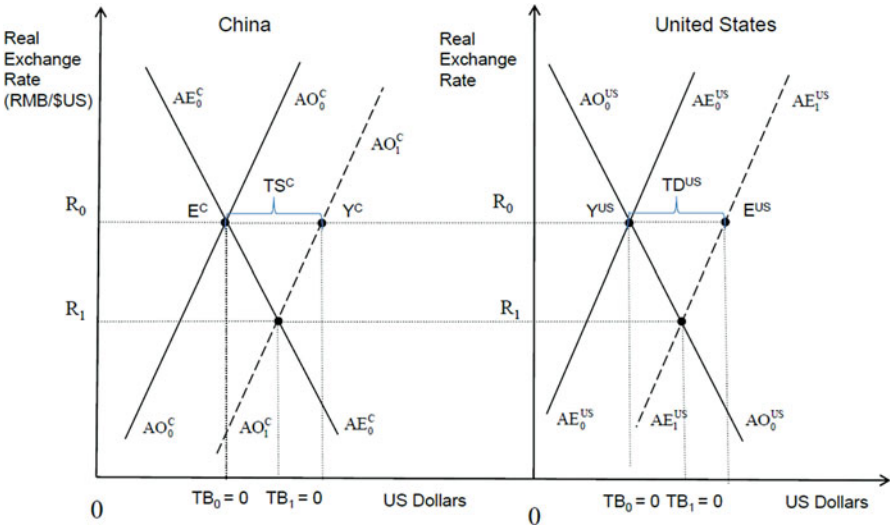

Fig. 1.6 The China-US trade imbalance and real exchange rate misalignment

However, nominal appreciation harms China's international competitiveness, and to prevent that, the central bank, the People's Bank of China (PBC), has heavily bought $US. The $US acquired is invested in $US bonds which add to the PBC's foreign reserves. While PBC purchases of $US reduce the US money supply in the first instance, other things equal, immediately investing those dollars in $US denominated bonds means the US money supply is unaffected.

When the PBC buys US bonds with the proceeds of its foreign exchange market intervention, it effectively generates excess Chinese saving over investment to fund excess investment over saving in the United States. Capital outflow from China also allows lower US interest rates that sustain excess US expenditure over output. China's national income is supplemented by interest income on its US bonds, while US national income is reduced by interest paid by the PBC on these bonds.

Figure 1.6 also shows important, though hitherto neglected, macroeconomic consequences of pegging the CNY/$US exchange rate. In particular, by managing an undervalued exchange rate, China's output and exports are higher than had the CNY/$US exchange rate appreciated. Therefore, the managed exchange rate has been instrumental to China achieving higher output growth than otherwise, as shown in Fig. 1.7, where the level of output of Y^C under a managed exchange rate exceeds that when the trade account balances. Accordingly, China's pegged exchange rate policy has acted as a form of trade protection for its manufacturing sector and can be termed "exchange rate protection" (see Makin 2009 for related discussion).

The earlier Fig. 1.3a and 1.3b shows that when China's relative economic growth surged, the CNY/$US exchange rate did strengthen significantly, especially in the years leading up to the GFC. Yet the model suggests further real appreciation is

necessary to eliminate the significant ongoing bilateral trade imbalance. Meanwhile, with a stronger real exchange rate, higher Chinese expenditure, including on US imports, implies the living standards of Chinese households would be higher to the extent there is increased consumption of cheaper US imports.

4.2 Subsidies, Tariffs, and Countertariffs

In recent years, US policy concern has shifted to the subsidies the Chinese government provides to its state-owned enterprises via direct subsidies for exports, production inputs, or concessional finance. State subsidies in any of these forms imply higher Chinese output than otherwise. Again, with reference to Fig. 1.6, this implies a rightward shift of China's AO schedule, further widening of the trade imbalance in China's favor in the absence of further CNY appreciation against the $US.

To counter this, as discussed earlier, the US has imposed hefty tariffs on a range of Chinese goods, which, other things equal, curbs Chinese imports and total US spending. As Fig. 1.7 shows, this shifts the US AE schedule leftward (starting from a post-subsidy equilibrium), offsetting the output effect of China's subsidies, which puts Chinese exporters under pressure as US sales fall. The extent to which Chinese production also falls depends on how much the US tariffs are absorbed in Chinese pricing.

Either way, the profitability of Chinese firms is dented by the US tariffs, and relocating production to third countries for export to the United States becomes an

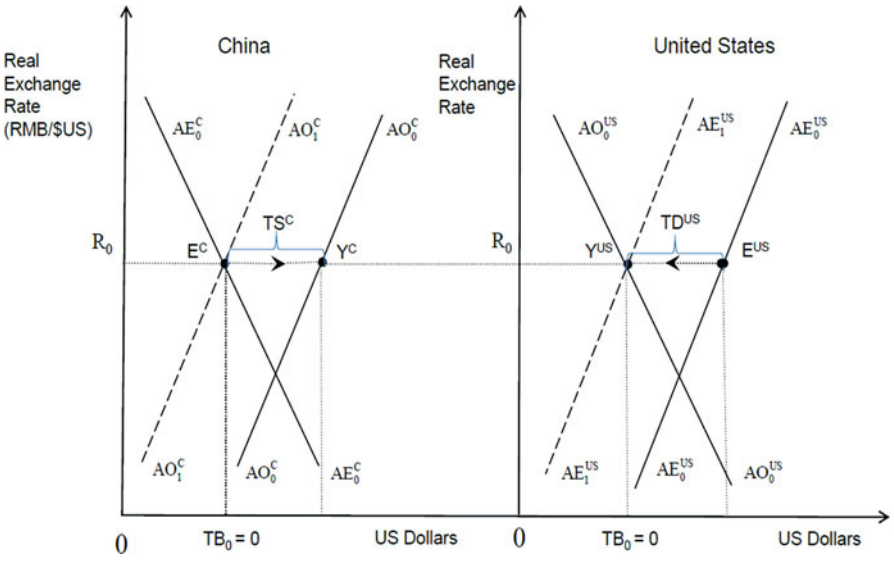

Fig. 1.7 Chinese subsidies, US tariffs, and the trade imbalance

option. Meanwhile, countervailing tariffs imposed by China on US imports reduces US output relative to its expenditure and lowers China's expenditure relative to its output, reversing any effect the US tariffs may have had on the trade imbalance.

4.3 Increased Consumption

A nonprotectionist option for reducing the trade imbalance is to encourage greater Chinese household consumption of US goods and services. In other words, induce a behavioral shift toward lower private Chinese saving. This policy measure is consistent with an objective of China's 12th 5-Year Plan to reorient the economy more toward consumption and away from exports. As shown in Fig.1.8, an autonomous rise in Chinese household consumption increases aggregate spending relative to output, shifting the AE schedule in the left panel rightward.

This narrows China's trade surplus, other things equal, at the same time bolstering Chinese demand for US output, shifting the US AO schedule in the right panel rightward. Hence, without affecting China's output, living standards there increase as consumption rises, whereas in the United States, output rises leaving expenditure unchanged. Alternatively, the trade imbalance may be corrected as a result of US saving increasing, though this would reduce China's output and, other things the same, lower US living standards.

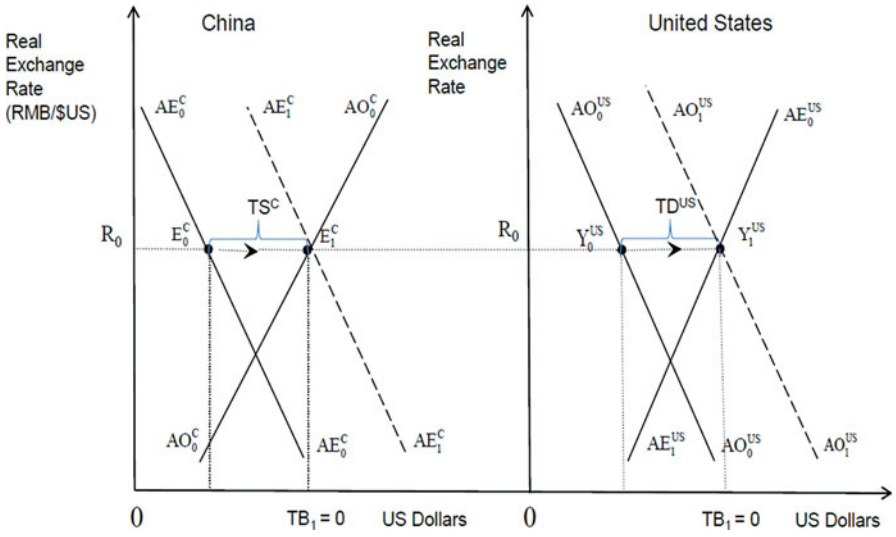

Fig. 1.8 Increased Chinese consumption and the trade imbalance

4.4 Increased Foreign Direct Investment

The final policy option to consider focuses not on the trade imbalance per se but on increasing foreign direct investment (FDI) flows. From balance of payments accounting and in the absence of indirect capital flows, direct foreign capital inflow must equate to the difference between exports and imports, as defined above. Though China has encouraged selective inward FDI from the outset of the reform era that began in the early 1980s, a host of foreign investment restrictions and prohibitions remains. Specific government approval is needed for all foreign investment projects, with regulations and restrictions, that are frequently subject to variation, differing across sectors and locations.

Figure 1.9 illustrates that extensive Chinese liberalization of existing controls over inward FDI increases private investment in China from the United States and, hence, China's expenditure, shifting the AE schedule rightward. Meanwhile, domestic US investment diverted to China shifts the US AE schedule leftward. As suggested by neoclassical foreign investment theory (see, for instance, McDougall 1960; Makin 2004; Razin and Sadka 2007; Chowdhury and Mavrotas 2006 and Mah 2010), if the rate of return on capital in China exceeds that in the United States, FDI outflow from the United States to China unambiguously raises national income in both economies, where national income is defined to include profits from abroad. This happens as a larger capital stock also subsequently raises Chinese and US national income.

Increased foreign investment also bestows productivity benefits by spurring greater competition domestically and exposing host economies to international best management and product development practices. Makin and Chai (2018) elaborates.

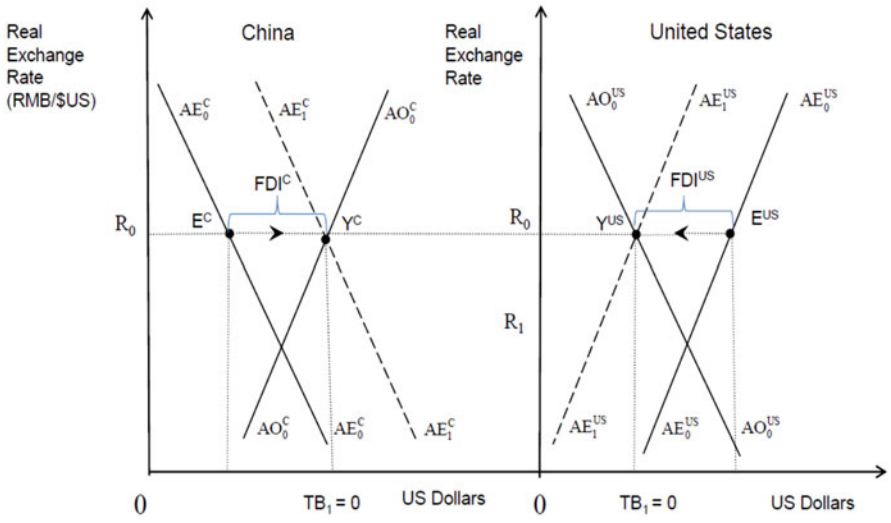

Fig. 1.9 Increased US FDI and the trade imbalance

Liberalizing FDI flows from the United States in China would allow real capital to flow to where it can be most productively used. This would confer macroeconomic welfare gains in addition to those bestowed by expanding goods and services trade with the United States, suggesting a complimentary yet potentially stronger means of raising Chinese living standards.

5 Conclusion

This paper has examined the China-US trade imbalance from an international macroeconomic perspective and has evaluated several policy options for narrowing it by adapting a two-country output-expenditure framework. Table 1.1 summarizes the results of the analysis. Bearing in mind that private consumption has long been considered the end goal of economic activity, macroeconomic welfare improves if either an economy's national income rises, enabling higher consumption possibilities, or if its private consumption rises autonomously.

The above analysis has examined the impact on macroeconomic welfare defined this way of four major policy options – real exchange rate adjustment, higher US tariffs in response to Chinese subsidies (along with Chinese countertariffs), higher Chinese private consumption, and foreign investment liberalization.

Firstly, the framework shows that allowing the CNY/$US exchange rate to appreciate sufficiently would close the trade imbalance, likely with a lag (see IMF 2019), other things equal. Yuan appreciation would curb China's exports to the United States, reducing its national income, while increasing expenditure on US imports, including consumption goods and services. This would narrow the imbalance, but suggests an ambiguous effect on macroeconomic welfare, with the impact on national income offsetting the impact on consumption. Meanwhile, the opposite occurs in the United States, yielding an ambiguous effect on macroeconomic welfare there as well since national income rises and private consumption falls.

Secondly, the impact of US tariffs in response to Chinese subsidies, followed by Chinese countertariffs, was shown to unambiguously worsen macroeconomic welfare in China and the United States via both the national income and consumption channels, without narrowing the external imbalance. Hence, this measure fails on

Table 1.1 Policy options for narrowing the China-US trade imbalance

	Macroeconomic welfare		*Trade imbalance*
Effect on	China	US	
Policy measure			
Real exchange rate adjustment	?	?	↓
Higher US tariffs	↓	↓	?
Higher Chinese consumption	↑	↑	↓
Chinese foreign investment liberalization	↑	↑	↓

both counts and should be denied as a policy option for either narrowing the imbalance or improving macroeconomic welfare in either or both countries.

Thirdly, and alternatively, policy initiatives that encourage higher private consumption in China, for instance, by improving the social safety net, would increase Chinese expenditure relative to output, lower private saving, and narrow the trade imbalance. This option, consistent with the aim of China's 12th 5-Year Plan to reorient the economy more toward consumption, also improves Chinese macroeconomic welfare in terms of living standards. At the same time, increased private consumption in China would induce greater US production for export to China, thereby increasing US national income and US macroeconomic welfare.

Finally, liberalizing restrictions on US FDI in China would increase total investment and hence expenditure in China relative to its short run output, thereby narrowing the external imbalance. By enlarging China's capital stock, higher foreign investment also subsequently generates higher Chinese national income. Meanwhile, additional US investment in China generates higher US national income to the extent the return on US capital invested in China exceeds the return on that capital otherwise invested in the United States, consistent with neoclassical foreign investment theory. Hence, increased US FDI in China unambiguously narrows the bilateral imbalance while generating mutual macroeconomic welfare gains for both countries.

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Chapter 2
Does Carbon Emission Reduction Affect Corporate Performances: Evidence from China

Shaolong Tang, Yueying Cao, Xiaoyue Zhang, and Wenjie Wang

Abstract Stakeholders including managers, shareholders, customers, suppliers, communities, and government have raised increasing concerns about corporate social responsibilities (CSR). The objective of this research is to examine the impact of environmental performances measured by percentage change of carbon emissions on corporate operating and financial performances. We collect data from China and Hong Kong SAR about carbon emission records at individual company level. This study adds a forward 1-year lag effect on dependent variables measuring corporate performances. We incorporate company size, leverage ratio, sales growth rate, sector, and location as control variables. By conducting random-effect panel data analysis, the results show that carbon reductions enhance corporate operational and financial performances measured by ROA and Tobin's q, respectively. Our work suggests that the environmental efforts would result in better managerial decision-making and be compensated by higher profitability in the immediately following year.

Keywords Environmental performance · Fossil fuels · Return on equity · Return on asset · Tobin's q · Willingness to communicate

1 Introduction

Global climate change is one of the greatest challenges that humans face at this time. As a bottom line in corporate social responsibility, environmental responsibility initiates corporations to implement environmental-friendly practices to achieve

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sustainability, such as launching recycling programs, investing in R&D, and investing in green equipment. In fact, many companies in the world are committing reducing carbon emission amounts to fulfill their corporate social responsibility in recent years. For example, Apple Company has reduced carbon emissions per product every year since 2011, from 137.2 kg in 2011 to 114.2 kg in 2015; it has also lowered emissions from facilities to 1% of the comprehensive carbon footprint (Environmental Responsibility Report 2016). These efforts improve stakeholders' perspectives on how they value these companies, as most of stakeholders believe that benefits to the environment and benefits to the corporation itself go hand in hand. For example, customers are likely to support companies whose production process is green; employees gain more psychological satisfaction in an eco-friendly workplace; the government is in favor of those companies which take the lead to sustainable practice and behave under the instructions of relevant regulations. However, profit maximization whenever possible, as a goal for most companies, may sometimes not be in line with environmental responsibilities, and stakeholders who pursue short-term returns also affect managers' decisions regarding environmental protection. In heavy industries, manufacturing activities, such as the burning of fossil fuels, the discharges of chemical waste, and the exploiting of oil, generate a large amount of carbon emissions. Although companies may have incentives to reduce carbon emissions, they concern about the associated cost. While sustainability and the resurgence of environmentalism are driving global business to minimize negative impacts on the environment (Pearce and Robinson 2014), companies in special situations face the dilemma of balancing economic responsibility and environmental responsibility.

This research is to examine the relationship between carbon emission reduction and corporate performances. We collect data from listed companies in China and Hong Kong SAR, which release the information of carbon emission, and construct empirical models to examine the impact of carbon emission reduction on corporate financial performance.

2 Literature Review

Prior studies focus on the impacts of environmental responsibilities on corporate financial performances. Many of them have found that good environmental performance and good financial performances go hand in hand. Al-Tuwaijri et al. (2004) find that the environmental performance is significantly related to financial performances. The study uses a quantitative measure of the ratio of toxic wastes recycled to total toxic waste as an indicator of environmental performance and profit margin as an indicator of financial performances. Boiral et al. (2012) also prove that there is a win-win rational between GHG performance and financial performance. Another study examining stock price changes and environmental performance shows that the

stock price of firms reacts differently according to firm's environmental management ranking. Gallego-Álvarez et al. (2015) find that a reduction in emissions generates higher financial performance for companies, although no evidence has proven that it would improve operational performance. The U-shape indicates that the carbon performance has a positive effect on corporation's financial performance to a certain level, and then the marginal benefits of reducing carbon emissions do not offset marginal cost (Misani and Pogutz 2015). However, some researchers have found contrary outcomes. Wang et al. (2014) present a positive correlation between greenhouse gas emissions and corporate financial performance using samples from Australian companies, which could be explained by the unique background of the country. Whalley and Walsh (2009) hold a view that companies who have made efforts to reduce emissions balanced economic costs with environmental gain, so that the companies may compromise other commitments. A study conducted by Dragomir (2012) has reached an interesting result that return on equity (ROE) of large representative companies is a significantly positive relation to increases in pollution levels (GHG level), although there is a limitation of unobservable country differences. Schaltegger and Synnestvedt (2002) explain that difference in the results of the relationship between environmental performance and financial performance may be caused by different data sets used and a lack of a clear theoretical framework to investigate the relationship.

3 Empirical Models, Variables, and Sample

3.1 Empirical Models

Environmental strategies on carbon emission reductions are competitive advantages for a firm and can lead to improved financial performance in near future (Boiral et al. 2012). Previous studies have found that poor environmental performances negatively influence firm's corporate performances. Based on the literature review mentioned above, we propose that increasing carbon emissions have negative impacts on financial performances measured by ROE (King and Lenox 2002; Gallego-Álvarez et al. 2015) and Tobin's q (King and Lenox 2002; Delmas et al. 2015). Moreover, carbon reductions exert positive impacts on ROA, a proxy for operational performances (Hart and Ahuja 1996).

Pollution is a sign of operational inefficiency, while pollution control saves costs from compliance and liability and then increases efficiency and profitability (Rooney 1993). Hart and Ahuja (1996) find that carbon reductions enhance operational and financial performance in the immediately following year. Actually, there are some time lags between the efforts on carbon reduction control and the gains from the "bottom line." Firstly, substantial initial investments on equipment and employee training for pollution prevention practices could encroach the revenues in the same

year. Efficiency and productivity would be realized after a better utilization of inputs with less raw materials and waste disposal costs. Second, firms require time to renegotiate with suppliers, conduct new pollution disposal contracts, and reorganize internal management before benefiting from pollution reductions. Since firms require fewer raw materials for productions and operations, the amount of supply should be adjusted to a lower inventory level. Similarly, for ROE and Tobin's q, market value would increase only after shareholders, and investors have noticed the pleasant outcomes of a firm's environment protection approaches. According to Misani and Pogutz (2015), a forward 1-year lag effect of ROE and Tobin's q is appropriate to add in the model. For statistical reasoning, lagging effects can avoid endogeneity issues since financial performances could also be a cause for firms to reduce carbon emissions. Therefore, the following three hypotheses are formulated on examining the impact of the increasing percentage change of carbon emissions on firms' corporate performances (ROE, ROA, Tobin's q):

H1: The carbon emission has negative impacts on the firm's operational performance measured by ROA in the next year.
H2: The carbon emission has negative impacts on the firm's financial performance measured by ROE in the next year.
H3: The carbon emission has negative impacts on the firm's financial performance measured by Tobin's q in the next year.

Then three models are given as follows:

Model 1:

$$\begin{aligned} ROA_{i,t} =& \beta_0 + \beta_1 \triangle \mathrm{CO2\%_{i,t-1}} + \beta_2 SIZE_{\mathrm{i,t}} + \beta_3 Sector_{\mathrm{i,t}} \\ &+ \beta_4 LEVERAGE_{i,t} + \beta_5 GROWTH_{i,t} \\ &+ \beta_6 LOCATION_{i,t} + \epsilon \end{aligned}$$

Model 2:

$$\begin{aligned} ROE_{i,t} =& \beta_0 + \beta_1 \triangle \mathrm{CO2\%_{i,t-1}} + \beta_2 SIZE_{\mathrm{i,t}} \\ &+ \beta_3 Sector_{i,t} + \beta_4 LEVERAGE_{i,t} \\ &+ \beta_5 GROWTH_{i,t} + \beta_6 LOCATION_{i,t} + \epsilon \end{aligned}$$

Model 3:

$$\begin{aligned} \mathrm{Tobin's\ q_{i,t}} =& \beta_0 + \beta_1 \triangle \mathrm{CO2\%_{i,t-1}} + \beta_2 \mathrm{SIZE_{i,t}} \\ &+ \beta_3 \mathrm{Sector_{i,t}} + \beta_4 \mathrm{LEVERAGE_{i,t}} \\ &+ \beta_5 \mathrm{GROWTH_{i,t}} + \beta_6 \mathrm{LOCATION_{i,t}} + \epsilon \end{aligned}$$

3.2 Variables

In this research, we use ROA, ROE, and Tobin's q to measure corporate performances. All the financial information of each firm in 2012 and 2013 has been collected from China Stock Market and Accounting Research Database (CSMAR database). The definition of variables can be found in Table 2.1.

3.3 Sample Selection

We have collected the carbon dioxide emissions (CO2) from the Carbon Disclosure Project (CDP) website. The sample consists of 8 firms from Hong Kong SAR and the other 31 from mainland China during the period 2012–2013. The companies are from seven energy-extensive industries with highest CO2 emissions, including air transportation, chemicals, construction materials, electrical equipment and machinery, food and beverage processing, forest and paper products, as well as iron and steel. (In the Appendix, we list the companies in our sample.)

Table 2.1 Definition of variables

Variable name	Variable type	Variable definitions	Measurement scale
Return on asset (ROA)	Dependent variable	Accounting-based financial performance measured by the ratio between earnings before interest and total assets	Numerical
Return on equity (ROE)	Dependent variable	Accounting-based operational performance measured by the ratio between earnings before interest and shareholder's equity	Numerical
Tobin's Q	Dependent variable	Market-based financial performance measured by total market value divided by total asset value	Numerical
△CO2%	Independent variable	Percentage change of each firm's CO2 emissions	Numerical
Growth	Control variable	Annual change of firm's sales	Numerical
Size	Control variable	Natural log of total asset	Numerical
Sector	Control variable	Representatives of company sector by using numbers	Dummy
Leverage	Control variable	Ratio between total debt and total asset	Numerical
Location	Control variable	Equal to 0 for mainland China listed companies and 1 for Hong Kong SAR listed companies	Dummy

4 Empirical Results

We first conduct redundant fixed effect tests to determine the appropriateness to construct panel data in this phenomenon. The Chi-square tests suggested that the null hypotheses are rejected for three models. In other words, the pooled OLS methods should be used (Prob. chi-square < 0.05). Besides, separated from time series and cross-sectional data, fixed or random effects have to be determined for panel data since they rely on contradictory assumptions. Fixed effect estimation is more conservative by considering each α_i as a specific constant (e.g., intercept) to each firm. Thus, fixed effect estimation takes advantages on controlling all time-invariant unobserved firm-level characteristics, which would otherwise mitigate the explaining power of independent variables.

Random effect estimation assumes that variables are nonrandom and not correlated with independent variables. It can generate more efficient coefficients with low variance of the estimate when there is no correlation between explanatory variables and the fixed effects. Our regression analysis is based on panel data of 39 horizontal-level observations from 2012 to 2013. For this panel, random effect models are adopted for three hypotheses. Hausman tests have suggested that random effect estimations are more appropriate (Prob>chi-square > 0.05). The null hypothesis for Hausman test is that all exogenous variables are uncorrelated with all disturbance terms, which means firm-level heterogeneity and independent variables are not correlated. When it fails to reject the null hypothesis, random effects should be adopted for higher degree of efficiency in the estimation (Table 2.2).

In conclusion, operational performance measured by ROA and market-based financial performance measured by Tobin's q increase as carbon emissions reduce. Therefore, H1 is supported at 95% confidence level, while H2 should be rejected for the period covered in this study, since carbon emission reductions do not influence market-based financial performance.

5 Conclusion

What we have found from this research is that corporate environmental performance is significantly affecting firms' financial performances. While it could be said that "it pays to be green" (Ghisetti and Rennings 2014), the result suggests that the efforts of reducing carbon emissions will be compensated by higher profitability. However, this effect might only take place for firms who invest in green technologies to better utilize resources and energies. As explained in our earlier discussion, green management takes a major part in deciding the level of innovations a firm is willing to explore. Investing more in R&D may lead to a higher return from tangible assets, which contributes to making the best of the resources and turning them into better corporate performances. More importantly, firms that take social responsibilities will gain support from intangible assets including human resources and organizational

Table 2.2 Results of empirical analysis

Random effects	Dependent variables					
Independent variables	Model 1 ROA		Model 2 ROE		Model 3 Tobin's q	
	Coefficient	P value	Coefficient	P value	Coefficient	P value
△CO2 % (−1)	**−0.0027**	**0.0177**∗∗	−0.0010	0.6116	**−0.0221**	**0.0000**∗∗∗
Leverage	**−0.1887**	**0.0000**∗∗∗	**−0.2030**	**0.0000**∗∗∗	**0.0634**	**0.0314**∗∗
Location	**0.0243**	**0.0002**∗∗∗	**0.0762**	**0.0004**∗∗∗	**0.2720**	**0.0009**∗∗∗
Sector	**0.0109**	**0.0001**∗∗∗	0.0022	0.3323	0.0279	0.1073
Size	**−0.0006**	**0.0000**∗∗∗	0.0014	0.1294	**−0.0370**	**0.0000**∗∗∗
Growth	0.0136	0.2399	**0.0327**	**0.0245**∗∗	**−0.0515**	**0.0316**∗∗
C	0.1060	0.0000	0.1303	0.0000	0.2468	0.0000
R-squared	0.1359		0.1814		0.2858	
Prob.(F-statistics)	0.0110		0.0022		0.0000	
Durbin-Watson stat	1.7847		1.6885		2.4357	
Number of firms	39		39		39	
Observations	78		78		78	

Note: Significant coefficients are in bold. ∗p value<0.1 and significant at 10%, ∗∗p value<0.05 and significant at 5%, ∗∗∗p value<0.01 and significant at 1%
ROA Hausman test Chi-square = 0.561; ROE Hausman test Chi-square = 0.065; Tobin's q Hausman test Chi-square = 0.453; Models with random or fixed effects are shown, depending on the value obtained for Hausman's test
△CO2 % (−1) is the 1-year lag of percentage change of carbon emissions; ROA is the return on asset; ROE is the return on equity

capabilities. Employees will devote more efforts to a firm with high operating ethics, utilizing what they have to outperform than their competitors. Meanwhile, a corporate culture around saving energy will positively influence the production and delivery process. Eventually, the firm's value will be recognized by its stakeholders.

The result may also give insight to policy makers. The "win-win" situation in which reducing the pollution leads to improved firms' economic performances indicates that adoption of a strict environmental regulation is even more important than the firm's own efforts. Although there is a possibility that government regulations may pose stress on companies' development, the sustainability of the economy counts largely on the governments' tighten policies on carbon emissions. Comparing results in this research between mainland China and Hong Kong SAR, it is shown that the latter one has more statistical significance. One of the possible reasons may be because listed companies in Hong Kong SAR are requested to disclose carbon emissions in their annual reports. As an indicator of corporate social responsibility, environmental responsibility is thought highly by stakeholders. If a corporation has shown progress in carbon emission reductions, its shareholders would be more loyal and supportive. Thus, the company will have more incentive to reduce pollution. In fact, foreign governments and institutions have published relevant laws to enforce companies to fulfill their environmental responsibilities. For example, the European Council adopted the Directive on disclosure of environmental matters to improve transparency of large companies (European Commission Statement 2014). The UK also requested quoted companies to state the annual quantity of emissions in the directors' report. By contrast, in mainland China, listed companies' disclosure of emissions is mostly voluntary. Hence, policy makers in China should consider how to improve transparency of companies' environmental behaviors. Other relevant regulations to constrain carbon emissions, such as assigning certain emission quotas or imposing a carbon tax, should also be discussed wisely. Beside, more efforts are needed to raise the awareness of the seriousness of the rising carbon emissions. Policy makers should push the whole society to achieve sustainability as a long-term blueprint.

Our study shows that reducing carbon emissions will have significant positive impact on corporate performances. By extracting data from annual reports of companies in mainland China and Hong Kong SAR and using E-views software to test three linear regression models, this report reveals that the increased percentage change of carbon emissions has a negative impact on ROA and Tobin's q, but not on ROE. While the win-win effect can be explained by the effect of innovations, green management, governmental environmental strategies, and the support from stakeholders, certain limitations of this research draw upon necessity for further research. Nevertheless, the results show that it is worthy for companies to take proactive strategies in reducing carbon emissions.

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Appendix

Sample of companies

Number	Company	Ticket symbol	Industry
1	Air China Limited	753 HK	Air transportation – Airlines
2	Anhui Annada Titanium Industry Co Ltd	002136 CH	Chemicals
3	Anhui Conch Cement	914 HK	Construction materials
4	BBMG Corporation	601,992 CH	Construction materials
5	Beijing Dabeinong Technology Group	002385 CH	Forest and paper products – Forestry, timber, pulp and paper, rubber
6	China Eastern Airlines Co., Ltd.	670 HK	Air transportation – Airlines
7	China Hongqiao Group Ltd	1378 HK	Mining – Iron, aluminum, other metals
8	China Resources Enterprise	291 HK	Food and staples retailing
9	China Shanshui Cement Group Limited	691 HK	Construction materials
10	China Southern Airlines Company Limited	600,029 CH	Air transportation – Airlines
11	China Tianrui Group Cement Co Ltd	1252 HK	Construction materials
12	Fujian Minfa Aluminum Co Ltd	002578 CH	Mining – Iron, aluminum, other metals
13	Guangdong Delian Group Co Ltd	002666 CH	Chemicals
14	Henan Billions Chemicals Co Ltd	002601 CH	Chemicals
15	Henan Zhongfu Industry Co Ltd	600,595 CH	Mining – Iron, aluminum, other metals
16	Hengyi Petrochemical Co Ltd	000703 CH	Chemicals
17	Inner Mongolia Xingye Mining Co Ltd	000426 CH	Mining – Iron, aluminum, other metals
18	Jiangxi Black Cat Carbon Black Co Ltd	002068 CH	Chemicals
19	Jiangxi Copper Company Limited	600,362 CH	Mining – Iron, aluminum, other metals
20	Kweichow Moutai	600,519 CH	Food and beverage processing
21	Qinghai Salt Lake Industry	000792 CH	Chemicals
22	Shandong Chenming Paper Holdings Limited	000488 CH	Forest and paper products – Forestry, timber, pulp and paper, rubber
23	Shandong Huatai Paper Co Ltd	600,308 CH	Forest and paper products – Forestry, timber, pulp and paper, rubber
24	Shandong Nanshan Aluminum Co Ltd	600,219 CH	Mining – Iron, aluminum, other metals

(continued)

Number	Company	Ticket symbol	Industry
25	Shenzhen Zhongjin Lingnan-A	000060 CH	Mining – Iron, aluminum, other metals
26	SINOPEC Shandong Taishan Petroleum Co. Ltd.	000554 CH	Chemicals
27	Suzhou Tianma Specialty Chemicals Co Ltd	002453 CH	Chemicals
28	Tangshan Jidong Cement Co-A	000401 CH	Construction materials
29	Tiangong International Co Ltd	826 HK	Mining – Iron, aluminum, other metals
30	Tongling Nonferrous Metals-A	000630 CH	Mining – Iron, aluminum, other metals
31	Tongyu Heavy Industry Co Ltd	300,185 CH	Electrical equipment and machinery
32	Tsingtao Brewery Company Limited	168 HK	Food and beverage processing
33	Wuhan Iron and Steel (A)	600,005 CH	Mining – Iron, aluminum, other metals
34	Wuliangye Yibin Co Ltd-A	000858 CH	Food and beverage processing
35	Yunnan Aluminium Co-A	000807 CH	Mining – Iron, aluminum, other metals
36	Yunnan Chihong Zinc & Germanium Co Ltd	600,497 CH	Mining – Iron, aluminum, other metals
37	Yunnan Coal Energy Co Ltd	600,792 CH	Chemicals
38	Yunnan Copper Industry Co-A	000878 CH	Mining – Iron, aluminum, other metals
39	Zibo Qixiang Tengda Chemical Co Ltd	002408 CH	Chemicals

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Chapter 3
Return and Asymmetric Volatility Transmissions Between Main Stock Market and Second-Tier Stock Market: The Case of Hong Kong

Trang Nguyen, Taha Chaiechi, Lynne Eagle, and David Low

Abstract This study aims to investigate the dynamic return and asymmetric volatility transmissions between the main stock market and the Growth Enterprise Market in Hong Kong. Unlike previous studies, this study examines the cross-market transmissions under the joint impacts of volatility breaks, thin trading, and trading volume. A linear state-space AR model with Kalman filter estimation and an augmented bivariate VAR asymmetric BEKK-GARCH model are employed for empirical analysis. The results determine that under the joint impacts of volatility breaks, thin trading, and trading volume, a unidirectional return transmission from the GEM to the main market survives with the diminishing magnitude and significant level. However, the underlying volatility transmission from the GEM to the main market, in essence, is eliminated. This paper aims to be a *proof of concept* to provide sufficient evidence of methodological viability, which can then be used in larger-scale research or replicated in new settings.

Keywords Return and asymmetric volatility transmissions · Volatility break · Thin trading · Trading volume · Augmented bivariate VAR asymmetric BEKK-GARCH

1 Introduction

Being legally structured as a separate board under the main stock markets, second-tier stock markets have been acting as an alternative financing source to bank lending for small and medium enterprises (SMEs). The second-tier markets provide a

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platform for SMEs to raise long-term equity capital without waiving majority control and to improve market visibility and credit rating. The second-tier markets can be seen as a pathway for SMEs to be listed in the main market, thereby increasing the liquidity of the main market (Harwood and Konidaris 2015). In 2015, the World Federation of Exchanges had recognized second-tier stock markets as one of the critical components in the financing ecosystem for SMEs. Since the 1990s, an increasing number of second-tier markets have been established in different part of the world, reaching a total of 51 markets in 2016, of which nearly a quarter are located in Asia.

In spite of the importance of the second-tier stock markets for SME finance and their growing establishments worldwide, they have largely been under-researched. Specifically, the dynamic interactions between the main markets and the second-tier markets have yet been investigated in the finance literature. On the other hand, several studies have provided evidence of the dynamic impacts of the main market returns and volatility on economic development in both developed and emerging economies. Therefore, such investigation could potentially provide further knowledge about an indirect impact of the second-tier markets to economic development via return and volatility transmissions with the main markets.

Moreover, the transmissions of return and volatility between small and large stock markets can be affected by a number of factors such as volatility breaks (i.e., the structural changes in unconditional variance), thin trading, and trading volume. Lamoureux and Lastrapes (1990b) postulated that in the presence of volatility breaks in return series, the underlying volatility persistence can be overestimated by a standard Generalized Autoregressive Conditional Heteroscedastic (GARCH) process. Lo and MacKinlay (1990) placed emphasis on spurious autocorrelation in return series due to the issue of thin trading that occurs when stocks are traded at low volume. Gallo and Pacini (2000) showed evidence of the reducing or eliminating effect of trading volume on volatility persistence. While the research on dynamic transmissions between small- and large-cap stock portfolios are extensive, very few of them controlled for the effects of either volatility breaks or trading volume. Therefore, this calls for further examination of cross-market transmissions under the joint impacts of volatility breaks, thin trading, and trading volume. Failure to account for these impact factors may lead to biased estimation of the cross-market transmissions.

Accordingly, this study is intended to explore the dynamic return and asymmetric volatility transmissions between the main markets and the second-tier markets under the joint impacts of volatility breaks, thin trading, and trading volume. Hong Kong stock markets are selected as a case study due to their critical role in the global financial markets. For decades, Hong Kong Stock Exchange (HKEX) has developed into the world's sixth largest stock market and the third in Asia, mobilizing capital to several multinational companies and conglomerates. The Growth Enterprise Market (GEM), established by the HKEX in 1999, has also emerged as one of the world's most successful examples of a second-tier stock market for SMEs (Peterhoff et al. 2014). In fact, since its establishment to 2016, the GEM has successfully raised

around USD22.7 billion through IPOs and SPOs[1]. In 2015, the funds raised through the GEM peaked at USD2.8 billion, which is equivalent to a significant 27.9% of the SME credit gap in Hong Kong.

This study is unique in its way of being the first to explore the dynamic return and asymmetric volatility transmissions between a main stock market and a second-tier stock market. Different from previous studies, this study examines these cross-market transmissions under the joint impacts of volatility breaks, thin trading, and trading volume. Additionally, this study further contributes to the existing empirical models by augmenting a standard VAR asymmetric BEKK-GARCH model with volatility break dummies and aggregate trading volume variable.

2 Literature Review

A large body of literature on the causality and long-term relationship between the main stock market returns and economic development has emerged since the 1990s. Several studies have shown the presence of these relationships in both advanced and emerging economies, for example, see Lee (1992), Choi et al. (1999), Nasseh and Strauss (2000), Mauro (2003), and Forson and Janrattanagul (2014). As for Hong Kong, these relationships were also confirmed in the studies of Henry et al. (2004), Tang et al. (2008), Liu and Sinclair (2008), and Mahmood and Dinniah (2009). Moreover, the evidence of reciprocal spillover between stock market return volatility and macroeconomic volatility was also found to be significant in emerging and developed markets. For instance, one can refer to the studies of Liljeblom and Stenius (1997), Caporale and Spagnolo (2003), Ahn and Lee (2006), Kanas and Ioannidis (2010), and Guo (2015).

On the other hand, most second-tier stock markets are legally structured as a separate board under the main stock market. As such, the second-tier markets are considered as a liquidity pump for the main markets by supplying potential listings to the main markets. In return, the second-tier markets can benefit from the reputation and credentials of the main markets and are able to maintain low costs for listings and trading (Harwood and Konidaris 2015). Legally, the main markets are classified as regulated markets, which are administered by the national securities regulators and comply with stricter requirements for listing and information disclosure. The second-tier markets are classified as alternative trading platforms, which are controlled by the management of the regulated market, also known as a regulated market operator, and conform to less stringent regulations.

Accordingly, the dynamic influence of the main market return and volatility on economic development and the legal relationship between the main markets and the second-tier markets are well-documented in the existing literature. Arguably, the second-tier markets could potentially contribute to economic development via the

[1]IPOs is Initial Public Offerings, and SPOs is Secondary Public Offerings.

transmissions of return and volatility across the main market channel. However, the dynamic transmissions between the two markets have never been investigated.

Turning now to the literature on factors that can affect the cross-market transmissions of return and volatility. Some of the factors are known to be volatility breaks, thin trading, and trading volume. Lamoureux and Lastrapes (1990b) postulated that the persistence of volatility can be overestimated by a standard GARCH process if one fails to account for the structural breaks in unconditional volatility. Hillebrand (2005) provided solid evidence on the strong bias toward unity of the summations of the estimated ARCH and GARCH parameters when breaks in the unconditional volatility are neglected. Ewing and Malik (2005) argued that if structural shifts in unconditional variance of one series can affect the volatility persistence in the series itself, then they may also affect the volatility persistence across two series. In addition, the presence of structural breaks in unconditional variance can give rise to volatility asymmetry and volatility clustering.

Dimson (1979) and Lo and MacKinlay (1990) placed emphasis on thin trading-instigated autocorrelation in the return series, which may cause bias in the cross-market transmissions of return and volatility. To adjust for thin trading, Miller et al. (1994) proposed to use a fixed AR coefficient; however, this method is unsuitable for newly established markets which are likely to be highly volatile. Later, to solve this problem, Harrison and Moore (2012) suggested using a time-varying AR coefficient, which is estimated by a state-space AR model with Kalman filter. Kuttu (2014), in his empirical study on the dynamic transmissions between the African stock markets, asserted that neglect of adjusting for thin trading can induce inconsistent and unreliable model estimation.

Clark (1973) introduced the Mixture of Distributions Hypothesis, stating that return volatility and trading volume are determined simultaneously by a stream of information. By contrast, Copeland (1976) proposed the Sequential Information Arrival Hypothesis, positing that given the sequential response of traders to information, return volatility can be predicted from trading volume information. Empirically, Lamoureux and Lastrapes (1990a), Gallo and Pacini (2000), and Girard and Biswas (2007) found the reducing or eliminating effect of trading volume on volatility persistence in many developed and emerging stock markets. Chakraborty and Kakani (2016) underlined the role of trading volume in providing endogenous dynamic information that evolves together with return volatility.

Furthermore, the studies of McQueen et al. (1996), Harris and Pisedtasalasai (2006), Karmakar (2010), and Hung and Lin (2013) are among the voluminous studies on return and volatility transmissions between different size stock portfolios. However, a very few studies in this body of literature controlled for the effects of either volatility breaks or trading volume. For example, Ewing and Malik (2005) showed that volatility breaks significantly weaken the volatility spillover and, in some instances, wipe out the spillovers between the small- and large-cap stocks in New York and American stock markets. Koulakiotis et al. (2016) reported volatility transmissions with a feedback effect among the large-, medium-, and small-cap stocks in the Athens stock market. Accordingly, the joint impacts of volatility

breaks, thin trading, and trading volume on return and volatility transmissions between size-based stock portfolios have yet to be explored.

3 Empirical Models

As discussed previously, the objective of this paper is to examine the dynamic transmissions of return and asymmetric volatility between the main stock market and the GEM in Hong Kong under the joint effects of three factors: volatility breaks, thin trading, and trading volume. Failure to account for these factors may lead to overestimated volatility persistence. To test the presence of volatility breaks, the iterated cumulated sum of squares (ICSS) algorithm was employed. To avoid the thin-trading-induced autocorrelation, the GEM return series were adjusted for thin trading using a state-space AR model with Kalman filter estimation. The de-thinned return series, the dummy series indicating volatility breaks, and the aggregate trading volume series were then integrated into an augmented bivariate VAR asymmetric BEKK-GARCH model to examine the cross-market dynamic transmissions. The econometric models and techniques used in this paper are described in the following sections.

3.1 Iterated Cumulative Sum of Squares (ICSS) Algorithm

Introduced by Inclan and Tiao (1994), the ICSS algorithm is used to identify multiple structural breaks in the unconditional variance of returns (volatility breaks). Initially, the cumulative sum of squared observations from the beginning of the residual series (ε_t) obtained from the AR(1) process of the GEM return series (R_{2t}) to the k^{th} point in time is determined as follows:

$$C_k = \sum_{t=1}^{k} \varepsilon_t^2, for\ k = 1, 2, \ldots, T \tag{3.1}$$

The statistic D_k is then defined as

$$D_k = \left(\frac{C_k}{C_T}\right) - \frac{k}{T}, with\ D_0 = D_T = 0 \tag{3.2}$$

where C_T is the cumulative sum of squared observations for the entire sample.

When plotting the D_k against k, it is a horizontal line. If there are volatility breaks, the statistic D_k will deviate from zero; otherwise, it will oscillate around zero. When the maximum absolute value of D_k, $\left\{\max_k \sqrt{T/2}|D_k|\right\}$, is greater than the critical values obtained from the distribution of D_k, the null hypothesis of constant variance

is rejected. Consequently, the $k*$, which is the value at which $max_k|D_k|$ is reached, is an estimate of volatility breakpoint.

3.2 Linear State-Space AR Model with Kalman Filter Estimation

To de-thin the GEM return series (R_{2t}), the linear state-space AR(1) model (Harvey 1989; Hamilton 1994; Koopman et al. 1999) with a Kalman filter estimation (Kalman and Bucy 1961) was employed. The model captures the dynamics of AR (1) parameter overtime and can be written as

$$R_{2t} = \beta_0 + \beta_{1t} R_{2,t-1} + e_t \tag{3.3}$$

$$\beta_{1t} = \beta_{1t-1} + v_t \tag{3.4}$$

where e_t and $v_t \tilde{N}\left(0, \sigma_t^2\right)$. Eq. (3.3) is the space equation, representing the time-varying AR(1) parameter (β_{1t}). Equation (3.4) is the state equation, using a Kalman recursive filter to estimate the dynamics of AR(1) parameter. Kalman filter basically is a recursive algorithm to estimate one-step-ahead parameter sequentially to generate a set of β_{1t} and the corresponding standard deviations over time. Alternatively, Kalman filter estimates the unknown parameter (β_{1t}) by producing a set of measurements observed over time. The time path of β_{1t} parameter represents the time-varying adjustment for thin trading.

Following Harrison and Moore (2012), de-thinned GEM return series (R_{2t}^d) is obtained by the following equation:

$$R_{2t}^d = \frac{e_t}{1 - \beta_{1t}} \tag{3.5}$$

where time-varying coefficient (β_{1t}) and residuals (e_t) were extracted from the linear state-space AR(1) model.

3.3 Augmented Bivariate VAR Asymmetric BEKK-GARCH Model

To access the joint effects of three factors volatility breaks, thin trading, and trading volume on the dynamic transmissions between the main market and the GEM, a standard bivariate VAR asymmetric BEKK-GARCH model was augmented. Specifically, together with the main market return series (R_{1t}), the de-thinned GEM return series (R_{2t}^d) was used to run the mean equation A set of dummies for volatility breaks in the two markets was included in variance equation. In addition, the

Table 3.1 Hong Kong stock markets (2016)

Main market – Second-tier market	HKEX	GEM
Market opened	1986	1999
No. of listed companies	1713	260
Representative index	HSI	GEM
Market capitalization[a]	1720.7	40.1
Percentage of GDP (%)	542.7%	12.6%
Percentage of main index (%)		2.3%
Trading value[a]	745.7	19.0
Percentage of main index (%)		2.5%
Trading volume[b]	424.7	231.9
Percentage of main index (%)		54.6%

Source: Exchange factbooks
Notes:
[a]in US$ billion
[b]in billion shares; HSI is Hang Seng Composite Index; GEM is Growth Enterprise Market Index

aggregate trading volume series of the two markets was incorporated in both mean and variance equations. The aggregate volume series is used instead of individual volume series mainly because the idiosyncratic buying or selling pressure does not create systematic risk for market makers (Campbell et al. 1993). Moreover, using a single aggregate volume series also addresses the issue of large disparity in trading volume between the main market and the GEM (see Table 3.1). Gallant et al. (1992), Hussain (2011), and Koulakiotis et al. (2016) are some of the proponents of this approach.

Accordingly, our augmented model can be expressed in the following mean and variance equations:

$$\begin{pmatrix} R_{1t} \\ R^d_{2t} \end{pmatrix} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} + \begin{pmatrix} \varphi^1_{11} & \varphi^1_{12} \\ \varphi^1_{21} & \varphi^1_{22} \end{pmatrix} \begin{pmatrix} R_{1,t-1} \\ R^d_{2,t-1} \end{pmatrix} + \cdots + \begin{pmatrix} \varphi^p_{11} & \varphi^p_{12} \\ \varphi^p_{21} & \varphi^p_{22} \end{pmatrix} \begin{pmatrix} R_{1,t-p} \\ R^d_{2,t-p} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} + \begin{pmatrix} \gamma_1 \\ \gamma_2 \end{pmatrix} ATV_t \tag{3.6}$$

$$H_t = C'C + A'\left(\varepsilon_{t-1}\varepsilon'_{t-1}\right)A + B'H_{t-1}B + D'\left(\kappa_{t-1}\kappa'_{t-1}\right)D + \sum\nolimits_{i=1}^{n} V'_i\left(X_i X'_i\right)V_i + T'ATV_t T \tag{3.7}$$

where

- $\mu_i (i = 1, 2)$ denotes constants for the return series i (where 1 and 2 stands for the main market returns and the GEM returns, respectively).
- The diagonal parameters $\varphi^p_{ij} (i = j)$ gauge the effect of return spillover within individual return series (own return spillover).

- The off-diagonal parameters $\varphi_{ij}^{p}(i \neq j)$ quantify the effect of return spillover between return series (cross return spillover).
- $\varepsilon_{it}(i = 1, 2)$ denotes the innovation term (shock) for the return series i at day t.
- $\gamma_i(i = 1, 2)$ quantifies the impact of aggregate trading volume on the return spillover in return series i.
- ATV_t is the aggregate trading volume of the main market and the GEM at day t.
- C denotes a (2x2) lower triangular matrix of constants.
- A denotes (2x2) squared matrix of coefficients measuring the impact of past shocks on present volatility (short-run volatility spillover).
- B denotes (2x2) squared matrix of coefficients measuring the influence of past volatility on present volatility (long-run volatility spillover).
- D denotes (2x2) matrix of coefficients capturing the asymmetry of the conditional variance-covariance (asymmetric volatility spillover).
- H_{t-1} denotes a (2x2) conditional variance matrix.
- ε_{t-1} denotes a (2x1) vector of squared error terms and cross product of error terms.
- κ_{t-1} denotes a (2x1) vector of squared asymmetric terms and cross products of asymmetric terms.
- V_i is a (2x2) lower triangular matrix of parameters measuring the effect of volatility breaks on the conditional variance of return series i.
- T denotes (2x2) lower triangular matrix of parameters measuring the effect of aggregate trading volume on the conditional variance of return series i.
- X_i is a (1x2) vector of dummies for volatility breaks in return series i; if the series is subjected to a volatility break at time t, X_i will take a value of 0 before time t and a value of 1 from time t onwards; n is the number of breakpoints detected in variance.

Equation (3.7) can be expanded in the conditional variance equations for the main market ($h_{11,t}$) and the GEM ($h_{22,t}$) as follows:

$$\begin{aligned} h_{11,t} = {} & c_{11}^2 + b_{11}^2 h_{11,t-1} + 2b_{11}b_{21}h_{12,t-1} + b_{21}^2 h_{22,t-1} + a_{11}^2 \varepsilon_{1,t-1}^2 \\ & + 2a_{11}a_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{21}^2 \varepsilon_{2,t-1}^2 + \delta_{11}^2 \kappa_{1,t-1}^2 \\ & + 2\delta_{11}\delta_{21}\kappa_{1,t-1}\kappa_{2,t-1} + \delta_{21}^2 \kappa_{2,t-1}^2 + v_{11}X_1 \\ & + 2v_{11}v_{21}X_1X_2 + v_{21}X_2 + \tau_{11}ATV_{1t} \\ & + 2\tau_{11}\tau_{21}ATV_{1t}ATV_{2t} + \tau_{21}ATV_{2t} \end{aligned} \tag{3.8}$$

$$\begin{aligned} h_{22,t} = {} & c_{21}^2 + c_{22}^2 + b_{12}^2 h_{11,t-1} + 2b_{12}b_{22}h_{12,t-1} + b_{22}^2 h_{22,t-1} + a_{12}^2 \varepsilon_{1,t-1}^2 \\ & + 2a_{12}a_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + a_{22}^2 \varepsilon_{2,t-1}^2 + \delta_{12}^2 \kappa_{1,t-1}^2 + 2\delta_{12}\delta_{22}\kappa_{1,t-1}\kappa_{2,t-1} \\ & + \delta_{22}^2 \kappa_{2,t-1}^2 + v_{12}X_1 + 2v_{12}v_{22}X_1X_2 + v_{22}X_2 + \tau_{12}ATV_{1t} \\ & + 2\tau_{12}\tau_{22}ATV_{1t}ATV_{2t} + \tau_{22}ATV_{2t} \end{aligned} \tag{3.9}$$

Following Kearney and Patton (2000), the standard errors of these coefficients were computed using a first-order Taylor expansion of the function around its mean. This involves the estimated variance-covariance matrix of the coefficients together with vectors of the mean and standard error. Presuming errors follow a normal distribution, the model is estimated using the following maximum-likelihood function.

$$L(\theta) = -\frac{T}{2}\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\left(\ln|H_t| + \varepsilon_t' H_t^{-1}\varepsilon_t\right) \tag{3.10}$$

where T is the number of observations and θ is the vector of estimated coefficients.

4 Data

Daily index closing prices and trading volumes of the main markets and the GEM in Hong Kong were retrieved from Bloomberg Database from July 1, 2009, to December 30, 2016, yielding 1853 observations for this study. The main market and the GEM are represented by the following pair of indices: Hong Kong Hang Seng Composite Index (HSI) and S&P/HKEX GEM Index. The daily index series and volume series were screened for valid trading days before processing since there are many duplicates of non-trading days in the raw series. Two econometric software packages, RATS9.2 and Eviews10, were used for data analysis. The daily price series of the main markets and the GEM were transformed to daily log return series, R_{1t} and R_{2t}, respectively. The daily trading volume series of the main markets and the GEM were rescaled and combined into one single aggregate trading volume series (ATV_t).

Table 3.2 reports the characteristics of return and trading volume series of the main market and the GEM. Compared to the main market, the GEM's mean return series is negative but shows higher standard deviations, indicating no risk and return trade-off in this market. The main market return series has fatter tails and longer left tails compared to the Gaussian distribution due to negative skewness. In contrast, the aggregate trading volume series is highly positively skewed, suggesting that it exhibits fatter tails and much longer right tails than the Gaussian distribution. Large values of kurtosis indicate that all return and volume series are leptokurtic and have a sharp peak.

The Jarque and Bera (1980) statistics further confirm the non-normality in the return and volume distributions. The Ljung and Box (1979) Q and Q^2 statistics and the Engle (1982) ARCH statistics were significant, indicating the presence of autocorrelation and conditional heteroscedasticity in the mean and variance of the return and volume series. Thus, the return and volume series should be fit by a model that accommodates the ARCH/GARCH processes.

Table 3.2 Descriptive statistics

	R_{1t} (HSI)	R_{2t} (GEM)	ATV_t (HSI & GEM)
Obs.	1853	1853	1853
Mean	0.0001	−0.0003	0.0255
Median	0.0002	0.0003	0.0229
Std. Dev.	0.012	0.015	0.011
Skewness	−0.3	1.0	2.5
Kurtosis	5.0	75.3	13.8
Jarque-Bera	332∗	403,695∗	10,868∗
Q(10)	6.3	79.6∗	4614.0∗
Q(20)	27.4∗∗	108.9∗	6930.4∗
$Q^2(10)$	307.2∗	502.3∗	2829.7∗
$Q^2(20)$	514.8∗	509.6∗	4204.0∗
ARCH(5)	24.8∗	78.1∗	209.6∗
ARCH(10)	16.1∗	40.1∗	108.9∗

Notes: ∗, ∗∗ indicate that the test statistic is significant at 1% and 5%, respectively; R_{1t} and R_{2t} denote daily returns of the main market (represented by Hang Seng Index – HSI) and the GEM, respectively; ATV_t denotes daily aggregate traded volumes of the main market and the GEM (in 100 billion shares); JB represents Jarque-Bera statistic; Q and Q^2 are statistics of the Ljung-Box test for autocorrelation in return series and squared return series, respectively; ARCH represents the Engle's Autoregressive Conditional Heteroscedastic statistic

5 Preliminary Analysis

Initially, a set of unit root tests was performed to examine the stationarity of the return series and aggregate trading volume series of the main market and the GEM (see Appendix). Then, to identify the appropriate mean and variance models for the return series, tests of asymmetric return volatility and cross-correlations of returns and residuals were conducted. The presence of volatility breaks was also tested to determine whether a set of dummies for volatility breaks should be entered into the model. The preliminary test results are reported in the following subsections.

5.1 Asymmetric Return Volatility

The size and sign bias tests introduced by Engle and Ng (1993) were adopted to test for asymmetry in return volatility. Table 3.3 reports that the GEM exhibits both size bias and sign bias (negative and positive) in return volatility, while the main market shows only positive sign bias in return volatility. In spite of the inconsistency in the individual tests, the joint test of size and sign bias for the two market return series were significant, implying the presence of asymmetric return volatility. The results suggest that an asymmetric volatility model might fit the return series of the two markets.

Table 3.3 Test for asymmetry in return series

	R_{1t}	R_{2t}
Size bias (t-test)	0.03	2.37**
Negative sign bias (t-test)	0.63	5.40*
Positive sign bias (t-test)	2.16**	1.84***
Joint effect (F-test)	10.37**	33.51*

Notes: *, **, *** indicate that the test statistic is significant at 1%, 5% and 10%, respectively; R_{1t} and R_{2t} denote daily returns of the main market (represented by Hang Seng Index – HSI) and the GEM, respectively

Table 3.4 Cross-correlations of returns and residuals

Return cross-correlations	R_{1t}	R_{2t}
$R_{1,\,t-1}$	−0.008	−0.056
$R_{2,\,t-1}$	0.033	0.168
Residual cross-correlations	ε_{1t}	ε_{2t}
$\varepsilon_{1,\,t-1}$	−0.001	−0.001
$\varepsilon_{2,\,t-1}$	−0.005	−0.003

Notes: R_{1t} and R_{2t} denote daily returns of the main market (represented by Hang Seng Index – HSI) and the GEM, respectively; ε_{1t} and ε_{2t} denote residuals from estimates of VAR(1) process for daily returns of the main market and the GEM, respectively

5.2 Cross-Correlation of Returns and Residuals

To test for the cross-correlation of returns and residuals between the main market and the GEM, the procedure suggested by Conrad et al. (1991) was applied. Accordingly, the first-order lagged cross-correlation matrices of returns and residuals between the two markets were produced from a VAR(1) process. The results are displayed in Table 3.4, showing that the absolute values of the first lagged cross-correlations between the previous day's return on the main market ($R_{1,\,t-1}$) and the current day's return on the GEM (R_{2t}) were 5.6%. On the other hand, the absolute cross-correlations between the previous day's return on the GEM ($R_{2,\,t-1}$) and the current day's return on the main market (R_{1t}) were 3.3%. Moreover, the first lagged cross-correlations of the residuals of the VAR(1) process declined substantially. In particular, approximately 0.5% of variation in the residual of VAR(1) model for the main market return can be explained by that of the GEM lagged return, and 0.1% of variation in the residual of VAR(1) model for the GEM return can be explained by that of the main market lagged return.

Therefore, the presence of an asymmetric cross-correlation of returns between the two markets is confirmed. This is important because variations in the returns of each individual market may induce a different asymmetric effect on the cross-market correlation of returns. Consequently, a VAR process that incorporates asymmetric features might be a good fit for the returns of the main market and the GEM.

Table 3.5 Detected volatility breaks

Breakpoint	Corresponding event	Break regime	SD
Main market – HSI			
		02/07/2009–26/11/2009	0.016
27/11/2009	Dubai debt standstill due to a massive	27/11/2009–18/08/2010	0.013
	renovation projects and the Great Recession	19/08/2010–21/09/2011	0.012
22/09/2011	The US Federal Reserve's operation twist failed to	22/09/2011–18/02/2014	0.012
	calm financial markets after the crash in August	19/02/2014–30/12/2016	0.011
Second-tier market – GEM			
		02/07/2009–10/11/2010	0.013
11/11/2010	Chinese Central Bank announced an increase in	11/11/2010–08/07/2015	0.013
	the monetary policy rate	09/07/2015–21/08/2015	0.056
24/08/2015	Black Monday of Chinese stock market	24/08/2015–13/06/2016	0.017
		14/06/2016–30/12/2016	0.009

Notes: The usual 5% level of significance was used to detect volatility breaks in the return series; SD denotes standard deviation for each break regime

5.3 Detected Volatility Breaks

Multiple volatility breaks in the return series of the main market and the GEM were detected by the ICSS procedure. The results show that the identified breakpoints are likely to align with major macroeconomic and financial events as reported in Table 3.5.

6 Dynamic Transmissions of Return and Asymmetric Volatility

Based on the outcomes of preliminary analysis, a bivariate VAR asymmetric BEKK-GARCH model appears to be a good fit for modeling the dynamic transmissions of return and asymmetric volatility between the main market and the GEM. As discussed previously, the presence of volatility breaks can diminish or even eliminate volatility spillover effects; thin trading can instigate specious autocorrelation in the return series. Furthermore, trading volume can disturb the price movements and

the pattern of volatility clustering. Therefore, to avoid biased estimation of the dynamic transmissions, the three factors – volatility breaks, thin trading, and trading volume – were incorporated into an augmented version of the bivariate VAR asymmetric BEKK-GARCH model.

Initially, lag order was selected based on three criteria: minimum AIC value, parsimonious model, and the convergence of coefficient estimation. As such, lag 2 was selected for the mean model (VAR), and lag 1 was selected for both ARCH and GARCH terms in the variance model (asymmetric BEKK-GARCH). Table 3.6 reports the model estimation for the four different cases as described further.

- Case 1: Analysis using raw return series in modeling
- Case 2: Analysis incorporating detected volatility breaks into the model
- Case 3: Analysis using thin trading-adjusted return series and incorporating detected volatility breaks into the model
- Case 4: Analysis using thin trading-adjusted return series and incorporating detected volatility breaks and aggregate trading volume into the model

The results determine that after controlling for volatility breaks, thin trading, and aggregate trading volume, own return transmissions within the main market and the GEM declined in magnitude and later became insignificant (equation $R_{1,\,t}$, coefficient of $R_{1,\,t\,-\,2}$ and equation $R_{2,\,t}$, coefficient of $R_{2,\,t\,-\,2}$). Nonetheless, a unidirectional return transmission from the GEM to the main market survives with diminishing magnitude and significance level. In particular, the magnitude and the significance level reduced from 0.049 (1%) to 0.034 (5%) (equation $R_{1,\,t}$, coefficients of $R_{2,\,t\,-\,2}$). The presence of cross return transmission from the GEM to the main market may have been due to hedging activities between the main market and the GEM and the sharing of common information between the two markets.

When considering the variance equation ($h_{11,\,t}$ and $h_{22,\,t}$), the results show that own volatility spillover within the GEM in both short and long run (equation $h_{22,\,t}$, coefficient of $\varepsilon^2_{2,t-1}$ and $h_{22,\,t\,-\,1}$) remained highly significant though declined in the level of persistence (from 0.120 to 0.084 and from 0.809 to 0.714, respectively). In contrast, own volatility spillover within the main market in the long run (equation $h_{11,\,t}$, coefficient of $h_{11,\,t\,-\,1}$) remained highly significant and increased in level of persistence (from 0.939 to 0.946). Asymmetric effect on volatility spillover within the main market (equation $h_{11,\,t}$, coefficient of $\kappa^2_{1,t-1}$) weakened in magnitude and significance level from 0.076 (1%) to 0.074 (5%). However, direct short-run volatility spillover from the GEM to the main market (equation $h_{11,\,t}$, coefficient of $\varepsilon^2_{2,t-1}$) became statistically insignificant after all three factors were taken into account. This indicates the eliminating impact of volatility breaks, thin trading, and trading volume on the cross-market volatility spillover and the reducing impact of these factors on asymmetric volatility spillover.

Table 3.7 displays the post-estimate diagnostics for our augmented bivariate VAR asymmetric BEKK-GARCH model. As can be seen, multivariate portmanteau statistics of Ljung-Box test (M-Q) and Engle ARCH test (M-ARCH) up to lag 10 and 20 were insignificant in Case 4. This implies no serial correlation and

Table 3.6 Augmented bivariate VAR asymmetric BEKK-GARCH model estimation

Case 1: Raw return series					
R_{1t}=	−5E−06	+0.021$R_{1,\ t-1}$	+0.01$R_{2,\ t-1}$	−0.036$R_{1,\ t-2}$	+0.049$R_{2,\ t-2}$
	(−0.03)	(1.00)	(0.45)	(−1.65)***	(2.59)*
R_{2t}=	−0.0004	+0.025$R_{1,\ t-1}$	+0.067$R_{2,\ t-1}$	−0.004$R_{1,\ t-2}$	+0.058$R_{2,\ t-2}$
	(−1.51)	(1.34)	(3.11)*	(−0.23)	(2.25)**
$h_{11,\ t}$=	3E-06	+0.939$h_{11,\ t-1}$	−0.014$h_{12,\ t-1}$	+5E-05$h_{22,\ t-1}$	+0.001$\varepsilon^2_{1,t-1}$
	(3.13)*	(75.99)*	(−0.33)	(0.82)	(0.28)
	+0.003$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.003$\varepsilon^2_{2,t-1}$	+0.076$\kappa^2_{1,t-1}$	−0.0002$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+2E-07$\kappa^2_{2,t-1}$
	(0.09)	(1.75)***	(3.60)*	(−0.02)	(0.01)
$h_{22,\ t}$=	6E-06	+4E-06$h_{11,\ t-1}$	+0.004$h_{12,\ t-1}$	+0.809$h_{22,\ t-1}$	+0.004$\varepsilon^2_{1,t-1}$
	(1.68)***	(0.05)	(0.08)	(19.05)*	(0.44)
	−0.041$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.120$\varepsilon^2_{2,t-1}$	+0.013$\kappa^2_{1,t-1}$	+0.055$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+0.055$\kappa^2_{2,t-1}$
	(−0.51)	(4.67)*	(0.48)	(0.30)	(1.10)
Case 2: Volatility breaks in volatility incorporated					
R_{1t}=	1.5E-05	+0.019$R_{1,\ t-1}$	+0.010$R_{2,\ t-1}$	−0.037$R_{1,\ t-2}$	+0.047$R_{2,\ t-2}$
	(0.07)	(1.12)	(0.70)	(−1.87)***	(3.62)*
R_{2t}=	−0.0004	+0.024$R_{1,\ t-1}$	+0.065$R_{2,\ t-1}$	−0.005$R_{1,\ t-2}$	+0.057$R_{2,\ t-2}$
	(−1.28)	(1.31)	(3.90)*	(−0.43)	(3.00)*
$h_{11,\ t}$=	4E-06	+0.944$h_{11,\ t-1}$	−0.019$h_{12,\ t-1}$	+1E-04$h_{22,\ t-1}$	+0.0004$\varepsilon^2_{1,t-1}$
	(3.23)*	(76.49)*	(−0.27)	(1.19)	(0.19)
	+0.002$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.004$\varepsilon^2_{2,t-1}$	+0.072$\kappa^2_{1,t-1}$	+0.002$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+9E-06$\kappa^2_{2,t-1}$
	(0.09)	(2.16)**	(2.88)*	(0.06)	(0.09)
$h_{22,\ t}$=	1E-05	+0.0001$h_{11,\ t-1}$	+0.018$h_{12,\ t-1}$	+0.789$h_{22,\ t-1}$	+0.006$\varepsilon^2_{1,t-1}$
	(1.85)***	(0.21)	(0.20)	(18.38)*	(0.43)
	−0.054$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.127$\varepsilon^2_{2,t-1}$	+0.008$\kappa^2_{1,t-1}$	+0.046$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+0.066$\kappa^2_{2,t-1}$
	(−0.34)	(4.64)*	(0.24)	(0.26)	(1.08)

Case 3: Volatility breaks in volatility incorporated and thin trading adjusted					
R_{1t}=	3.5E-06	+0.019$R_{1,\ t-1}$	+0.009$R_{2,\ t-1}$	−0.036$R_{1,\ t-2}$	+0.040$R_{2,\ t-2}$
	(0.02)	(0.86)	(0.76)	(−1.87)***	(2.56)*
R_{2t}=	−0.0002	+0.028$R_{1,\ t-1}$	−0.079$R_{2,\ t-1}$	−0.003$R_{1,\ t-2}$	+0.040$R_{2,\ t-2}$
	(−0.58)	(0.99)	(−3.56)*	(0.99)	(1.62)
$h_{11,\ t}$=	4E-06	+0.944$h_{11,\ t-1}$	−0.016$h_{12,\ t-1}$	+7E-05$h_{22,\ t-1}$	+0.0005$\varepsilon^2_{1,t-1}$
	(2.82)*	(71.79)*	(−0.19)	(0.88)	(0.27)
	+0.002$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.003$\varepsilon^2_{2,t-1}$	+0.072$\kappa^2_{1,t-1}$	+0.001$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+2E-06$\kappa^2_{2,t-1}$
	(0.07)	(2.47)**	(2.90)*	(0.04)	(0.06)
$h_{22,\ t}$=	1.5E-05	+0.0002$h_{11,\ t-1}$	+0.021$h_{12,\ t-1}$	+0.789$h_{22,\ t-1}$	+0.007$\varepsilon^2_{1,t-1}$
	(1.72)***	(0.20)	(0.18)	(15.81)*	(0.45)
	−0.061$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.127$\varepsilon^2_{2,t-1}$	+0.010$\kappa^2_{1,t-1}$	+0.052$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+0.065$\kappa^2_{2,t-1}$
	(−0.36)	(4.25)*	(0.25)	(0.26)	(1.11)
Case 4: Volatility breaks in volatility and aggregate trading volume incorporated and thin trading adjusted					
R_{1t}=	0.001	+0.020$R_{1,\ t-1}$	+0.006$R_{2,\ t-1}$	−0.027$R_{1,\ t-2}$	+0.034$R_{2,\ t-2}$
	(1.16)	(0.92)	(0.29)	(−1.31)	(2.00)**
R_{2t}=	0.0002	+0.025$R_{1,\ t-1}$	−0.074$R_{2,\ t-1}$	+0.007$R_{1,\ t-2}$	+0.031$R_{2,\ t-2}$
	(0.22)	(1.11)	(−2.67)*	(0.38)	(1.45)
$h_{11,\ t}$=	4.4E-07	+0.946$h_{11,\ t-1}$	−0.031$h_{12,\ t-1}$	+3E-04$h_{22,\ t-1}$	+0.001$\varepsilon^2_{1,t-1}$
	(0.44)	(42.05)*	(−0.23)	(0.77)	(0.16)
	−0.003$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.002$\varepsilon^2_{2,t-1}$	+0.074$\kappa^2_{1,t-1}$	+0.015$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+0.001$\kappa^2_{2,t-1}$
	(−0.06)	(1.55)	(2.50)**	(0.14)	(0.54)
$h_{22,\ t}$=	6E-06	+0.002$h_{11,\ t-1}$	+0.081$h_{12,\ t-1}$	+0.714$h_{22,\ t-1}$	+0.004$\varepsilon^2_{1,t-1}$
	(0.41)	(0.31)	(0.31)	(5.66)*	(0.19)
	−0.037$\varepsilon_{1,\ t-1}\varepsilon_{2,\ t-1}$	+0.084$\varepsilon^2_{2,t-1}$	+0.001$\kappa^2_{1,t-1}$	−0.022$\kappa_{1,\ t-1}\kappa_{2,\ t-1}$	+0.169$\kappa^2_{2,t-1}$
	(−0.30)	(3.18)*	(0.04)	(−0.11)	(1.10)

Notes: *, **, *** indicate that the t-statistic is significant at 1%, 5% and 10%, respectively; R_{1t} and R_{2t} are the mean equations for the main market return series (represented by Hang Seng Index – HSI) and the GEM return series, respectively; $h_{11,\ t}$ and $h_{22,\ t}$ are the conditional variance equations for the main market return series and the GEM return series, respectively. Numbers below the estimated coefficients are the corresponding t-statistics (in parentheses), which were computed using a first-order Taylor expansion of the function around its mean

Table 3.7 Post-estimation diagnostics

Case	M-Q(10)	M-Q(20)	M-ARCH(10)	M-ARCH(20)	$\alpha_{11}^2 + \beta_{11}^2$	$\alpha_{22}^2 + \beta_{22}^2$
1	41.14	91.42	133.73∗	210.21∗∗∗	0.94	0.93
2	45.06	94.83	131.35∗	202.34	0.94	0.92
3	45.39	95.43	131.68∗	202.52	0.94	0.92
4	42.82	87.87	104.46	172.45	0.95	0.80

Notes: ∗, ∗∗∗ indicate the test statistic is significant at 1% and 10%, respectively; M-Q(q) is multivariate statistics of the Ljung-Box test for serial correlation up to lag q in the residuals; M-ARCH(q) is multivariate statistics of the Engle ARCH test for conditional heteroscedasticity up to lag q in the residuals; α_{ii} and β_{ii} are diagonal elements of the A and B matrices of the model

heteroscedasticity in the residuals after volatility shifts, thin trading, and trading volume were included in the model. Also, the sum of $(\alpha_{ii}^2 + \beta_{ii}^2)$ was less than unity (α_{ii} and β_{ii} are diagonal elements of the A and B matrices of the model), suggesting that the model is covariance stationary and, thus, is well specified.

7 Implications of the Findings

Findings of this study have important implications for policymakers and portfolio managers. According to the previous analysis, the GEM is found to have a significant impact on the main market via its return transmission to the main market. Also, there exists in the finance-growth literature a causal relationship and a long-run equilibrium relationship between the main market return and economic development in Hong Kong. To confirm these relationships exist during the period under study, tests for Granger causality and Johansen cointegration between the main market return and macroeconomic indicators were performed. The macroeconomic indicators used for the tests were real GDP growth (RYG), growth of real physical capital stock (RKG), real productivity growth (RPG), and real wage growth (RWG)[2].

Tables 3.8 and 3.9 report the test results, showing the evidence of unidirectional causality from the main market return to the four macroeconomic indicators and a long-term relationship between the main market return and the four macroeconomic indicators. Consequently, it can be argued that the GEM can contribute indirectly to Hong Kong's economic development via the main market channel. Therefore, any policies that facilitate the development of the GEM would indirectly promote economic stimulation in Hong Kong through its return transmission mechanisms with the main market.

[2]Data were obtained quarterly from various issues of Hong Kong Census and Statistics Department, International Financial Statistics (IFS-IMF), World Bank Database (WDI), for the period of 2009: Q2 to 2016:Q4. The quarterly data were adjusted for seasonality and increased the frequency to monthly data.

Table 3.8 Pairwise granger causality test

Null hypothesis	F-statistic	Causal relation
RM does not Granger cause RYG	1.98**	RM → RYG
RYG does not Granger cause RM	0.52	
RM does not Granger cause RKG	2.14**	RM → RKG
RKG does not Granger cause RM	0.63	
RM does not Granger cause RPG	1.83***	RM → RPG
RPG does not Granger cause RM	0.77	
RM does not Granger cause RWG	2.85***	RM → RWG
RWG does not Granger cause RM	1.95	

Notes: **, *** indicate that the test statistic is significant at 5% and 10%, respectively; observations used in the test were monthly 74–88

Table 3.9 Johansen cointegration test

	RM – RYG		RM – RKG		RM – RPG		RM – RWG	
No. of	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
CE(s)	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.
None	34.6*	25.6*	28.9*	24.7*	46.4*	27.4*	42.4*	26.1*
At most 1	8.9*	9.0*	4.2**	4.2**	19.0*	19.0*	16.3*	16.3*

Notes: *, ** indicate the test statistic is significant at 1% and 5%, respectively. CE(s) denotes cointegrating equation(s)

Furthermore, the estimation of volatility transmissions also has crucial implication for portfolio managers in minimizing the risk of a portfolio. Kroner and Sultan (1993) asserted that the risk of a small- and large-cap stocks portfolio can be minimized should investors short $\$\beta$ of the large-cap stock portfolio that is \$1 long in the small-cap stock portfolio. Accordingly, the "risk minimizing hedge ratio" β^* is defined as

$$\beta_t^* = \frac{h_{12,t}}{h_{22,t}} \tag{3.11}$$

Table 3.10 presents the estimated "risk minimizing hedge ratio" β^* for our augmented bivariate VAR Asymmetric BEKK-GARCH model with four different cases (as described in the previous section). As can be seen, from case 1 to case 4, the hedge ratios accelerated from 0.005 to 0.113 as volatility breaks, thin trading, and trading volume were sequentially incorporated into the model. The average correlations between hedging ratios of the two sequential cases also declined substantially from 0.118 to 0.077. Therefore, failure to account for volatility breaks, thin trading, and trading volume may drastically underestimate the hedging ratio for a large-cap stock portfolio. Accordingly, the hedging ratio can be interpreted as follows: to hedge a long position of \$100 in a small-cap stock portfolio, investors should hold a short position of \$11.3 in a large-cap stock portfolio.

Table 3.10 Risk minimizing hedge ratios

	Case 1	Case 2	Case 3	Case 4
β_t^*	0.005	0.023	0.027	0.113
Average correlation		0.118	0.091	0.077

Notes: Case 1 refers to analysis using raw return series in modeling; Case 2 refers to analysis incorporating detected volatility breaks into the model; Case 3 refers to analysis using thin trading-adjusted return series and incorporating detected volatility breaks into the model; Case 4 refers to analysis using thin trading-adjusted return series and incorporating detected volatility breaks and aggregate trading volume into the model

8 Conclusions and Future Research

This study investigated the return and asymmetric volatility transmissions between the main stock market and the Growth Enterprise Market (GEM) in Hong Kong under the joint impacts of volatility breaks, thin trading, and trading volume. The study provided a further knowledge about an indirect contribution of a second-tier stock market to economic development through its impact on the main stock market. Accordingly, various econometric models and estimation techniques were adopted for the empirical analysis: (1) iterated cumulated sum of squares (ICSS) algorithm to identify volatility breaks, (2) linear state-space AR model with the Kalman filter to adjust for thin trading, and (3) augmented bivariate VAR asymmetric BEKK-GARCH model to estimate the return and asymmetric volatility transmissions under the joint effects of volatility breaks, thin trading, and trading volume.

The authors found a number of important consequences when the joint impacts of volatility breaks, thin trading, and trading volume were integrated into the modeling of return and asymmetric volatility spillovers, as follows:

- A unidirectional return spillover from the GEM to the main market survives with diminishing magnitude and significance level.
- Own return spillover within the main market and the GEM became insignificant.
- Direct short-run volatility spillover from the GEM to the main market was eliminated.
- Asymmetric volatility spillover within the main market weakened in magnitude and significance level.
- Own volatility spillover within the GEM decreased in persistence level, while this effect within the main market increased in persistence level.

The results also reveal the causal and long-run relationship between the main market return and economic development in Hong Kong. Together with the evidence of return transmission from the GEM to the main market, it is arguable that the GEM can make an indirect contribution to economic development in Hong Kong through its dynamic return transmission with the main market. This finding is highly relevant to policymakers in the sense that any supporting policies for the development of the GEM could potentially promote the country's economic stimulation via the main market channel. Furthermore, the estimation of volatility transmissions also

has a strong implication for portfolio managers in determining an optimal hedge ratio in order to minimize the risk of a small- and large-cap stock portfolio.

Finally, while return and asymmetric volatility spillovers between the main market and the GEM in Hong Kong were examined in this study, liquidity spillover between the two markets is also worthwhile to investigate. This could help provide further evidence for the indirect contribution of the GEM to Hong Kong's economic development via the main market channel.

Appendix: Unit Root Tests

Unit root test		R_{1t}	R_{2t}	ATV_t
ADF	C	−42.41∗	−25.79∗	−7.13∗
	C&T	−42.40∗	−25.79∗	−7.34∗
PP	C	−42.40∗	−37.19∗	−28.56∗
	C&T	−42.40∗	−37.19∗	−28.88∗
NP – C	MZ_α^d	−12.01∗∗	−14.48∗	−71.36∗
	MZ_t^d	−2.38∗∗	−2.69∗	−5.96∗
	MSB^d	0.20∗∗	0.19∗	0.08∗
	MP_T^d	2.34∗∗	1.70∗	0.36∗
NP – C&T	MZ_α^d	−26.89∗	−30.33∗	−181.05∗
	MZ_t^d	−3.66∗	−3.89∗	−9.50∗
	MSB^d	0.14∗∗	0.13∗	0.05∗
	MP_T^d	3.40∗	3.06∗	0.53∗

Notes: ∗, ∗∗ indicate that the test statistic is significant at 1% and 5%, respectively; R_{1t} and R_{2t} denote daily returns of the Main market and the GEM, respectively; ATV_t denotes daily aggregate traded volumes of the Main market and the GEM; C represents constant; C&T represents constant and trend; $MZ_\alpha^d, MZ_t^d, MSB^d$ and MP_T^d represents the four test statistics of the Ng-Perron unit root test

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Chapter 4
The Road to Service Export Diversification: Gambling and Convention in Macao

Weng Chi Lei

Abstract Macao is a major exporter of gambling service in the world. Economies of scale in the gaming industry are the driving forces behind Macao's pattern of export. However, rather than exploiting the economies of scale through further specialization in gambling service, the government of Macao aims at diversifying the service exports, focusing on Macao's relatively small convention industry. To provide a theoretical ground for this seemingly counterintuitive strategy of the city, this paper builds a multiproduct model of service export diversification. In line with previous studies, the present model shows that if the cost of providing gambling service is relatively low, it is optimal for a city to export relatively more gambling service than convention services. However, as the tourism market expands, the city will pursue a higher degree of diversification among the two services. Analyses of 2008 Q1–2019 Q1 data of visitor arrivals, visitor expenditure, and production costs of Macao match the propositions of the theoretical model. Furthermore, the VAR model provides empirical evidence that the degree of service export diversification is positively related to the size of the tourism market.

Keywords Service trade · Export diversification · Macao · Tourism · Gaming · Gambling · MICE · Convention

1 Introduction

Having a tiny area of 28.2 km^2, Macao' natural resources are particularly scarce (Central Intelligence Agency 2019). While Macao's export of goods is insignificant in the world market, its export of services in the form of tourism is much more prominent. As one of the world's major integrated destinations, Macao provides a full package of tourism services, from gambling to convention and from world heritage tours to world-class entertainment and shows. Among them, the gaming

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industry is the most established. Since the twentieth century and until recently, Macao had been the only legal casino hub in the region. Since 2008, Macao has surpassed Las Vegas to receive the highest gaming revenue in the world (Mccartney 2008). As of 2017, production of gambling service took up 49.1% of all economic activities of the city (Statistics and Census Service 2019). With a population of merely 653,100 (in 2017), Macao has to have a highly skilled and specialized labor force to sustain its gaming industry (Statistics and Census Service 2019). In this way, Macao's gaming sector enjoys economies of scale in the production of gambling service. Macao has the world's fourth highest GDP per capita in 2017 (Central Intelligence Agency 2019). The city's gaming industry is clearly a key to its economic success.

As long as demand for the good or service is sufficiently large, it is sensible for Macao to pursue further specialization in gambling service production in order to exploit its economies of scale. Yet, while its gaming industry flourishes, the Macao government addresses a policy goal to diversify its tourism sector by "adopting the 'conventions as the priority' approach" (Macao government 2018). ("Convention" generally refers to all the meetings, incentives, conferences, and exhibitions (MICE).) It is puzzling why the Macao government pursues such new challenge. When accessing the motive behind Macao government's objective, many cited social factors such as gambling addictions of the local people, financial crimes, and conflicts with religious values (Lewis 2016). There are also political factors. China's high official Zhang Dejiang emphasized the city should diversify its economy during his visit to Macao (Wu and Master 2017). However, as discussed in McCartney (2008), solid economic explanations are lacking.

An economic event that has influenced both gaming and convention production in the past decade is the surge of tourists from mainland China. As shown in Fig. 4.1, the number of mainland Chinese visitors has skyrocketed in the past decade. This is

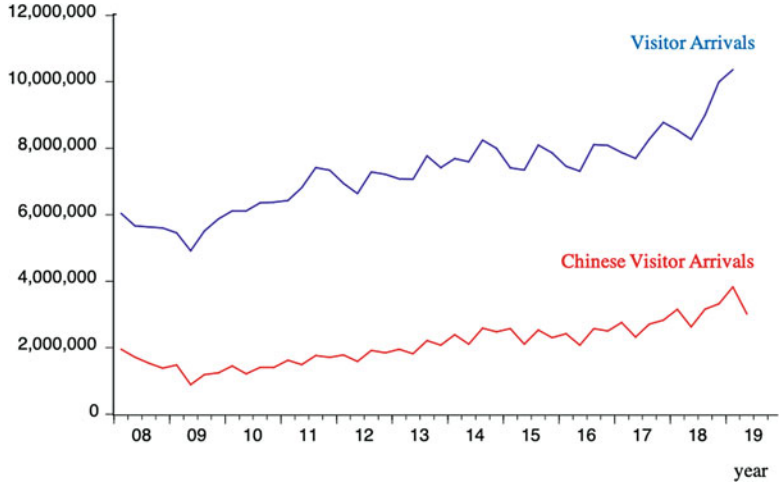

Fig. 4.1 Visitor arrivals of Macao. (*Source*: Statistics and Census Service 2019)

mainly due to the rise of the Chinese economy and lower visa requirements on Chinese visitors (China Contact). As this is the major economic event in the tourism market of Macao, this paper hypothesizes that the increase of the market size is a determinant of Macao's degree of service export diversification. Before testing this hypothesis empirically, this paper provides a theoretical model in which the optimal degree of diversification can be determined. Because the research question of this paper primarily concerns Macao's tourism sector, the model will be stylized to match real-life observations in the sector. Once a theoretical ground is laid, this paper attempts to search for empirical evidence in Macao's tourism data. One additional motivation of this empirical study is data availability. Macao's Statistics and Census Service (DSEC) collects gaming and convention sector data regularly. This kind of tourism industrial data are not typically available elsewhere in the world.

Among the related literature, Li et al. (2009) are those that are closely related to this study. Li et al. (2009) provided a two-country, two-good, general equilibrium model of trade. Their model assumed Macao could produce gambling service more efficiently, but could produce all other related services (including convention) less efficiently than foreign countries. As in a standard trade model, when Macao had comparative advantage in producing gambling service but comparative disadvantage in all other related services, Macao would export gambling service, but import all other related services. However, when allowing for demand shocks, the model of Li et al. (2009) found that service producers should invest on the related services and achieve diversification. There is one major difference between Li et al. (2009) and the present study. Li et al.'s (2009) general equilibrium model considered both the production side and the consumption side. Hence, they concluded that Macao was a net importer of all other related services including convention. Contrarily, this paper focuses on the production side. From the point of view of Macao producers, both gambling service and convention service are export produce choices. In another study, Derosa (1992) allowed for export of more than one good and incorporated market uncertainty in the trade model. Derosa (1992) found that risk-averse producers directed resources away from a specialized production when there were substantial market risks, resulting a higher degree of export diversification. On the other hand, this paper is motivated by observations in Macao's tourism market and views export diversification as the city's production strategy in response to demand expansion rather than due to risk aversion.

Some previous studies investigated the possible determinants of export diversification empirically. Mubeen and Ahmad (2016) found that export diversification of Pakistan was positively related to foreign direct investment, real effective exchange rate, and world GDP, but negatively related to geographic concentration of exports and trade openness. Alemu (2016) estimated that export diversification of African countries is related to oil resources negatively. However, neither Mubeen and Ahmad (2016) nor Alemu (2016) tested for Granger causality, so the direction of causality was not clear. Naudé and Rossouw (2010) theorized that a country started to specialize its exports as its comparative advantages emerged at a later stage of economic development. Naudé and Rossouw (2010) empirically tested this theory

using data of emerging countries, BRICS, and found evidence of Granger causality from GDP per capita to export diversification in India only. Naudé and Rossouw's theory (2010) does not apply on Macao because the city enjoys a high level of economic development, but its strategy is to diversify its exports rather than specializing in the production of gambling service, in which the city has comparative advantage.

The roadmap of this chapter is as follows: Section 2 presents a model of tourism service diversification. The model provides a theoretical, economic explanation of the determinants of a city's optimal levels of gambling and convention services production. The comparative statics of the model form testable hypotheses. Section 3 looks into the tourism data found in the visitor expenditure survey, service survey, and gaming sector survey conducted by the Statistics and Census Service (2019). The section builds a VAR model and aims at deriving empirical evidence that supports the propositions made in Sect. 2. Section 4 concludes.

2 A Model of Tourism Service Diversification

The goal of this section is to build a theoretical foundation for analyzing Macao's tourism service diversification. The comparative statics derived in this model provide empirically testable hypotheses for the next section. The model is stylized according to the recent observations in Macao's gaming and MICE industries, so that it serves best at explaining the city's optimal degree of service export diversification.

Since the purpose of this chapter is to analyze Macao's production choice among two different tourism services, a byproduct model is suitable. Suppose the two products are gambling (G) and convention (V). In a multiproduct model, products are typically linked on the demand side, on the supply side, or both. On the demand side, tourists may consider gambling and convention services to be related. For example, a visitor that comes to Macao to attend a conference may spend his/her after-work leisure time in a casino, which is conveniently located in the same building. In this sense, the visitor considers gambling and convention services to be complements. However, it is more appropriate to treat the two services as unrelated products in this paper. As will be explained in Sect. 3, the Statistics and Census Service (2019) distinguishes visitors by their "main purpose[s] of visit." Gaming and attending MICE are two different choices of "purposes." Even if a conference participant gambles during his/her visit, he/she will still state that his/her "main purpose of visit" is to attend MICE. For this reason, the present model specifies the (inverse) demand function of a product such that it depends on its price only; that is, the demand functions of G and V are $P_G = P_G(G)$ and $P_V = P_V(V)$ respectively.

On the other hand, the market size of the tourism market as a whole can influence both the demand for gambling service and the demand for convention service. If there are more travelers in the world and if they are willing and capable of spending

more on tourism services, there should be higher demand for both gambling and convention services of major destinations like Macao. To capture these exogenous factors that influence the tourism market of Macao, this model assumes $P_G(0) = P_V(0) = a$. a is a sufficiently large constant that signifies the potential demand for each tourism service. The simplest demand functions that achieve the purposes of this model are $P_G = a - bG$ and $P_V = a - bV$, where b is a positive constant. These linear demand functions satisfy standard properties: quantities are nonnegative, $\frac{\partial P_G}{\partial G} = -b < 0$, $\frac{\partial P_V}{\partial V} = -b < 0$.

Notice that the model assumes the two demands are equally price elastic mainly because it largely simplifies the model solutions without affecting its major insights. Moreover, there is no evidence that the demand for one is more elastic to price changes than the other. Williams and Siegel (2014), for instance, believed that the price elasticity of demand for gambling service is relatively high due to the availability of alternative ways to gamble. The same argument should also apply to the demand for convention because there are many competing producers in the world. Singapore, for example, has a well-established convention industry and integrated resorts that attract casino goers.

On the supply side, the linkage between the two services is not prominent. It is true that integrated resorts such as the Venetian house both a casino and conference rooms, so the production of gambling and convention services shares some space. If demand for the services is so large that a firm does not have enough capacity to serve all the visitors, the firm faces a capacity constraint. Lei (2018a) illustrates how a firm chooses the optimal allocation of its scarce resources to produce the products when facing a binding capacity constraint. However, this is not the case in Macao. Frost and Chan (2014) and Erheriene (2018), for example, discussed how casinos were empty during Macao's recent economic downturn in 2015 and how there had been empty seats at famous shows. These are pieces of evidence that there is idle production capacity in Macao. There is no obvious supply-side bond between gambling and convention services through any production capacity constraint.

Besides, the construction costs of the resort buildings are sunk costs that do not affect a firm's choice of quantities supplied. Rather, a firm's production decision depends on the marginal cost of each service. As shown in Table 4.1, as of 2017, the major production costs of gambling and convention services were purchase of goods and services and commission paid, compensation of employees, and operating expenses. Since production of the two services requires different equipment (e.g., a baccarat table versus a projector) and employs different skilled labor (e.g., a dealer versus an event planner), the cost function of one service should be independent of

Table 4.1 Production costs of gaming and MICE industries in Macao in 2017

Type of costs	Gaming	MICE
Purchase of goods/services and commission paid	53%	67.2%
Compensation of employees	18.6%	20.4%
Operating expenses	24.3%	12.4%

Source: Statistics and Census Service (2019)

the quantity of the other service. There are neither economies nor diseconomies of scope. Therefore, this model uses a cost structure[1] that is simple yet enough to capture the characteristics of the production of the two services: $C_G = c_0 + c_1 G + c_2 G^2$ and $C_V = \phi c_0 + \phi c_1 V + \phi c_2 V^2$, where c_0, c_1, c_2, and ϕ are positive constants.[2] This specification captures the cost difference in the parameter, ϕ for easy comparison. Specifically, if $G = V$, then $C_V = \phi C_G$. In this case if $\phi > 1$ ($\phi < 1$), then convention is more (less) costly than gambling; and if $\phi = 1$, then the two tourism services are equally costly.

Suppose a city's objective is to choose the quantities of G and V to be produced in order to maximize total profits in the two industries. When the markets are in equilibrium, the objective function is defined in (4.1).[3]

$$\begin{aligned}\max_{\{G,V\}} \pi =& (P_G G - C_G) + (P_V V - C_V) \\ =& (a - bG)G - \left(c_0 + c_1 G + c_2 G^2\right) \\ &+ (a - bV)V - \left(\phi c_0 + \phi c_1 V + \phi c_2 V^2\right).\end{aligned} \tag{4.1}$$

The first-order conditions are

$$\frac{\partial \pi}{\partial G} = a - c_1 - 2(b + c_2)G = 0 \ , \tag{4.2a}$$

$$\frac{\partial \pi}{\partial V} = a - \phi c_1 - 2(b + \phi c_2)V = 0 \ . \tag{4.2b}$$

The second-order conditions are $\frac{\partial^2 \pi}{\partial G^2} = -2(b + c_2) < 0$, $\frac{\partial^2 \pi}{\partial V^2} = -2(b + \phi c_2) < 0$ and the determinant of the Hessian matrix $H = 4(b + c_2)(b + \phi c_2) > 0$, which are satisfied under the model assumptions. Solving the first-order conditions yields the profit-maximizing production levels,

[1] It is common to assume increasing marginal costs in simple models like this one, which satisfy the second-order conditions for stable solutions as long as c_2 is not too negative. Even if c_1 were negative, the main results would not be affected as long as a was sufficiently large.

[2] If c_0 is sufficiently high, production of each service exhibits economies of scale. This is a reasonable assumption because the costs of developing and filling up newly reclaimed land with luxurious integrated resorts involved tremendous costs. Average costs of production drop drastically as more and more visitors are served.

[3] This model is a special case of the multiproduct model in Lei (2018b). Here, the profits of the two products in (4.1) are additively separable. Elements of the Hessian matrix, H_{12} and H_{21}, are zeros. Yet, separating (4.1) into two profit maximization problems would not yield different results. Also, there are parameters, a and ϕ, that connect and help to compare the two services. In a model of service diversification, it is useful to compare the optimal levels of the two services side by side. Hence, this model considers the two services in a single optimization problem.

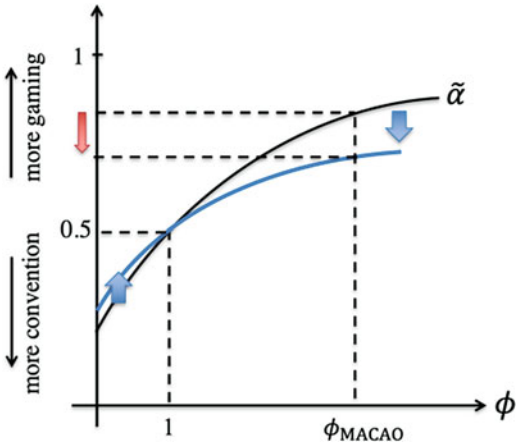

Fig. 4.2 Responses of $\tilde{\alpha}$ to market expansion

$$\tilde{G} = \frac{a - c_1}{2(b + c_2)} \quad , \tag{4.3a}$$

$$\tilde{V} = \frac{a - \phi c_1}{2(b + \phi c_2)} \quad , \tag{4.3b}$$

using "~" to denote optimal levels of G and V. To describe how a city optimally diversifies the production of G and V, define a variable $\alpha \equiv G/(G + V)$, which is the production of gambling service as a proportion of the total production.[4] In particular, if the city produces more (less) gambling than convention, α will be greater (less) than 0.5. Denote $\tilde{\alpha}$ to be α evaluated at the optimal levels, $\tilde{G}$ and $\tilde{V}$. Hence, $\tilde{\alpha}$ tells the optimal degree of diversification of the city. (4.3a and 4.3b) indicates that it is optimal for the city to produce more (less) gambling than convention if $\phi > 1$ ($\phi < 1$). In other words,

$$\begin{matrix} > \\ \tilde{\alpha} = 0.5 \\ < \end{matrix} \quad if \quad \begin{matrix} > \\ \phi = 1 \\ < \end{matrix} \quad . \tag{4.4}$$

Figure 4.2 plots $\tilde{\alpha}$ against ϕ, holding other parameters constant. The $\tilde{\alpha}$ line crosses 0.5 at $\phi = 1$. For $\phi < 1$, the $\tilde{\alpha}$ line is below 0.5. For $\phi > 1$, the $\tilde{\alpha}$ line is above 0.5. Figure 4.3 illustrates the position of $\tilde{\alpha}$ along the interval [0, 1]. $\tilde{\alpha}$ is on the right side of 0.5 in Panel (a), so the city specializes more on gambling service when $\phi > 1$. In Panel (b), $\phi < 1$, so the city specializes more on convention service and $\tilde{\alpha}$ positions on the left of 0.5. Perfect diversification happens only if $\phi = 1$, which is illustrated in Panel (c). The city produces equal amounts of each service and $\tilde{\alpha}$ is right at 0.5.

[4] Alemu (2016) also defined the degree of diversification in a similar way. His study focused on two types of goods – primary goods and manufactured goods.

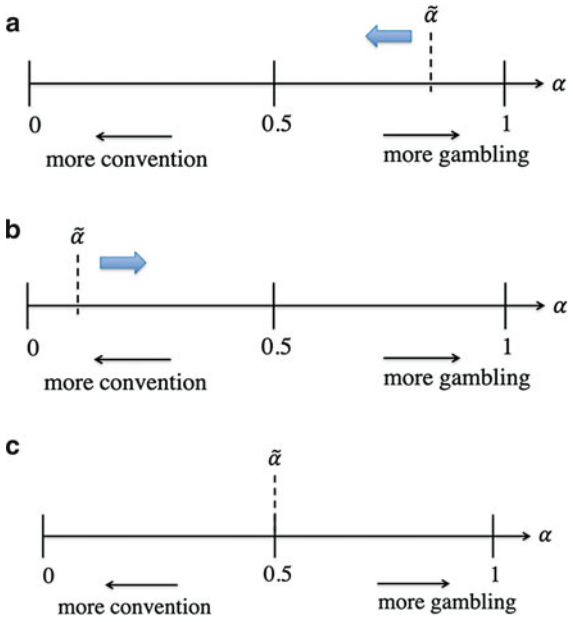

Fig. 4.3 Movement of $\tilde{\alpha}$ in response to market expansion. Panel (**a**) An example of φ>1. Panel (**b**) An example of φ<1. Panel (**c**) An example of φ=1.

Proposition 1 *If it is more (less) costly to produce convention service than gambling service, a city produces a larger (smaller) proportion of gambling service, and if it is equally costly to produce the two tourism services, a city produces half of each;* i.e., *if* $\phi \gtreqless 1$, *then* $\tilde{\alpha} \gtreqless 0.5$.

The interest of this chapter is to find out what determines the degree of diversification of a city. Whether it is optimal for a city to diversify more depends on changes in demand. Because the model assumes gambling and convention face the same exogenous market changes in a, optimal levels of the two tourism services have to respond to the same market expansion or contraction. Differentiating (4.3a and 4.3b) with respect to a yields

$$\frac{\partial \tilde{G}}{\partial a} = \frac{1}{2(b + c_2)} > 0 \ , \tag{4.5a}$$

$$\frac{\partial \tilde{V}}{\partial a} = \frac{1}{2(b + \phi c_2)} > 0 \ . \tag{4.5b}$$

Both $\tilde{G}$ and $\tilde{V}$ increase with a. However, (4.5a) and (4.5b) differ by the term ϕ. Hence, the increase in $\tilde{G}$ and the increase in $\tilde{V}$ can be of different extents. As a result, the market expansion can move the position of $\tilde{\alpha}$. Differentiate $\tilde{\alpha}$ with respect to a:

$$\frac{\partial \widetilde{\alpha}}{\partial a} = \frac{(1-\phi)c_1}{\left(\widetilde{G}+\widetilde{V}\right)^2 H} \quad . \tag{4.6}$$

The signs of all the terms in (4.6) except for $(1-\phi)$ are unambiguous. Therefore, the sign of (4.6) depends on how ϕ compares to 1. In particular, $\widetilde{\alpha}$ decreases in response to a rise of a if $\phi > 1$. On the other hand, if $\phi < 1$, $\widetilde{\alpha}$ increases when a rises. Figure 4.2 shows that as a increases, the slope of the $\widetilde{\alpha}$ line decreases for all ϕ. In other words, for any level of ϕ, $\widetilde{\alpha}$ approaches 0.5 from either direction. Hence, even though the sign of (4.6) changes with the value of ϕ, there is a higher degree of diversification when the tourism market expands.

Figure 4.3 illustrates the movement of $\widetilde{\alpha}$ along the interval [0, 1] in response to the tourism market expansion. In Panel (a), $\phi > 1$ and $\widetilde{\alpha}$ is greater than 0.5. After the market expansion, $\widetilde{\alpha}$ drops down toward 0.5. In Panel (b), $\phi < 1$ and $\widetilde{\alpha}$ is less than 0.5. The market expansion also moves $\widetilde{\alpha}$ closer to 0.5. In Panel (c), $\phi = 1$, so there is perfect diversification. $\widetilde{\alpha}$ remains at 0.5 before and after the market expansion. Production becomes more spread out among gambling and convention services in all three cases.

Proposition 2 *Expansion in the tourism market leads to higher degree of diversification in gambling and convention service production;* i.e., *if* $\phi \gtreqless 1$, *then* $\widetilde{\alpha} \gtreqless 0.5$ *and* $\frac{\partial \widetilde{\alpha}}{\partial a} \lesseqgtr 0$.

Propositions 1 and 2 have important implications about Macao's tourism service diversification. Scarce in land, Macao has relied heavily on export of tourism services for years. The long establishment of Macao's gaming industry has equipped the city with a well-trained labor force that specializes in running casinos. Macao has established advantage and enjoys economies of scale in the gaming industry. In contrast, tourists seldom regarded Macao as a convention center until recent years, after some world-class MICE facilities were built and new talents were hired. It is reasonable to believe that Macao's gambling service production is relatively costlier than its convention service. (Sect. 3.1 will provide empirical ground for this assumption.) Using the language of the present model, Macao's ϕ should be greater than 1. In this case, Proposition 1 hypothesizes that Macao's $\widetilde{\alpha}$ should be greater than 0.5, leaning toward gambling. Figure 4.2 shows this hypothesized level of ϕ of Macao, at which $\widetilde{\alpha}$ is greater than 0.5. By the same token, Macao's case should be like the example in Panel (a) of Fig. 4.3.

However, in its recent annual policy addresses, the government of Macao expressed strong will to diversify, especially toward convention (Macao Government 2018). That is, its objective is to move Macao's $\widetilde{\alpha}$ closer to 0.5. The present model provides an economic explanation why the city's strategy may be optimal. According to Proposition 2, other things equal, a rise of a causes $\widetilde{\alpha}$ to approach 0.5. In other words, when experiencing an expansion in the tourism market, it is desirable for the city to diversify. Due to the rise of the Chinese economy, the number of

mainland Chinese tourists has risen tremendously in recent years. Macao is one of the most appealing destinations to Chinese tourists, so as shown in Fig. 4.1, there has been a significant increase in the tourism market size. In response to this influx of tourists, Macao chooses to diversify its tourism services. This situation is illustrated graphically in Fig. 4.2 and in Panel (a) of Fig. 4.3, that is, when a increases, Macao's $\widetilde{\alpha}$ approaches 0.5. In other words, the city diversifies its production toward the previously smaller convention service.

3 Empirical Evidence

The theoretical model derived in Sect. 2 provides two important insights into Macao's production diversification of gambling and convention services. Propositions 1 and 2 summarize the insights and provide empirically testable hypotheses. These empirical analyses are possible because secondary data that concern the tourism sectors are relatively abundant in Macao. The Statistic and Census Service of Macao (DSEC) conducts visitor expenditure surveys, gaming sector surveys, as well as service sector surveys regularly.

Table 4.2 presents the descriptive statistics of the time series collected for this empirical study. In the period from the first quarter of 2008 to the first quarter of 2019, there was an average of over 7.2 million visitors that arrived in Macao in a quarter and an average of over 2 million were mainland Chinese. Out of all visitors, an average of about 680 thousand considered "gaming" to be the main purpose of their visit. A much smaller number, about 98 thousand visitors, considered "attending international or regional conventions/exhibition" as their main purpose of visit.

Table 4.2 Descriptive statistics

	Period	N	Mean	Min	Max	SD
Visitor arrivals (thousands)	2008 Q1–2019 Q1	45	7267.23	4916.81	10359.76	1169.05
Gamblers (thousands)	2008 Q1–2019 Q1	45	677.83	181.09	1978.84	503.32
MICE participants (thousands)	2008 Q1–2019 Q1	45	98.07	12.29	494.71	135.30
Proportion of gamblers (%)	2008 Q1–2019 Q1	45	88.91	66.67	97.89	8.81
Chinese visitor arrivals (thousands)	2008 Q1–2019 Q1	45	2089.71	890.73	3826.24	635.78
Relative cost	2008 Q1–2017 Q4	40	22.16	6.52	41.61	11.27

3.1 Empirical Evidence of Proposition 1

The key parameter in Proposition 1 is ϕ. If $\phi > 1$, it is less costly for a city to produce gambling service than the same amount of convention service. Hence, it is optimal for the city to produce more of the former than the latter. Table 4.1 shows the composition of the production costs of each tourism service in 2017. The DSEC has collected such annual data of the gaming sector since 2004 and those of the MICE sector since 2007.[5] To estimate ϕ, it is necessary to estimate the cost function of each tourism service based on the production cost data and the number of visitors that receives the service. However, not only that the estimated cost functions will not look like the simple quadratic functions assumed in the model, the estimates of the coefficients based on only a few annual data points will not be very useful. Luckily, the interest of this paper is not to derive an accurate estimate of ϕ but to find out whether it is greater than 1. Intuitively, this analysis only needs to find out which of the two tourism services is costlier to produce in Macao. One tell-tale measure found in DSEC's surveys is the expenditure-gross-surplus ratio, which reflects the cost of production for every pataca earned in the industry. "Relative cost" in Table 4.2 is calculated by dividing the expenditure-gross-surplus ratio of the MICE sector by that of the gaming sector. As shown in Table 4.2, the relative cost of the two tourism services ranges from 6.52 to 41.61, which are much higher than 1, indicating that Macao produces gambling service much more cheaply than convention service.

According to Proposition 1, if it is less costly to produce gambling service than convention service, it is optimal for a city to produce a greater proportion of the former. The number of gamblers measures the amount of gambling service provided. In other words, it is "G" in the model. MICE participants, on the other hand, measure the amount of convention services provided, so it is a measure of "V" in the model. α in the model, which is G as a proportion of the sum of G and V, is, therefore, the number of gamblers as a proportion of the sum of gamblers and MICE participants. As described in Table 4.2, this measure ranges from 66.67% to 97.89%, with a mean of 88.91%. Hence, the measure of α is greater than 0.5 (or 50%). Together with the fact that of Macao's ϕ should be greater than 1, there is empirical evidence for Proposition 1. Intuitively, Macao, which has a competitive edge in producing gambling service, specializes in that tourism service (Fig. 4.4).

3.2 Empirical Evidence of Proposition 2

Proposition 2 in Sect. 2 hypothesizes that if $\phi > 1$, α, even though greater than 0.5, will drop toward 0.5 following an increase of a. The previous subsection provides empirical evidence to the first part of Proposition 2. Since Macao produces gambling

[5]Two years' data of MICE production costs are missing in the time series.

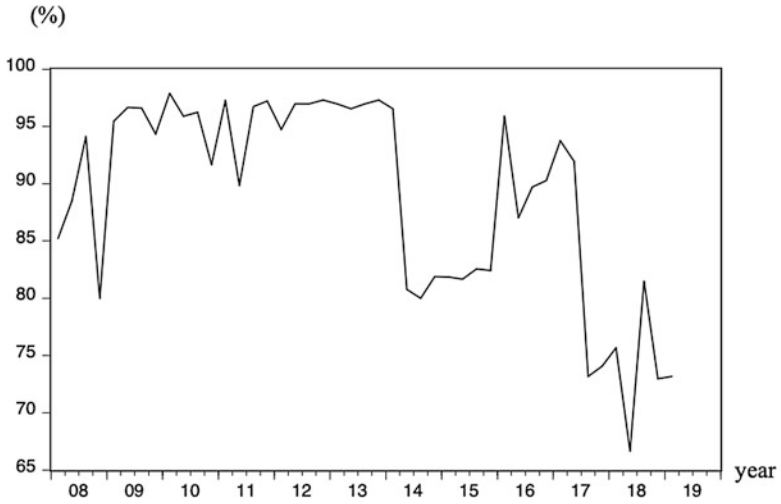

Fig. 4.4 Gamblers as a proportion of sum of gamblers and MICE participants since 2008. (*Source*: Author's calculation based on data of Statistics and Census Service 2019)

service relatively cheaply than convention service, it produces more gambling service. The second part of Proposition 2 requires a test to see how the proportion α responses to a change in the size of tourism market a.

a is a parameter of the demand functions of the tourism services. To derive a, an estimation of the demand functions is necessary. The estimated demand functions are probably nonlinear and more complicated than those assumed in the model. Nevertheless, the purpose of the model is not to describe the demand functions precisely; rather, a was incorporated in the model as a catch-all parameter of the exogenous factors that influence the size of the tourism market. Fortunately, neither does Proposition 2 require the actual changes in a be known. Proposition 2 focuses only on how the degree of diversification changes when a increases or decreases. Hence, known measures that reflect the size of the tourism market of Macao represent a in the model.

Econometric Model To analyze the relationship between the size of the tourism market and the degree of service export diversification, this paper uses a VAR model, which is one of the most widely used for time-series analyses. The specification of the VAR model of order p is as follows:

$$Z_t = \beta_0 + \sum_{i=1}^{p} \beta_i Z_{t-i} + \epsilon_t \quad . \tag{4.7}$$

In (4.7), Z_t is a (2×1) vector of the variables that measure the degree of service export diversification and the size of the tourism market. β_0 is a (2×1) intercept vector and β_i's are (2×2) coefficient matrixes. ϵ_t is a (2×1) vector of unobservable

Table 4.3 ADF unit root tests with lag length chosen based on AIC

Variable	Statistic	Prob.	Result
ALPHA	−1.240	0.6483	Non-stationary
VISITOR	−0.038	0.9492	Non-stationary
Δln(*ALPHA*)	−10.063	0.0000	Stationary
Δln(*VISITOR*)	−2.653	0.0911	Stationary

Table 4.4 Two-step Engle and Granger cointegration test

Step	Variable	Coefficient	Prob.
OLS regression: $ALPHA_t = 122.3708 - 0.004604 \times VISITOR_t + r_t$			
	Constant	122.371*** (6.697898)	0.0000
	VISITOR	−0.00460*** (0.000910)	0.0000
ADF test of residuals			
	r_t	−0.49166*** (0.127753)	0.0004

Note: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

i.i.d. zero-mean errors. The variable of the degree of service export diversification is *ALPHA*, which is the proportion of gamblers described in Table 4.2. A straightforward measure of the size of the tourism market is visitor arrivals, which is also described in Table 4.2 and is named as "*VISITOR*" in the following estimation.

Empirical Results Before choosing the VAR model, it is necessary to ensure the stability of the time series. As shown in Table 4.3, the augmented Dickey and Fuller (1981) (ADF) unit root indicates that the series of *ALPHA* and *VISITOR* are not stationary. The first difference of their logged values, on the other hand, is stationary. Hence, the VAR model shall be based on the two stationarized series.

Furthermore, to examine whether correlations between the time series exists, this estimation proceeds with a cointegration test through the two-step Engle and Granger (1987) procedure. As shown in Table 4.4, both coefficients are statistically significant. Besides, the ADF unit root test over the residuals cannot reject the null hypothesis that the variables are cointegrated.

Choosing the right VAR model is crucial for further investigation of the relationship between the variables. To determine the order of the VAR model, this analysis considers the common model selection criteria, including LR (Likelihood), FPE (Final Prediction Error), AIC (Akaike Information Criterion), SC (Schwarz Information Criterion), and HQ (Hannan–Quinn Information Criterion) (Akaike 1992; Schwarz 1978; Hannan and Quinn 1979). As shown in Table 4.5, almost all criteria points find the lag length of 4 to be optimal. However, the SC penalizes model complexity more heavily, so it selects a smaller model than the other criteria. Checking of the residual serial correlation of each equation indicates that the

Table 4.5 Determination of the order of the VAR model based on different criteria

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.79e-05	−5.255208	−5.167235[a]	−5.224503
1	8.676861	1.72e-05	−5.295921	−5.032001	−5.203806
2	10.17229	1.55e-05	−5.401837	−4.961971	−5.248312
3	5.740367	1.60e-05	−5.377559	−4.761746	−5.162623
4	10.67630[a]	1.36e-05[a]	−5.550755[a]	−4.758995	−5.274410[a]
5	2.683527	1.56e-05	−5.435874	−4.468168	−5.098118
6	3.137091	1.74e-05	−5.350047	−4.206394	−4.950881
7	4.499503	1.83e-05	−5.342087	−4.022487	−4.881511
8	4.811672	1.87e-05	−5.373110	−3.877565	−4.851125

Note: [a]Lag order selected by each criterion

Table 4.6 Estimation of the *VAR*(4) model

	$\Delta\ln(ALPHA)$	$\Delta\ln(VISITOR)$
$\Delta \ln (ALPHA)_{t-1}$	−0.334989** (0.16623)	−0.096936 (0.11009)
$\Delta \ln (ALPHA)_{t-2}$	−0.073745 (0.16831)	0.157129 (0.11147)
$\Delta \ln (ALPHA)_{t-3}$	0.132203 (0.19072)	0.049039 (0.12631)
$\Delta \ln (ALPHA)_{t-4}$	−0.328175* (0.18901)	0.078973 (0.12518)
$\Delta \ln (VISITOR)_{t-1}$	−0.340728 (0.23222)	−0.015680 (0.15380)
$\Delta \ln (VISITOR)_{t-2}$	0.332112 (0.25278)	−0.300901* (0.16741)
$\Delta \ln (VISITOR)_{t-3}$	−0.498826* (0.25117)	−0.193654 (0.16635)
$\Delta \ln (VISITOR)_{t-4}$	−0.285554 (0.23440)	0.413904*** (0.15524)
Intercept	0.000509 (0.01263)	0.018950** (0.00837)
R^2	0.338367	0.524696
Adjusted R^2	0.167622	0.402037
F	1.981717	4.277677

Note: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

model selected is superior to the model indicated by the SC and confirms the selection of a *VAR*(4) model.

Table 4.6 shows the VAR estimates. There are only a few significant coefficients. They clearly indicate that the major influencing factors of each variable are their own lagged values. The only exception is at lag 3, where $\Delta\ln(VISITOR)_{t-3}$ has a significant negative impact on $\Delta\ln(ALPHA)$. Before further investigation of the relationship between the two variables, it is necessary to ensure the stability of the VAR model. AR root test for joint stationarity of the two series shows that all unit

Table 4.7 VAR Granger causality tests

Dependent variable	Excluded	χ^2	Prob.
$\Delta\ln(ALPHA)$	$\Delta\ln(VISITOR)$	8.990678	0.0613
$\Delta\ln(VISITOR)$	$\Delta\ln(ALPHA)$	4.904642	0.2972

roots fall within the unit circle. Hence, the VAR model is stable and meaningful. Furthermore, the diagnosis tests for the residuals confirm that they are well-behaved. In particular, the LM test confirms that there is no serial correlation in the residuals. The Doornik-Hansen test for multivariate normality does not reject that residuals are normal (Doornik and Hansen 2008). The White test does not reject homoskedasticity (White 1980).

The major objective of estimating the VAR model is to examine whether there is empirical evidence for Proposition 2. In other words, the interest of the present study is to find out whether greater tourism market (i.e., higher a) leads to a greater degree of diversification among the tourism services of gambling and convention (indicated by lower α). The Granger (1969) causality test is useful for this purpose. As shown in Table 4.7, at 7% level, the null hypothesis that $\Delta\ln(VISITOR)$ does not Granger cause $\Delta\ln(ALPHA)$ is rejected. However, the null hypothesis that $\Delta\ln(ALPHA)$ does not Granger cause $\Delta\ln(VISITOR)$ cannot be rejected. It is clear that Granger causality runs from $\Delta\ln(VISITOR)$ to $\Delta\ln(ALPHA)$, but not the other way around. This is a supportive evidence to Proposition 2 that when Macao experiences an expansion in the tourism market (i.e., a positive percentage change in *VISITOR*), it is optimal for the city to further diversity its tourism services by producing a smaller proportion of gambling as compared to convention (i.e., a negative percentage change in *ALPHA*).

Both Granger causality test and the impulse responses provide empirical evidence to Proposition 2. As more visitors arrived in Macao, the tourism market expanded, and there was greater demand for both gambling and convention services. In response, Macao diversified its production toward convention. Imagine the total number of visitors to be a "pie." The theoretical model and the above empirical results describe a case that as the "pie" gets bigger and each "slice" is bigger, each "slice" does not grow by the same percentage. The "slice" of gamblers grows less than the "slice" of MICE participants.

To assess the empirical evidence for Proposition 2, it is also helpful to look into the impulse response of one variable to another. Figure 4.5 shows the orthogonal impulse responses computed using standard Cholesky method. Panel (a) shows that a one-standard deviation change to $\Delta\ln(VISITOR)$ produces a negative response in $\Delta\ln(ALPHA)$ two periods later and a positive response three periods later. However, neither of them has $\pm 2SE$ confidence band that is completely negative or positive. Hence, neither response is statistically significant. The statistically negative response comes four periods after the shock. Afterwards, the responses become statistically and economically insignificant. In Panel (b), the response of $\Delta\ln(VISITOR)$ to $\Delta\ln(ALPHA)$ is insignificant in all the periods. These are empirical evidence that a positive shock in *VISITOR* leads to a significant negative response of *ALPHA* four quarters later. Even though the negative response is not immediate, it is still evident

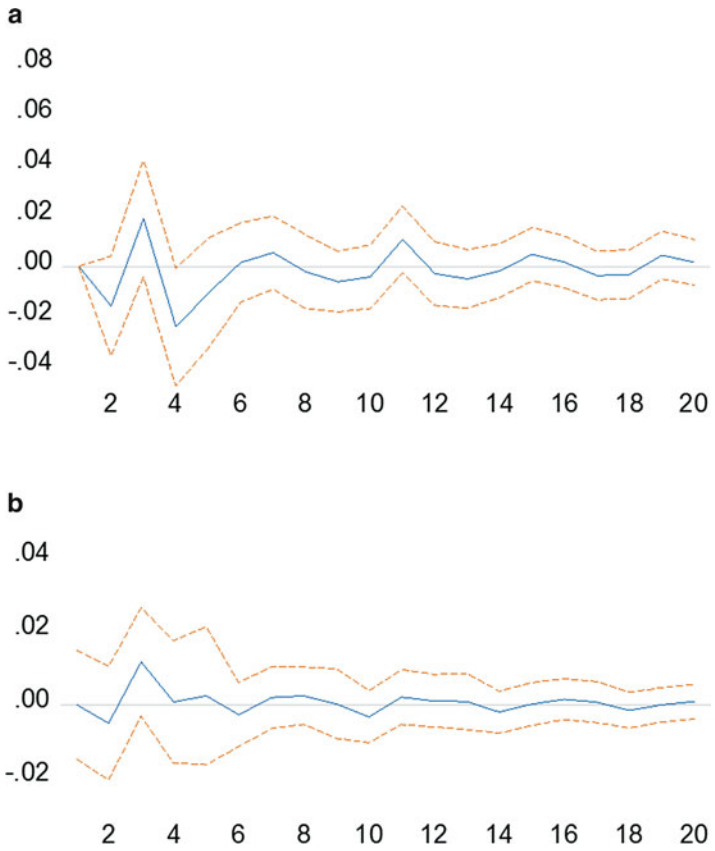

Fig. 4.5 Impulse responses. Panel (**a**) Response of Δln(ALPHA) to Δln(VISITOR). Panel (**b**) Response of Δln(VISITOR) to Δln(ALPHA).

that an increase in visitor arrivals brings a decrease in the proportion of gamblers, which is in line with Proposition 2.

A Robustness Check Table 4.2 shows that a large percentage of Macao's visitors are mainland Chinese. As more mainland Chinese visit Macao, the market for Macao's tourism services certainly increases. Therefore, as a robustness check, the number of Chinese visitors, called *CHINESE*, can replace the total number of visitors as the measure of market size in Z_t in (4.7). The estimation of the VAR model follows the same procedures that are described above. Since the ADF test find the time series of *CHINESE* to be non-stationary, but the first difference of its logged values to be stationary, the VAR model makes use of the latter. The two-step Engle and Granger (1987) cointegration test first regresses *ALPHA* on *CHINESE* and finds

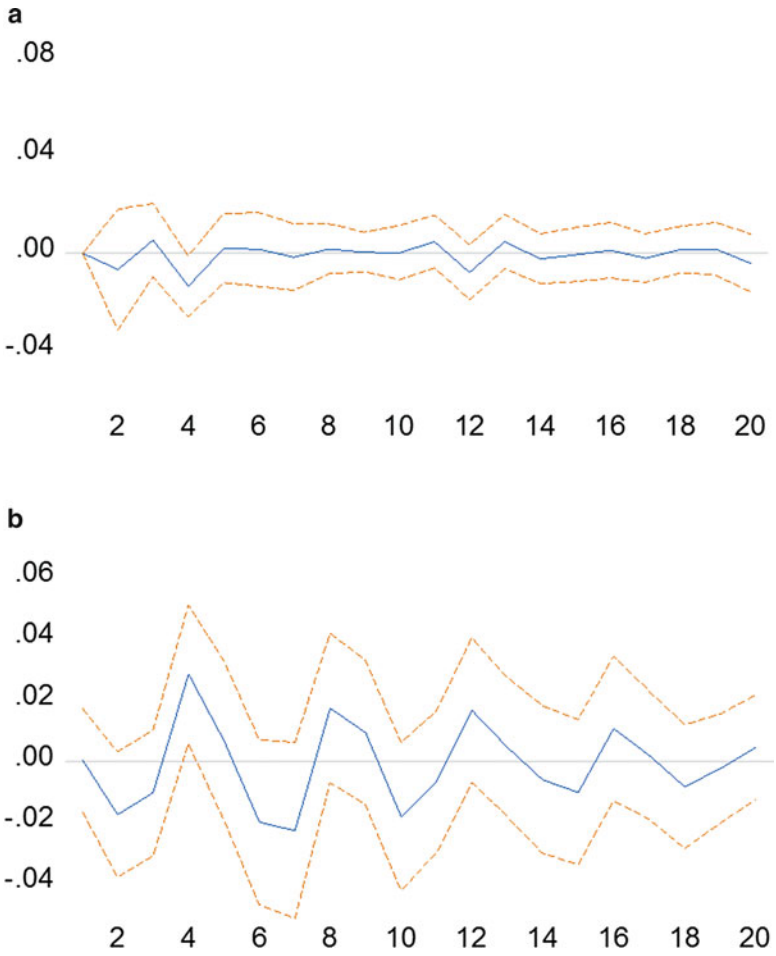

Fig. 4.6 Impulse responses. Panel (**a**) Response of Δln(ALPHA) to Δln(CHINESE). Panel (**b**) Response of Δln(CHINESE) to Δln(ALPHA).

significant coefficients for both the intercept and *CHINESE*. The ADF unit root test on the residuals fails to reject that there is cointegration between *ALPHA* and *CHINESE*, revealing a static relationship between the variables. The selection criteria disagree on the order of the VAR model. The AIC points to a lag length of 8, while the FRE and the HQ select an order of 7. However, LR and SC indicate a much lower order of 4. Hence, this study seeks a common ground between 4 and 8. After closely examining the stability of each VAR model and making sure there is no undesirable behavior in the error term, this study finds *VAR*(6) to be appropriate (Fig. 4.6, Tables 4.8 and 4.9).

Table 4.8 Estimation of the *VAR*(6) model

	$\Delta\ln(ALPHA)$	$\Delta\ln(VISITOR)$
$\Delta \ln (ALPHA)_{t-1}$	−0.151382 (0.19216)	−0.259773* (0.15243)
$\Delta \ln (ALPHA)_{t-2}$	−0.293325 (0.19893)	−0.228204 (0.15780)
$\Delta \ln (ALPHA)_{t-3}$	0.164188 (0.22643)	0.306312* (0.17961)
$\Delta \ln (ALPHA)_{t-4}$	−0.430544** (0.20310)	0.166406 (0.16111)
$\Delta \ln (ALPHA)_{t-5}$	0.200214 (0.22764)	−0.128469 (0.18057)
$\Delta \ln (ALPHA)_{t-6}$	−0.358471 (0.21788)	−0.384986** (0.17283)
$\Delta \ln (CHINESE)_{t-1}$	−0.129057 (0.23784)	−0.138947 (0.18866)
$\Delta \ln (CHINESE)_{t-2}$	0.066291 (0.18155)	−0.061600 (0.14401)
$\Delta \ln (CHINESE)_{t-3}$	−0.272796* (0.14790)	−0.172178 (0.11732)
$\Delta \ln (CHINESE)_{t-4}$	−0.007370 (0.14546)	0.418410*** (0.11538)
$\Delta \ln (CHINESE)_{t-5}$	−0.044547 (0.13583)	−0.263929** (0.10775)
$\Delta \ln (CHINESE)_{t-6}$	−0.023146 (0.11626)	−0.004288 (0.09222)
Intercept	−0.003175 (0.01768)	0.032552** (0.01403)
R^2	0.484719	0.888305
Adjusted R^2	0.237384	0.834691
F	1.959767	16.56861

Note: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

Table 4.9 VAR Granger causality tests

Dependent Variable	Excluded	χ^2	Prob.	Result
$\Delta\ln(ALPHA)$	$\Delta\ln(CHINESE)$	14.27481	0.0267	Rejected
$\Delta\ln(CHINESE)$	$\Delta\ln(ALPHA)$	14.15399	0.0280	Rejected

4 Concluding Remarks

The established advantages of Macao's gaming industry generate economies of scale in the city's production of gambling service. The same does not apply to other tourism services of Macao, such as convention service. The stylized model of this paper, therefore, assumes Macao incurs a relatively lower cost in producing gambling service than convention service. Comparison of the expenditure-gross-surplus

ratios of the two tourism services confirms this view. When Macao has cost advantage in gaming production, the model finds that it is optimal for the city to specialize in gambling service production. That is, gambling service as a proportion of the sum of gaming and convention services should be more than 50%. The visitor arrivals data distinguish gamblers and MICE participants by their main purpose of visit. The proportion of gamblers has a range that is higher than 50%, matching the model's proposition.

Rather than further specializing in gaming production, the government of Macao aims at prioritizing the production of convention service. The government's objective not to further exploit the economies of scale in the gaming industry appears to contradict economic reasoning. The model of this paper provides a theoretical explanation. When the tourism market expands, it is optimal for the city to diversify – to produce a larger proportion of the costlier product. This matches what happened in Macao's tourism market. The visitor arrivals in Macao have increased over the past decade mainly due to a surge of mainland Chinese tourists, so the response of the proportion of gamblers can be tested empirically. The VAR model indicates the percentage change in the number of visitors Granger causes a percentage change in the proportion of gamblers. The impulse responses of the proportion of gamblers to a positive shock are significantly negative four periods later. These provide empirical evidence that Macao diversifies its service export by inclining toward production of convention service when the tourism market expands. The VAR model constructed over mainland Chinese visitor arrivals offers a robustness check. The Granger causality test shows that the number of mainland Chinese tourists is a significant factor that influences the proportion of gamblers. The impulse responses of the proportion of gamblers to an increase of Chinese visitors, even though delayed for four periods, are significantly negative. Hence, both the theoretical and empirical analyses of this paper give the same conclusions.

A possible extension to this paper is to study competing cities of Macao. For example, Singapore is an interesting case to study because it is in the opposite situation of Macao. Singapore has an established convention industry, and it must have cost advantage in producing convention service over gambling service. Yet, Singapore also pursues diversification in tourism services by opening casinos in 2010. The present theoretical model would hypothesize that Singapore should diversify more when facing a growing tourism market. Future studies can test this hypothesis empirically using Singaporean tourism data. Besides, an extension to the theoretical model is to include multiple cities. For example, Lei (2018b) constructed a two-city strategic trade model and a three-city strategic trade model that emphasized competition between cities. Strategic interactions between cities can affect the optimal degree of tourism service export diversification. Such model can provide insights into the competition between Macao and Singapore. Lei (2018b) also suggested to consider Osaka as the third competing city since it might launch an integrated casino resort soon (Johnson 2017). While Lei (2018b) explored a theoretical explanation, future studies can further investigate on the empirical evidence.

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Chapter 5
The Impact of Incentives on Organizational Commitment in Public Organizations in Egypt

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Abstract The purpose of this research is to explore the dynamics of incentive systems practices in the public organizations. More specifically, this research tries to point out some main aspects of incentive systems, which strongly influence the degree of employees' organizational commitment. The practical study here tends to show greater insights into the incentives-organizational commitment relationship and its validation at the Ministry of Communications and Information Technology (MCIT) in Egypt as a case study. This research depends on descriptive analytical approach. The design of the study is both descriptive in the theoretical part and quantitative in the applied one. Theoretically, this research implemented the analytical approach to define the main concepts using an empirical study to explore correlations in practice. Although the issue studied in this case study of MCIT can be considered to some extent as a localized issue, the same case study can be resembled to other international entities that is working in the same domain (communications and information technology industry) and having the same conditions of the case study like being a public organization with almost the same circumstances. MCIT has already done some studies on enhancing the incentive systems, and these studies already enhanced the incentive systems to some levels; however, these studies were not efficient enough as they have neglected the organizational commitment as being an import factor to get the most benefit of the employees' capabilities and reinforce the employees' loyalty toward the organization. This research concludes that the employment of best incentive systems practices is considered a significant tool in enhancing the organizational commitment. Also, the results of analysis provide evidence that incentives systems contribute to organizational commitment at MCIT. The findings and recommendations of this research can practically guide management to devise effective policies to improve organizational commitment using right incentive systems, particularly in the Egyptian public organizations. Also, this research has good implications for both theory and practice, as it offers contribution on literature in the field of study, as well as the practical contribution.

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Keywords Incentives · Concept of incentives · Organizational commitment · MCIT · Public organizations

1 Introduction

The issue of incentives has always occupied a prominent place since the beginning of the researchers to examine how individuals perform optimally, and to study how to improve performance efficiency, which ensures the effective achievement of the organization's objectives. We can say that the human factor is the primary factor in increasing production. Therefore, upgrading the efficiency of the human factor becomes an important necessity in order to achieve the objectives pursued by the organizations.

Incentives in public organizations are considered a human input, whereby management can increase efficiency and stimulate the desire of individuals to do their job better. Incentives are divided in terms of nature or value into two types: nonmaterial (moral) incentives and material incentives (El Taaey 2006). On the other hand, organizational commitment determines the degree of cohesion among workers, the leadership style, and to what extent, the organizational climate encourages achievement, creativity, and the desire of the individual to achieve its objectives. The existence of a good system of incentives is a reason for making the employees behave positively toward themselves and toward the organization. This positive attitude toward the organization is the core of the organizational commitment process.

2 Research Problem and Objective

The research question in this study can be considered as "to what extent different incentive systems affect the level of organizational commitment of employees in Egyptian public organizations." This research question considers the Ministry of Communications and Information Technology (MCIT) as a case study.

The researcher here aims at achieving three main objectives which are introducing the basic concepts and types of incentives and studying the concept of organizational commitment in the public organizations, along with studying the impact of incentive systems on organizational commitment in Egyptian public organizations taking (MCIT) as a case study.

3 Literature Review for the Concept of Incentives and Organizational Commitment

The concepts and definitions of incentives and organizational commitment are varying according to the researchers who have addressed this concept, as well as according to the different schools of thought to which they belong. The study of human behavior in the public organizations is aiming at searching for the reasons behind why individuals do something enthusiastically, while there is no such enthusiasm in other individuals or even the same person in varying stages of time. There are several definitions of incentives; they can be defined as reinforcing the individual desire toward achieving the goals of the organization (Al Kaaiby and Samery 1990). Incentives can be also defined as all that is given to the employee materially or morally for his creations and innovations or for his outstanding work, in the field of work or the work space (Civil Service Law 1991). (Kreitner 2007) defines incentives as the ability to reward subordinates for their work and their commitment to the procedures, rules, instructions, and ethics and have to be attached to the behavior of individuals in the performance of their duties. Coccia Mario (2019) has split the incentives in definition in two ways: intrinsic incentives that exist in the job itself and give personal satisfaction to individuals, such as autonomy, reputation, self-confidence, trust, empowerment, etc., and extrinsic incentives that can be expressed as pay, gifts, promotion, advancement opportunities, etc. Extrinsic incentives are important in relation to continuance commitment to organizations.

Organizational commitment refers to the quality of the relationship between the individual and the organization; it sets the positive feeling of the employee toward his organization and reflects the extent of his association and his desire to remain an active member.

A distinguished theory in organizational commitment is the three-component model (TCM) (Jaros 2007). According to this theory, there are three distinct components to organizational commitment:

Affective commitment: Is the employees' feel of commitment in accordance with the rate of their adopting the organization's values, goals, and aims

Continuance commitment: Is the commitment that is developed as a result of employees' investment in their organizations

Normative Commitment: Is the level of commitment where an employee feels obligated to stay in the organization, where they feel staying in the organization is the right thing to do

Inas (2003) has discussed the level of organizational commitment. The researcher studied the relation between organizational commitment and job satisfaction through

some personal variables such as gender, educational qualification, and social status of the social supervisors. Amira (2003) also worked on measuring the impact of organizational commitment on the relationship between organizational justice and citizenship behavior in the public organizations. The study discussed the definitions of organizational commitment, organizational justice, and organizational behavior.

Afify et al. (2017) have also studied the impact of incentives on the organizational commitment of employees. The results of the study showed that incentives affect positively the organizational commitment and that organizational justice is defined as the relationship between material incentives and job satisfaction, and organizational trust can be defined as the relationship between job satisfaction and organizational commitment.

Nazir et al. (2016) conducted a study which examined the effect of intrinsic, extrinsic, and social rewards on organizational commitment. This study supports the three dimensions of organizational commitment. The questionnaire was provided in a Likert scale format and was given to the working individuals. After analyzing the data, it was found that extrinsic, social, and intrinsic rewards result in higher levels of affective and normative commitment in both public and private-sector employees. In Dabir and Azarpira (2017), the study concluded that there is a reverse and significant relationship between education and organizational commitment, like the higher the level of education, the lower the affective commitment and normative commitment.

The research hypotheses in this research were set out as there is no significant impact at significance level $\alpha = 0.05$ of either incentive systems availability, work environment conditions, organizational culture, or organizational leadership on organizational commitment at the Ministry of Communications and Telecommunications in Egypt. The hypotheses test will be furtherly explained later in "Testing the Research Hypotheses" section.

4 The Special Nature of Incentives in Public Organizations

Some special features for incentives can be noticed in public organizations. These special features include the following:

1. Variety of dimensions, stakeholders, and tasks
2. Trying to adopt the planned governmental policies, while keeping or even maximizing the productivity

From these special characteristics, we can explain why these public organizations are considered as public sector in the first place. That can also explain why one cannot just apply ready-made solutions like competitive or performance-based incentives directly in public organizations. Although applying these kinds of

ready-made incentives has some advantages in some dimensions or for some managers, it can generate some undesired reactions in other dimensions or to other managers (Dixit 2002). Ratto and Burgess (2003) have conducted a study discussing the special nature of incentives in public organizations, this study conducted a message that the use of performance-related incentives, and, in particular, performance-related pay, is more problematic in the public sector than in the private sector. This is due to aspects like multitasking, multiple principals, the difficulty of defining and measuring output, and the issue of the intrinsic motivation of workers.

5 Conditions for Successful Incentives in Public Organizations

There are some basic conditions for incentives that must be satisfied in public organizations, to ensure their increased returns in the organizations. Some of these conditions include that they should be linked to the objectives of both the employees and management together, also, choosing the appropriate time to use incentives, especially for material incentives; furthermore, one of the conditions is ensuring continuity of incentives and creating an inner feeling in the individual that there is a regularity in the incentives system.

6 The Importance of Organizational Commitment

The importance of the organizational commitment is reflected in its impact on both the workers on part and the organization on the other part.

Some studies (Mohamed 1997; Reichers 1985) have led to a greater focus on the concept of organizational commitment and lead toward further studies of the concept. There are several reasons for why we should focus on that concept, for example, organizational commitment is one indication of interdependence between the individual and the organization and stems from within the individual and not imposed by the organization. Also, organizational commitment helps to create a cooperative and complementary relationship between the employees and organizations in which they work together, rather than being at odds with each other in the organization. In addition, organizational commitment increases the degree of job satisfaction of employees as a result of reducing pressures and conflicts and solving employee problems.

So, it can be said that the organizational commitment is an important basis for judging the policy of using human resources in the suitable way and the effectiveness of these policies.

7 Research Methodology and Design

This research depends on descriptive analytical approach. The design of the study is both descriptive in the theoretical part and quantitative in the applied one. Theoretically, the research used the analytical approach to explain the key concepts and a practical study to investigate the correlations in practice. Therefore, in addition to providing a brief overview of relevant literature, a field survey was conducted to determine to what extent the incentives systems contribute toward the enhancement of the organizational commitment. The Ministry of Communications and Information Technology (MCIT) in Egypt was chosen to be the case study here because it is considered one of the crucial public service organizations and almost the most important governmental institution in Egypt that is responsible for providing communications services generally. Also, the contribution of the ICT sector to the national economy increased by 3.1%. The growth rate of this sector reached 11.5% during the first 9 months of 2016/2017, and the export of ICT services during the current year reached 1.87 billion dollars. MCIT contributed with 4% in the gross domestic product (GDP) in Egypt in 2018/2019. This show how important that organization is and how the increase in productivity in this sector will reflect in increasing the GDP in Egypt.

In the previous sections, the researcher has discussed the theoretical part of the research represented in discussing the literature review for the concept of incentives and organizational commitment, the special nature of incentives in public organizations, conditions for successful incentives in public organizations, and the importance of organizational commitment. In the following sections, the practical part is discussed.

7.1 Population, Sample, and Selection of the Sample

The field survey was conducted during September 2018. The researcher chose a random sample of employees in MCIT Headquarters located in Smart Village City in Cairo. The whole population included about 350 people who work for MCIT in this location, and only 315 people responded, with a 90% response rate. The sample size of 315 people was distributed between 110 managers [top and mid-level management] and 205 employees [non-managers]. This sample also was randomly selected.

7.2 Data Collection

For the purpose of collecting the required primary data, an adopted Arabic language-structured questionnaire was applied. Arabic language was chosen as it is the official language in Egypt (it was initially formulated in English and then translated to Arabic). It includes 50 items representing the various aspects of the subject; the questionnaire was designed and organized into the following sections: demographic profile and professional characteristics of respondents (moderating variable) (5 questions not included in the 50 main items), incentive systems attributes (independent variable) that consist of incentive systems availability (10 items), work environment conditions (10 items), organizational culture (10 items), and organizational leadership (10 items), whereas organizational commitment (dependent variable) contains the organizational commitment availability factors (10 items).

The translation was done to conduct the same meaning existed in English into Arabic. Being fluent in both English and Arabic, the researcher did not have any issue in conducting the same meaning in both languages.

It is worth mentioning here that the study used the questionnaire to gather data and a five-point Likert scale as the measurement tool, ranging from 1 = strongly disagree to 5 = strongly agree. Moreover, Cronbach's alpha test was used to assess the stability of the questionnaire and reliability of the measures, and it was found that all coefficients are above 0.50, so there is evidence that the research variables seem to be consistent, stable, reliable, and valid.

7.3 Methods of Statistical Analysis

Statistical Package for Social Survey (SPSS-V.23) was the tool for compiling and processing data in this research. Several statistical tools were also used for data analysis, which are descriptive analysis, simple linear regression, and structural equation modeling, along with multiple linear regression model.

Demographic and professional characteristics of respondents are shown in Table 5.1.

From the above table, we can see that the distribution of the samples according to the variable "gender" indicates that males have a ratio of 57.5% from the sample space, while the females are representing 42.5% from the sample space. This indicates that the dataset is balanced to good extent according to the "gender." From the "qualification" prospective, we can see that the highest number of samples has "University Degree" with a ratio of 57.1% from the sample space. This contributes to higher confidence in the study results as more education eventually means more awareness from the respondents about the scope and objective of the study questions.

Table 5.1 Demographic and professional characteristics of the sample space

Percentage %	Count	
Gender		
57.5	181	Male
42.5	134	Female
100	**315**	**Total**
Qualification		
20.3	64	Secondary school
57.1	180	University degree
22.5	71	Postgraduate
100	**315**	**Total**
Age		
17.8	56	< 30 years
41.6	131	Between 30 years and less than 40 years
31.1	98	Between 40 years and less than 50 years
9.5	30	$\geq$ 50 years
100	**315**	**Total**
Job level		
13	41	Higher management
21.9	69	Mid-level management
65.1	205	Entry level
100	**315**	**Total**
Years of experience		
13.3	42	< 10 years
39.7	125	Between 10 years and less than 15 years
26	82	Between 15 years and less than 20 years
21	66	$\geq$ 20 years
100	**315**	**Total**

For the "age" variables, the highest ratio of the sample space is having an age ranging from 30 to 40 years, indicating that the Ministry is tending to hire younger aged employee rather than hiring old aged ones. This age domain is reflected in the "job level" variable, indicating that the higher ratio of the sample space is in "entry level" jobs, with less percentage when going up to "mid-level" and "higher management" levels, which demonstrates the normal "pyramid" distribution in job levels, with broadband entry level jobs and narrower band for mid-level management and higher management, respectively.

The previous distribution for age and job level reflects in the "years of experience" variable, with most employees having less than 15 years of experience (53%).

7.4 Testing the Research Hypotheses

To accomplish the objectives of the practical study, the research set out the following hypotheses:

H.1 There is no significant impact at significance level $\alpha = 0.05$ of incentive systems availability on organizational commitment at Ministry of Communications and Telecommunications in Egypt.

H.2 There is no significant impact at significance level $\alpha = 0.05$ of work environment conditions on organizational commitment at Ministry of Communications and Telecommunications in Egypt.

H.3 There is no significant impact at significance level $\alpha = 0.05$ of organizational culture on organizational commitment at Ministry of Communications and Telecommunications in Egypt.

H.4 There is no significant impact at significance level $\alpha = 0.05$ of organizational leadership on organizational commitment at Ministry of Communications and Telecommunications in Egypt.

To show whether the previous hypotheses are acceptable, simple linear regression was used to test the impact of each dimension of the incentive systems, on organizational commitment, as presented in Table 5.2. The hypothesis will be rejected if the significance of the model is less than 0.05 and vice versa.

In simple linear regression models, the relation between each independent variable and the dependent variable (organizational commitment) is formulated, so in this case we have four models to study the relation of each independent variable (incentive systems availability, work environment conditions, organizational culture, and organizational leadership) on organizational commitment at Ministry of Communications and Telecommunications in Egypt.

In Table 5.2, beta represents the coefficient of the linear relation between the independent variable and the dependent variable, like the following equation:

Table 5.2 Simple linear regression models of the dependent variable on the different independent

Simple regression model	Dependent variable	Independent variable	Beta	Significance of the model	Adjusted R-squared
First	Organizational commitment	Incentives systems availability	0.805	0.000	0.649
Second		Working environments conditions	0.628	0.000	0.394
Third		Organizational culture	0.585	0.000	0.342
Fourth		Organizational leadership	0.750	0.000	0.563

$$\text{Dependent variable} = \alpha + \beta \times \text{independent variable}$$

The coefficient β affects the dependent variable in two ways:

The sign of the coefficient β represents the direction of the relation, meaning that if the sign of β is positive that means that the dependent variable value increases when the independent variable value increases, and if the sign of β is negative that means that dependent variable value decreases when the independent variable value increases.

The value of the coefficient β represents the change in the dependent variable value for every unit change in the independent variable value (e.g., if β equals to 0.805, this means that the dependent variable value changes by 0.805 units for every single unit of change of the independent variable).

The significance of the model is the P-value statistical measure, which is the probability of rejecting the null hypothesis. If this P-value is less than the significance level/threshold 0.05, this means that we can reject the null hypothesis.

The adjusted R-squared is a statistical measure that measures the amount of variation in the dependent variable (organizational commitment) that is explained by the independent variable.

$$\text{R} - \text{squared} = \text{Explained variation}/\text{total variation}$$

Table 5.2 indicates the following:

From the first model, it is obvious that incentive systems availability has a significant positive effect on organizational commitment at confidence level 95%, and this appears from the value of beta. From the adjusted R-squared, it is noticed that incentive systems availability has the ability to explain about 64.9% from the variation in organizational commitment in MCIT. For the second model, when working environment condition is the independent variable, it is clear that working environment condition has a significant positive effect on organizational commitment at confidence level 95%. From adjusted R-squared, it is noticed that working environment condition has the ability to explain about 39.4% from the variation in organizational commitment in MCIT. For the third model, when organizational culture is the independent variable, it is obvious that organizational culture has a significant positive effect on organizational commitment confidence level 95%. From adjusted R-squared, it is noticed that organizational culture has the ability to explain about 34.2% from the variation in organizational commitment in MCIT. For the fourth model, when organizational leadership is the independent variable, it is clear that organizational leadership has a significant positive effect on organizational commitment at confidence level 95%. From the adjusted R-squared, it is noticed that

organizational leadership has the ability to explain about 56.3% from the variation in organizational commitment in MCIT.

From the previous results, the study can conclude that there are significant impacts at significance level $\alpha = 0.05$ of the various incentive systems dimensions (incentive systems availability, working environment conditions, organizational culture, and organizational leadership) on organizational commitment at MCIT, which means that the four hypotheses are all rejected.

The linear regression equations for each of the independent variables (incentive systems availability, working environment conditions, organizational culture, and organizational leadership) and the dependent variable are illustrated as follows:

$$\text{Organizational commitment} = 0.870 + 0.805 \text{ Incentive systems availability}$$

$$\text{Organizational commitment} = 0.796 + 0.628 \text{ Working environment conditions}$$

$$\text{Organizational commitment} = 0.956 + 0.585 \text{ Organizational culture}$$

$$\text{Organizational commitment} = 0.849 + 0.750 \text{ Organizational culture}$$

The previous equations are formulated in the form of:

$$Y = \alpha + \beta \times X$$

which can be translated in our case to:

$$\text{Dependent variable“organizational commitment”} = \alpha + \beta \times \text{Independent variable}$$

where α is the constant part in the equation that represents the intersection of the line with the y-axis of the relation (organizational commitment); it can also be defined as the value of the dependent variable when the value of the independent variable is zero.

Also, multiple linear regression was implemented for the impact of different incentive systems dimensions on the organizational commitment. However, simple linear regression is implemented as explained before; the multiple linear regression is also done to understand the functional relationships between the dependent and the combined independent variables and to see what might be causing the variation in the dependent variable. It is about understanding how the combination of all the independent variable together affects the dependent variable rather than studying the individual effect of each of the independent variable on the dependent variable as in simple linear regression.

Table 5.3 Multiple linear regression for the impact of different incentive systems dimensions on the organizational commitment

Multiple regression model	Dependent variable	Independent variable	Beta	Significance of the model	Adjusted R-squared
Constant term			0.946		
First		Incentives systems availability	0.290		
Second	Organizational commitment	Working environments conditions	0.166	0.001	0.664
Third		Organizational culture	0.460		
Fourth		Organizational leadership	0.265		

The βs in Table 5.3 are the partial regression coefficients. Thus, β for the first independent variable represents the marginal effect of the first independent variable on the dependent variable keeping all other independent variables (second, third, and fourth) constant. The results are summarized in Table 5.3.

The multiple linear regression equation for the combined independent variables (incentive systems availability, working environment conditions, organizational culture, and organizational leadership) and the dependent variable is illustrated as follows:

$$\begin{aligned}\text{Organizational commitment} = {} & 0.946 + 0.29\ \text{Incentive systems availability} \\ & + 0.166\ \text{working environment conditions} \\ & + 0.460\ \text{organizational culture} \\ & + 0.265\ \text{organizational leadership}\end{aligned}$$

8 Conclusions

This study has gone a substantial way toward meeting its prime goal, which is examining the relationship between incentives and organizational commitment in public organizations, especially in developing countries. This research has concluded that good incentive system practices contribute to enhancing the organizational commitment, as it was relatively found at the MCIT, despite the need for further improvement efforts.

Through both the theoretical and applied parts of this research, the researcher reached to some recommendations. These recommendations include preparing periodic studies on the currently applied incentive systems along with the encountered difficulties. The researcher also recommends introducing some new incentives for employees like giving some promotions (e.g., discounts coupons) in some famous

retail chains, or commercial agencies. Furthermore, the researcher recommends paying more attention to the creation of an appropriate working environment for the employees, like increasing the value of reward policy and reducing the use of punishments for workers within the organization. Enhancing the emotional commitment of the employees in the ministry is one of the recommendations as well; this can be achieved by giving the employees the opportunity to participate in the decision-making process, especially the decisions that need discussions and affect the workers directly. This can be done through holding meetings and workshops with the employees to discuss ideas related to the work.

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Chapter 6
Impact of Various Employment Schemes on Employment Generation in Northern India: An Empirical Study in Punjab and Haryana, India

Neha Goyal and Meenal Sharma Jagtap

Abstract India's economic development saw a major boost with the introduction of the liberalisation policies in the early 1990s, which also affected the employment scenario. Over the years, various governments of the country have initiated several schemes to improve the employability of the populace. This paper aimed at analysing the impact of various employment schemes on the employment generation in Northern India especially the Haryana and Punjab states of India. Empirical study consisting of survey method was carried out on beneficiaries of employment generation schemes in selected rural areas of Northern India (four villages each from Haryana and Punjab). Data was gathered using close-ended, structured questionnaire, and a total of 138 individuals were included in the study. The responses were analysed using SPSS v23, wherein the impact of the employment schemes on the employment of the individuals was tested using correlation and regression analysis. There is a positive and significant impact of different government employment schemes on the employment generation of the rural unemployed in Punjab and Haryana. However, there are certain limitations mentioned in the paper that needs to be addressed in future studies.

Keywords Employment generation · Employment scheme · India

1 Introduction

The well-being of an economy is affected by various factors, and unemployment is the most crucial factor affecting the pace of growth and development (Srinivasan 2010). Unemployment and poverty act together; therefore, to eradicate poverty, an

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economy must overcome unemployment. India has been facing the higher unemployment rate and poverty for a long period of time. Indian government has initiated various employment generation programmes and schemes since the post-liberalisation such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA 2005), Jawahar Rozgar Yojana/Jawahar Gram Samridhi Yojana, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Rural Employment Generation Programme, and a few others to name (Basu 2013). Such schemes were and have been very effective and important for the growth and poverty alleviation as they focused on providing employment opportunities to backward areas, creating higher standard of living by providing higher wage income. For instance, MGNREGA has achieved to cover all districts in India, employing 50 million rural households in 2012/2013 at a cost of US$8.9 billion, whereas in 2017 it rose to 48 million since 2012. On the other hand, the Prime Minister's Employment Generation Programme (PMEGP) generated 17,799 employments at a total expenditure of Rs. 6001.36 crore. These schemes also reduce rural-urban migration as with development of rural area, people do not migrate to metropolitan cities for better jobs. Some schemes were initiated in order to enhance the skills and knowledge of workers by providing training programmes and skill development programmes. It is estimated that more than 2 million jobs have been created since 2010 from initiation of different employment and existing employment generation schemes in India (Dutta et al. 2014).

India came up with a few major employment generation programmes in the post-liberalisation period. The 10th 5-year plan (2002–2007) undertaken by the Planning Commission of India aimed to overcome the problem of unemployment by increasing the demand of labour force in the market. The Government initiated various employment generation schemes which had positive impact on employment rate and growth of India. One of such was the Rural Employment Generation Programme in 1995 with the objectives to provide employment opportunities in rural areas, to provide entrepreneurial skills and aptitude to unemployed youth in rural area, and to achieve the goal of rural industrialization (Government of India 2017). Since the commencement of REGP, 186,252 projects have been financed, and 22.75 lakhs job opportunities were created till 4th of April 2004. The Government initially set a target of creating 20 lakh additional jobs during the 10th plan period with a plan investment of Rs. 1177 crore. Similarly, the Indira Awaas Yojana (IAY) programme aims at providing free housing to below poverty line (BPL) families in rural areas, and the main targets would be the households of SC/STs (Governmnet of India 2017). It was first merged with the Jawahar Rozgar Yojana (JRY) in 1989, and in 1996, it broke away from JRY into a separate housing scheme for the rural poor. However, the prominent of all were Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in 2005 that aimed to provide 100 days assured employment every year to every rural household (Government of India 2019).

One-third of the proposed jobs would be reserved for women. In addition, it was also mandated that if anyone is not provided employment within 15 days he/she will be entitled to a daily unemployment allowance. In the next few years, many more skill development and employment generation programmes were launched.

Employment generation in India has been a prolonged issue according to the Ministry of Labour and Employment (2018) as presented in the Annual Report 2017–2018 especially in the rural areas. Among the rural population, the tribal unskilled labour, forest workers, and educated unemployed comprise the highest percentage of unemployment. Since the independence, the Indian Government has been fighting to improve the state of unemployment in India. Even though the annual reports and achievement reports of the mentioned employment schemes have indicated an increase in employed rural and urban youth, there is a lack of empirical evidence of the impact of these schemes in the lives of the rural population. In addition, literatures by Breitkreuz et al. (2017), Carswell and De Neve (2014), and Jha et al. (2017) do not show the perspectives of rural employed on the importance and need of these schemes for livelihood. Although the literature provides solution to the existing schemes, no recent study implicates how these schemes can be used by the unemployed youth and adults of rural areas in India to improve their lifestyle and living conditions. Therefore, the paper aimed at analysing the impact of various employment schemes on the employment generation in Northern India during the 1990–2016. In addition, the impact will be seen on the level of perspectives of the rural population who got employed on the basis of the employment schemes. In addition, this study also recommends for the unemployed rural population and the population from villages as a whole. The study also uses statistical assessments to signify the importance and the impact of various government employment schemes in Punjab and Haryana region.

2 Literature Review

To understand the impact of employment strategies taken up by the government of India in order to generate employment, it is more important to understand the effects of unemployment on economic growth and development, level of unemployment in India, employment challenges, poverty and unemployment, and so on. Mishra (2017) stated that economic crisis, gap between curriculum and industry demand, and jobless growth are the factor due to which employment still remains a challenge in India. Whereas the research by Reddy et al. (2014) emphasized more on youth unemployment, where according to research, with youth bulge and the increase in the enrolment in schools and colleges creates competition in labour market and unemployment which is a serious problem. Another research (Dutta et al. 2014)

analysed the impact of employment generation rate in India on the poverty rate in India taking state-wise data. The study analysed the inverse relation between the two indicators and suggested the accomplishment of growth of employment generation in order to eradicate poverty. Again, Niranjan and Shivakumar (2017) spotted the relationship between inequality in India and growth in employment generation where it was found that disparity in an economy leads to lower employment opportunities for poor people and those who belong to minority social groups like SC/ST.

Another research by Kiran et al. (2007) highlighted Integrated Rural Development Programme (IRDP), which was launched in 1978–1979, in order to deal with the dimensions of rural poverty in the country. As a result of scheme, many banks for the provision of credit facilities and the technical extension were developed due to which 70% of households had received financial assistance. Fatima and Pradesh (2017) also implicated that Swarna Jayanti Gram Swarozgar Yojana (SGSY) was introduced after the failure of IRDP, with the objective to bring the assisted poor families above the poverty line in 3 years from the date of their coverage under the scheme. Under the scheme, the loans were provided into one or two instalments. 64% of groups received loans in two instalments which had to be repaid in instalments, but 59% beneficiaries failed to repay the loan. Reddy et al. (2014) further elaborated the impact of Sampoorna Gram Rozgar Yojana (SGRY) launched on 25 September, 2001, with annual outlay of Rs 10,000 crore with sole motive of providing wage employment in all rural areas, thereby providing food security and improving nutritional levels. As a result, 43% of the respondents had received less than Rs 1000, and another 35% had earned Rs.1000–2000. Only 8% had received more than Rs.3000. Thus, large majority of the beneficiaries had received a mere amount under the scheme which is insufficient to control outmigration. Reddy et al. (2014) also elaborated the impact of MNREGA, which was passed by Parliament and notified in 2005, following up on an electoral promise made by the UPA after it came into power in 2004 with an objective of improving living standards of rural people by providing them 100 days of guaranteed minimum wage employment in financial year. As the result of the implementation of MNREGA, wages in the private sector rose to 4.7%, whereas wages rose to 4.8% in agriculture sector. The increment in income led to higher consumption and further employment opportunities.

The current findings from the literatures implicate the positive impact of different employment schemes provided by the Government of India as well as private organizations. These provide a base of research as to various aspects of the employment scheme like the ease of application, the eligibility criteria, employment and self-employment criteria for women, and others. These findings from the literatures provide a base of knowledge on different employment schemes in India and how rural or urban population can apply for the same. Lastly, the literature signifies the need and importance of taking advantage of these schemes and helps in both

personal financial development and the economic growth of the nation. This study is beneficial in this regard as it adds to the existing body of knowledge on the outcomes of employment programs which have played an important role in the policy formulation initiatives of the Central Government of the country since independence, more particularly, after the 1991 reforms. It aims to assess using first-hand information how these policies have affected the intended beneficiaries of the programs with specific emphasis on Northern India, where a significant proportion of these beneficiaries are based. The implications of this study will be useful in assessing the steps the government must undertake to further enhance the effectiveness of the programs.

3 Methodology

A quantitative empirical study was conducted to assess the impact of the employment generation schemes among the rural population of Haryana and Punjab. The study used a convenient sampling to choose four villages each from the states of Haryana and Punjab in India. This is because various employment awareness programmes were held in these villages and this provided an access to the researcher to motivate the employed rural population to participate in the study. In addition, these villages also recorded the top 4 in employed population or entrepreneurs. The village panchayat heads were initially approached with the scope of the study, and then 138 villagers and the middle aged between the ages of 18 and 40 years were surveyed by distribution of the close-ended questionnaires. Majority of the schemes allow employment eligibility to a range of age groups, and hence the age group of 18 to 40 was chosen. The data collection took a month after which the data was compiled and coded. The data gathered was then analysed using SPSS v23 for descriptive and inferential analysis. Reliability of the responses were also checked using Cronbach alpha for features of the employment schemes and advantages of the employment schemes found 0.913 and 0.918, respectively.

4 Analysis

4.1 Descriptive Analysis

Majority of the participants of the study are male with a percentage distribution of 71.7%, and female population comprised of 28.3%. In addition, it was also found that majority of the participants were between the ages of 23 and 29 years. These are

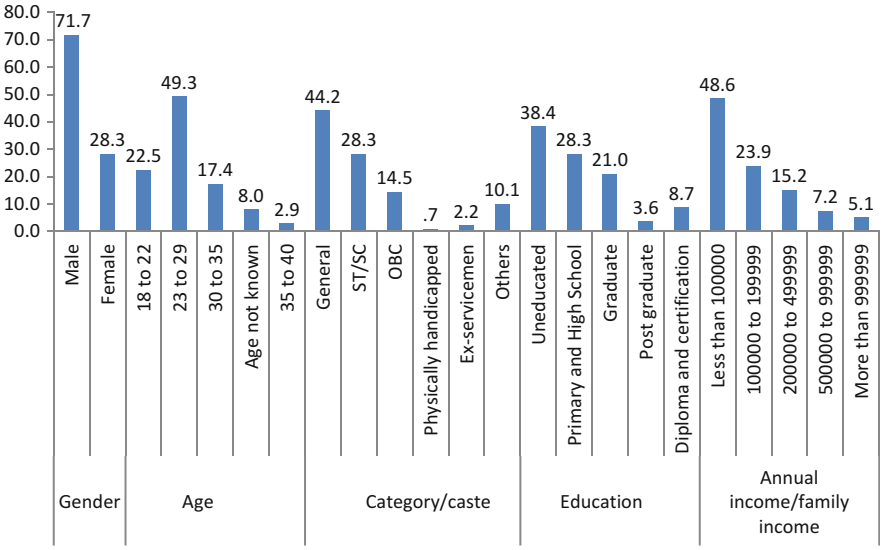

Fig. 6.1 Demographic profile

mostly the employed youth from the employment generation schemes provided by the Government of India. However, 2.9% of the population also comprised of 35–40 years, implicating that people who were ex-servicemen and physically handicapped and employed from the schemes had also participated in the study. This is evident from the fact that 2.2% and 0.7% of the population were actually handicapped and ex-servicemen as found from the category section of the questionnaire. As for the education category, 38.4% of the rural employed populations were found to be uneducated followed by 28.3% found to have high school education. This may appear from the fact that most of the uneducated and primary educated youth chose the skill development programmes whereby industrial skill development helped them achieve employment or they have started their own business. It is also found that 48.6% of the employed has a family or individual income of less than 1 lakh thereby implicating that majority of the participants falls under the below poverty line category and hence can easily avail the employment generation schemes Fig. 6.1.

In Fig. 6.2, it is found that 10.1% of the population remained unemployed for more than 7 years before having availed the employment scheme. However, with the rise in awareness of employment generation schemes for rural population, 50% of the respondents were found to remain unemployed for less than 2 years. Similarly, majority of the employed rural participants of the study were found to avail Mahatma

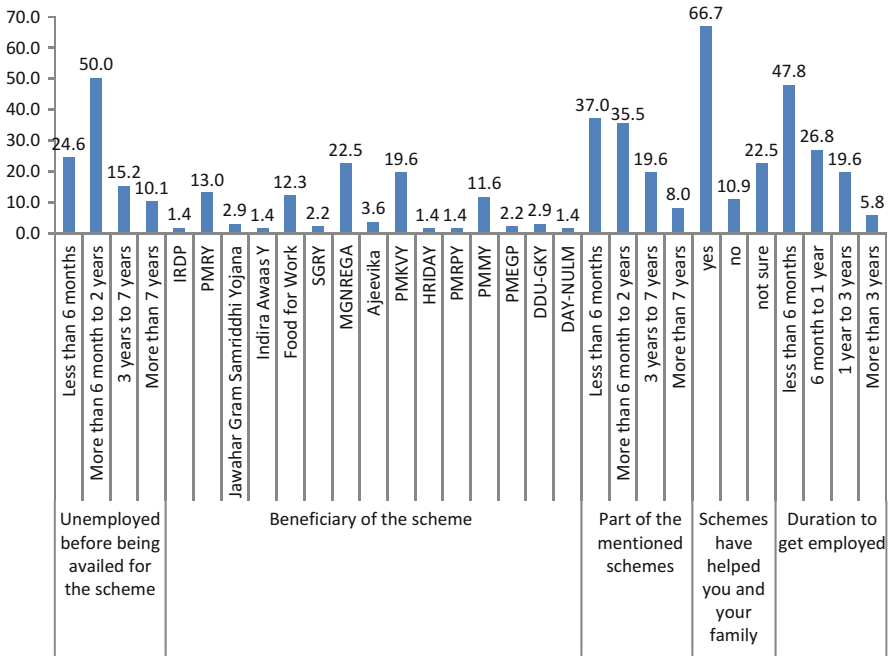

Fig. 6.2 General background

Gandhi National Rural Employment Guarantee Act (22%) followed by Pradhan Mantri Kaushal VikasYojna (19%) and Pradhan Mantri Mudra Yojana (11%). 27% of the participants were also found to have been associated with the employment schemes for more than 3 years, whereas 37% of the participants are associated for less than a year. Thus, it implicates that majority of the scheme beneficiaries are rural youth of 18 to 25 years. Lastly, it was also found that 67% of the scheme beneficiaries perceive that the employment schemes have helped them in their economic development and their livelihood.

5 Inferential Analysis

In this section of the study, the impact of the employment schemes on employment generation has been presented. In this regard, the dependent variable being employment generation and the independent variables comprised of the employment scheme objectives. The perspectives of the employed beneficiaries of different

Table 6.1 AVOVA statistics

R	R-square	Adjusted R square	F value	Sig
0.899	0.807	0.785	36.825	0.000

employment schemes have been presented in tabular form. To address the aim of the study, the following hypothesis has been formed.

Null hypothesis: *There is no impact of different government employment schemes on the employment generation of the rural unemployed.*

On bilateral correlation, it was found that all the features of the scheme such as available for people of all religion, caste creed and race, monetary assistance enough to start a new business, available to people despite of their physical and psychological condition, skill development of the youth, easily available, and allow fast disbursement monetary assistance were found to have high correlation value against advantages of the employment schemes. The values have been presented in Table 6.3. For instance, skill development of the youth found high correlation with people between the ages of 25 to 35 who get industrial training, beneficiaries of this scheme are allowed for self employment, women of the scheme are allowed to become self employed and start their own businesses, underwent training for industrial skill development are now employed and improved livelihood and wage. Similar implications were found from the correlation analysis. Therefore, it may be implicated that features of different government employment schemes help in employment generation of the rural unemployed.

In order to address the hypothesis of the study, ANOVA and regression tests were run. The results presented in Table 6.1 implicate that 0.899 regression lines find similarity of the responses. In other words, 89.9% of the responses meet the regression line. On adjusting, it was found that 78.5% of the responses by the employed beneficiaries of the employment schemes perceive that different government employment schemes have positive impact on the employment generation of the rural unemployed.

In Table 6.2, the coefficients of regression have been presented for scheme benefits on the perspectives of the scheme beneficiaries from the chosen villages of Haryana and Punjab. Scheme benefits such as youth between the ages of 18 and 20 years easily get admitted to skill development programmes (0.001), people between the ages of 25 and 35 get industrial training (0.002), beneficiaries of this scheme are allowed for self-employment (0.000), most of the youth of your village are either employed or under skill development (0.023), the scheme allows mandated subsidy of 15–35% (0.035), beneficiaries under scheme may start a business either in the rural areas or urban areas (0.000), and employment scheme is not only meant for

Table 6.2 Regression statistics

Scheme benefits	t	Significance
Youth between the ages of 18 and 20 years easily get admitted to skill development programmes	3.400	0.001
People between the ages of 25 and 35 get industrial training	3.096	0.002
Beneficiaries of this scheme are allowed for self-employment	−3.999	0.000
Beneficiaries are allowed a maximum amount of Rs 25 lakhs and a minimum of Rs 10 lakhs	−1.851	0.067
Most of the youth of your village are either employed or under skill development	2.302	0.023
The women of the scheme are allowed to become self-employed and start their own businesses	0.297	0.767
The scheme allows mandated subsidy of 15–35%	2.136	0.035
Beneficiaries underwent training for industrial skill development are now employed	−1.143	0.255
The rural people are employed with unskilled work	0.574	0.567
Beneficiaries under scheme may start a business either in the rural areas or urban areas	4.389	0.000
Employment scheme is not only meant for rural but also urban educated	4.203	0.000
The scheme has opened up new jobs for rural people in the urban areas	1.489	0.139
Improved livelihood and wage	1.852	0.066
Beneficiaries have availed wage employment opportunities	−0.240	0.811

rural but also urban educated (0.000) were found to be statistically significant at $p < 0.05$ and 95% confidence level. Since majority of the variables or the beneficial aspects of the employment generation scheme were found to be less than 0.05, the null hypothesis is rejected and the alternative is accepted. Therefore, the statement there is no impact of different government employment schemes on the employment generation of the rural unemployed is rejected. On the other hand, the statement that there is positive and significant impact of different government employment schemes on the employment generation of the rural unemployed is accepted.

6 Conclusion

The study mainly aimed to understand the perspectives of the rural employed and beneficiaries of the employment generation schemes in India on actual employment generation. The literatures have evidently implicated that the employment

generation schemes in India have effectively helped in the employment generation of the rural youth and unemployed adults. During the post-liberalisation period, over 15 employment generation schemes have been developed for the people of urban and the rural to develop the employment scope in India, most of which were considered in this study. Therefore, the current study does not specifically choose one or more employment schemes for the conduction of the study. The beneficiaries chosen for the study were from different employment schemes, and hence the employment generation scheme was kept general. However, the current study conducted among the beneficiaries of various employment schemes was surveyed to find their perspectives on employment generation and the importance of these schemes in the villages of Punjab and Haryana. Statistically, it was found that majority of the beneficiaries believe that the employment generation schemes have positive impact on employment generation of the rural population; it is also significant from literature studies where similar implications have been made. Further, it was statistically found that various scheme beneficial factors remain significant in impacting the employment generation of rural youth. However, certain limitation appears out of the study. Scheme beneficiaries of only two states were considered for the study, and therefore in future studies, scheme beneficiaries from different states must be targeted. In addition, future studies must also consider secondary employment statistics published by the Government of India to find the relevance of the employment generation schemes in India, which is missing in this study. The study informs the rural population that applying for employment scheme is an easy task and anybody post the age of 18 can apply for the same. The study findings implicated that employment schemes not only provide financial support but also improved livelihood and motivation to grow in the future. For the rural population, the study is beneficial as it highlights that employment schemes significantly improve the life and living conditions; in addition, they are also able to learn new skills and develop it to apply for better jobs in the future. Employment scheme also provides opportunities for women to work and earn at the same time and innovative rural to conduct their own business. Therefore, applying for employment schemes is an opportunistic aspect both for personal growth and the wellness of the family.

Appendices

Appendix I

Table 6.3 Correlation statistics table (the codes for F1–F8 and E1–E14 have been presented in Appendix II)

		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
F1	Pearson correlation	1.000**	0.627**	0.614**	0.645**	0.580**	0.594**	0.485**	0.642**	0.528**	0.683**	0.714**	0.491**	0.064	0.230**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.453	0.007
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138
F2	Pearson correlation	0.627**	1.000**	0.591**	0.521**	0.649**	0.433**	0.477**	0.551**	0.552**	0.562**	0.494**	0.543**	0.192*	0.213*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.012
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138
F3	Pearson correlation	0.614**	0.591**	1.000**	0.613**	0.527**	0.511**	0.469**	0.628**	0.582**	0.638**	0.531**	0.578**	0.178*	0.190*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.026
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138
F4	Pearson correlation	0.645**	0.521**	0.613**	1.000**	0.484**	0.565**	0.601**	0.711**	0.467**	0.564**	0.665**	0.687**	0.101	0.212*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.238	0.013
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138
F5	Pearson correlation	0.580**	0.649**	0.527**	0.484**	1.000**	0.612**	0.552**	0.447**	0.590**	0.552**	0.493**	0.573**	0.055	0.186*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.524	0.029
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138
F6	Pearson correlation	0.594**	0.433**	0.511**	0.565**	0.612**	1.000**	0.615**	0.665**	0.612**	0.624**	0.617**	0.565**	0.051	0.204*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.553	0.016
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138

(continued)

Table 6.3 (continued)

		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
F7	Pearson correlation	0.485**	0.477**	0.469**	0.601**	0.552**	0.615**	1.000**	0.502**	0.560**	0.548**	0.606**	0.618**	0.073	0.123
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.397	0.150
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138
F8	Pearson correlation	0.642**	0.551**	0.628**	0.711**	0.447**	0.665**	0.502**	1.000**	0.604**	0.631**	0.578**	0.662**	0.152	0.326**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.076	0.000
	N	138	138	138	138	138	138	138	138	138	138	138	138	138	138

Appendix II

Code	Features of the scheme
F1	The scheme is available for people of all religion, caste creed, and race.
F2	The scheme allows monetary assistance enough to start a new business.
F3	The scheme is available for all gender.
F4	The scheme is available to people despite their physical and psychological condition.
F5	The scheme allows skill development of the youth.
F6	The scheme is easily available with the right presentation of documents.
F7	The schemes do not allow business or self-employment in a few categories.
F8	The schemes allow fast disbursement of monetary assistance.
Code	**Employment benefits**
E1	Youth between the ages of 18 and 20 years easily get admitted to skill development programmes.
E2	People between the ages of 25 and 35 get industrial training.
E3	Beneficiaries of this scheme are allowed for self-employment.
E4	Beneficiaries are allowed a maximum amount of Rs 25 lakhs and a minimum of Rs 10 lakhs.
E5	Most of the youth of your village are either employed or under skill development.
E6	The women of the scheme are allowed to become self-employed and start their own businesses.
E7	The scheme allows mandated subsidy of 15–35%.
E8	Beneficiaries underwent training for industrial skill development are now employed.
E9	The rural people are employed with unskilled work.
E10	Beneficiaries under scheme may start a business either in the rural areas or urban areas.
E11	Employment scheme is not only meant for rural but also urban educated.
E12	The scheme has opened up new jobs for rural people in the urban areas.
E13	It improved livelihood and wage.
E14	Beneficiaries have availed wage employment opportunities.

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Chapter 7
Monetary Policy in India: Evidence of Financial Variables as Policy Indicators

Rohit Singh

Abstract The Central Bank of India changed the focus of monetary policy from direct instruments, i.e., cash reserve ratio (CRR) and statutory liquidity ratio (SLR), to indirect instruments, i.e., repos and OMO in its policy framework, thereby expanding the set of policy tools available for successful execution of Monetary Policy Outlook. This change pronounces for an orientation tilt toward medium-term instruments developed than long term. The study tries to find, empirically, if such a stance of apex bank has significant effect on every policy indicators in India in medium term. It uses the method of lag augmented vector autoregression to establish a linear relationship among short-term and long-term monetary aggregates such as money supply, bank credit, stock prices, exchange rates, and policy aggregates IIP and WPI under monetary policy targeting and monetary policy indicator approach.

Keywords Monetary policy and fiscal policy · IIP and WPI · LA-VAR · Policy indicators

1 Introduction

The preamble to the RBI Act of 1934 in India objectifies the apex bank's target as "the Reserve Bank of India to regulate banknotes issuance and maintenance of reserves in order to ensure monetary stability in India and generally to operate the currency and credit system in the country to your advantage." These goals and targets are generally an indication of the stability of the general price level and growth of the economy, and since then, the goals remain the same, however, and focus on, with the passage of time, it has changed because of different prevailing

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economic conditions. On the contrary, we saw the storyline of monetary policy in the India to experience substantial and significant changes.

In relation to operational tools of monetary policies in the 1990s, RBI began to change its constant focus from direct instruments of monetary policy, i.e., the CRR to a broader instruments based on markets, and this expansion widened the set of tools available at its disposal. Consider the instance, in April of 1997, the RBI reinitiated bank rate as policy variable by combining with interest rates in the market, and now, is used mostly, by RBI to indicate a medium-term orientation of monetary policy in India. In addition, as the Reserve Bank of India also carried out open market operations for sterilization as an instrument of monetary policy to manage the increase in capital flow impact during the latter half of the 1990s, and then in 2000, RBI initiated regulation of liquidity by LAF to moderate daily liquidity conditions (Singh and Kalirajan 2007; Vasudevan 1999).

Moreover, since the augmentation of financial sector reforms and thus resulting financial liberalization, monetary policy outlook of the Central Bank underwent a transformation. From 1985 to mid-1997, Central Bank adopted flexible monetary policy targeting, focusing on intermediate target of M3 growth. Under the monetary targeting as a policy, M3 was used as operational target to control capital reserve of the commercial banks through CRR (Cushman and Zha 1997). However, with increased financial decentralization, it was realized that the financial innovations and technological developments, structurally, have eroded the predictive ability to estimate the demand for money in relation to the past; on the other hand, the money supply maintained its informative character as policy variable.

Finally, in the April of 1998, Reserve Bank of India announced, officially, shift in the conduct of the monetary policy from monetary targeting policy approach to multi-policy indicator approach (MPIA) (McKibbin 1993). Since then, adhering to MPIA, the interest rates of overnight tenure are steadily emerging as a policy goal; the central bank sees a range of various financial and economic variables as proxy indicators of policy and tries to focus on their movements to draw the temporal prospects of the objectives of the policy (Mohanty and Mitra 1999). The set of policy indicators includes the various rates in the financial markets, currency markets, credit advances by banks, current financial layout, trade balances, capital flows, rate of inflation, various exchange rate, and refinancing and swap transactions in foreign currencies. Additionally, the study also highlights the inability of RBI's then policy in 1998 to address the rising inflationary tendencies. It was also observed that price stability failed to ensure the larger goals of financial stability, which meant a change in policy orientation had a pull factor too. The RBI in its policy document stated that its reaction function was stronger to the exchange rate rather than to inflation (McKibbin 1993). Thus, RBI, in its monetary policy, warned of a reversal of its stance if risks to current account emerge. However, over the medium term, the exchange rate is driven by inflation differentials necessitating stable inflation.

Therefore, to investigate the monetary policy framework, the paper attempts to establish and test the relationship of each policy indicative variable against level of output, proxy by index of industrial production, and price using statistical test such as Granger causality test (Granger 1988) and establish whether other indicative variables that RBI considers as indicator variable in reality a relationship with the

objective variables and tries to comment over RBI's efficacy over its new role of financially stability over long term and inflation targeting along with exchange rate management in the medium term.

2 Literature Review

As referred earlier, since the middle of I990s, RBI has significantly modified monetary management. The RBI as an apex body majorly targets stability of general price level and economic growth as policy targets by inter transmogrifying primarily the short tenured interest rates, adhering to framework of MPIA. Many recent studies attempt to establish the relation between the RBI's dictation of monetary policy and new conduct mechanism of transmission.

Studies conducted by Kalirajan et al. (2001) interpreted the rate of interest transmission mode as an effective manner of monetary policy transmission after the structural break of reforms, econometrically, using vector autoregression analysis technique. Another study by Kubo et al. (2009) illustrated that the impulse response function was calculated using a VAR model and tested whether mechanism of monetary transmission concentrates on movements in interest rates. Besides this, Aleem (2010) and Fuhrer and Moore (1995), to determine the importance of various modes of monetary transmission, ran a set of VAR models, i.e., mode of bank lending, the exchange rate mode, and the bank credit mode, and the result of his studies shows that bank lending has a significant role to play in transmission mode in case of India.

Also in the paper by Samantaraya (2009), he formulated a "monetary policy index" by analyzing qualitative data on various policy parameters extracted from the statements of Central Bank's governor and available data on growth of monetary aggregate M3 and lastly short-term interest rate. With the index he tried, in quantitative terms, to estimate the framework of monetary policy and illustrated that changes in monetary policy variables instantly affect the interest rates of various tenure, while it has less impact on quantum of credit advanced by banks, inflation growth rates, and IIP index, with some lag.

Diverging from earlier researches, this paper tries to investigate whether the variables that Central Bank considers as policy indicator variables have a statistical relationship with price and economic growth and analyses the paradigm of the new monetary outlook as proposed by RBI marking the structural break.

Empirical Technique Used

For empirical analysis, the paper applies Dickey-Fuller unit root test and Granger causality statistical techniques lag augmented (LA-VAR) model. In statistically using the vector autoregressive model, it is generally mandatory to check if variables are integrated (also using lag values of variables), stationarity of data series by using the Dickey-Fuller unit root test (Dickey and Fuller 1979). It is believed that conventional asymptotic theory for testing hypothesis in VAR model does not render accurate results if the variables considered in the study are integrated.

However, under certain lag values of data, DF-unit root test may not be sufficiently accurate for testing hypothesis (NG and Perron 2001; Phillips and Perron 1988). In order to sway such biases in statistical testing, this paper applies the lag augmented vector autoregressive model, which allows study to determine the restrictions on coefficients in a LA-VAR disregarding ideal statistical attributes of economic time series (Brischetto and Voss 1999). This method is as follows:

Suppose the following equation generates $\{y_t\}$, the "*n-dimensional vector*" for different level of the variables in this study:

$$y_t = \lambda_0 + \lambda_1 * time + \Upsilon_1 * y_{t-1} + \Upsilon_2 * y_{t-2} + \ldots . + \Upsilon_k * y_{t-k} + e_t \text{ for all } t = 1, 2, 3, \ldots, T$$

where time is the proxy measure for trend observed during sample period, k is the length of the lag and $\lambda_0, \lambda_1, \Upsilon_1, \Upsilon_2, \ldots \Upsilon_k$ represent respective matrices of coefficients that study considers, and e_t is the matrix of *independent and identical distributed* sequence of matrix with expectation $= 0$ and $\sum e_t$ as matrix of covariance.

Further, to test restrictions on coefficients in the model the study tests null hypothesis $H_0 : f(\Omega) = 0$, the study estimates the VAR model shown using OLS technique:

$$y_t = \widehat{\lambda_0} + \widehat{\lambda_1} * time + \widehat{\Upsilon_1 * y_{t-1}} + \widehat{\Upsilon_2 * y_{t-2}} + \ldots + \widehat{\Upsilon_k * y_{t-k}} + \widehat{e_t} \text{ for all } t = 1, 2, 3, \ldots, T$$

Finally, the paper tests the null hypothesis of Granger causality and tries to establish a causal relationship among monetary policy variables and objective policy variables. It is believed that asymptotically, i.e., as "n" is a large number, the test sample statistic follows a chi-square distribution with number of degrees of freedom (*dof*) equal to number of lag variables, i.e., (k).

3 Data and Variables

The Reserve Bank of India came out with different monetary policy variables under MPIA. The new setup majorly consisted of set of variables, viz., financial market-related indicators, fiscal sheets and trade balance, and capital flows. The study took into consideration M_1, M_2, and M_3 as different monetary aggregates estimated by RBI, exchange rate (ER) adjusted for purchasing power parity, stock prices (SP), and bank credit (BC), among available relevant variables. For dependent variable as policy variables, the paper considers index of industrial production (IIP) (adjusted seasonally by X_{12}) and wholesale price index (WPI) as both economic growth and price stability are regarded as objectives of monetary policy.

The data on exchange rate, stock prices, IIP, and WPI have been obtained from International Monetary Fund (2010) and monthly bulletin of Reserve Bank of India. The data on bank credit and call market rate have been sourced from RBI, and data

on M_1, M_2, and M_3, i.e., monetary aggregates, have been obtained from RBI monthly bulletin. The RBI had adopted monetary policy targeting, which primarily focused on growth of M_3 from 1985 to 1998. Post 1998 also, the apex bank kept its diluted emphasis on M_3, but other monetary policy indicators were also included in array of framework under the MPIA. The study regards special emphasis to M_3 and uses monthly data from 1998 to 2016 for the empirical analysis. This is precisely the period corresponding to current monetary policy outlook. In addition to the above statistical exercise, to test for structural changes, if any, to previous policy period regime, i.e., monetary policy targeting by Reserve Bank of India from April 1985 to June 1998, data has been sourced from the monthly bulletin of Reserve Bank of India RBI. Annual Reports 2010 till 2016.

4 Empirical Results

The study uses lag-augmented vector autoregressive models to establish causality of monetary variable on each policy indicator, considered in the study, i.e., the price levels and output. VAR model, under a scholastic process model, is primarily an econometric tool to capture linear independency among multiple time series data. Table 7.2 indicates the test statistic (Wald statistic) for the sample period from April of 1998 to 2016. This period marks the first 19 years of new monetary policy outlook by RBI, as MPIA was introduced in April of 1998. To estimate the test statistic, the study considers length of true length of the lag (k) from a maximum of 12 periods, premising on Akaike information criterion (AIC) used. The study has primarily chosen AIC over BIC, because in the understating, a false-negative relationship among variables would be considered as more misleading than a false-positive relationship among variables. Further, the study also fixes the maximum plausible integration of the order (d-max) to be unity, because in Table 7.1, Dickey-Fuller unit root test shows that the variables are integrated of order unity, at most.

The following empirical results can be inferred from Table 7.2. Both M_2 and M_1 do not Granger cause changes in price level at any level of significance (1% or 5% or 10%), while that in case of output monetary aggregates Granger cause output at 5% statistical level. M_3 on other hand has no impact on either output or level of prices. Similar to M_3, bank credit fails to establish any relation with either of objective policy variable (in the Granger sense). Stock prices Granger causes output at the 1% level of significance and 5% level in case of prices. Finally, exchange rate Granger causes only output at 5% level of significance.

Table 7.1 Dickey-Fuller unit toot test (lags of order one are used)

Test statistic	1% critical value	5% critical value	10% critical value
Z (t) for WPI = −2.897	−2.897	−3.850	−5.500
Z (t) for IIP = −4.756	−6.234	−8.984	−12.764

Note: MacKinnon approximate p-value for Z(t) = 0.0474 and 0.0243, respectively

Table 7.2 Causality during the MPIA sample period, i.e., from 1998 to 2016 (lags are indicated in parenthesis)

	Independent variables					
Dependent variable	SP(2)	ER(2)	M1(8)	M2(8)	M3(12)	BC(2)
WPI	0.675	4.069	12.805	12.860	16.078	1.435
IIP	22.245***	6.257**	15.678**	15.678**	7.545	0.226

Note: [a]***, **, and * indicate that the null hypothesis of Granger non-casualty is rejected at 1%, 5%, and 10% LOS, respectively. [b]The dependent variables are wholesale price index (WPI) and index of industrial production (IIP), while the independent variables are prices of stock (SP), exchange rate (ER), and bank credit (BC). M1, M2, and M3 are monetary aggregates

Table 7.3 Causality during monetary policy targeting, i.e., from 1985 to 1998 (lags are indicated in parenthesis)

	Independent variables					
Dependent variable	SP(2)	ER(2)	M1(8)	M2(8)	M3(12)	BC(2)
WPI	2.604	2.379	51.365***	22.78***	26.896***	2.88
IIP	17.771***	5.311**	7.060*	6.710*	1.573	0.512

Note: [a]***, **, and * indicate that the null hypothesis of Granger non-casualty is rejected at 1%, 5%, and 10% LOS, respectively. [b]The dependent variables are wholesale price index (WPI) and index of industrial production (IIP), while the independent variables are prices of stock (SP), exchange rate (ER), and bank credit (BC). M1, M2, and M3 are monetary aggregates

Consider now, Table 7.3 shows test statistic (Wald statistic) for the sample period from 1985 to April of 1998. This period considered for study corresponds to one, wherein monetary targeting was adopted by RBI. In this table too, the study sets the maximum integration of the order, i.e., d-max to be equal to 1.

The following results may be observed from Table 7.3. M_2 and M_1 Granger cause changes in the level of prices at 1% level of significance, while output at 10% level of significance, M_3, on other hand, differs in the sense that it does not Granger cause output at any level of significance. Bank credit does not cause either output or level of prices in the Granger cause sense. Exchange rate Granger causes output only at 10 level of significance, while stock prices Granger cause level of prices at 5% level of significance. With these results, it can be concluded that the monetary policy variables do have significant causal relationships with the dependent variables, in the study. The differnces obtained in the results presented in Tables 7.2 and 7.3 have a strict implication that significant changes among the pair-wise relationships between the monetary policy indicator variables and the objective variables because of enactment of RBI's new policy framework (Table 7.4).

For the robustness check of results obtained, the study also tests true length of the lag k using the criteria of the Schwarz Bayesian information criterion (SBIC) instead of the AIC. The results thus obtained show even after switching to a different k for monetary policy variables, there is least deviation from previous results on objective policy variables, implying the robustness of the initial findings. The study does not consider analysis using cointegration tests, because by definition such tests are used to ascertain long-term relationship between two or more economic variables.

Table 7.4 Causality during the MPIA sample period, i.e., from 1998 to 2016 (lags are indicated in parenthesis)

	Independent Variables					
Dependent Variable	SP(2)	ER(2)	M1(2)	M2(2)	M3(2)	BC(2)
WPI	0.675	4.069	12.805	12.860	16.078	1.435
IIP	22.245***	6.257**	15.678**	15.678**	7.545	0.226

Note: [a]***, **, and * indicate that the null hypothesis of Granger non-casualty is rejected at 1%, 5%, and 10% LOS, respectively. [b]The dependent variables are wholesale price index (WPI) and index of industrial production (IIP), while the independent variables are prices of stock (SP), exchange rate (ER), and bank credit (BC). M1, M2, and M3 are monetary aggregates

Table 7.5 Causality during monetary policy targeting, i.e., from 1985 to 1998 (lags are indicated in parentheses)

	Independent variables					
Dependent variable	SP(2)	ER(2)	M1(2)	M2(2)	M3(2)	BC(2)
WPI	1.415	1.898	36.875***	36.405***	20.384***	2.540
IIP	14.881***	4.291**	6.078**	5.942*	1.683	0.321

Note: [a]***, **, and * indicate that the null hypothesis of Granger non-casualty is rejected at 1%, 5%, and 10% LOS, respectively. [b]The dependent variables are wholesale price index (WPI) and index of industrial production (IIP), while the independent variables are prices of stock (SP), exchange rate (ER), and bank credit (BC). M1, M2, and M3 are monetary aggregates

Although, one of the objectives of the study was to ascertain long-term impact of RBI policy on financial stability, but since co-integration identifies variables that typically do not drift too far away from each other in the longer term and revert to their mean distance, thus, the variables considered study are unable to find such a prerequisite holding true to proceed for cointegration tests. Additionally, the variables considered in the study can derive from each other on a short-term basis, but there is no significant attempt in the theory that economic forces can restore the original equilibrium between them on the long run; therefore, the variables cannot be considered purely cointegrated (Table 7.5).

5 Conclusions

To sum up, the studies' empirical results demonstrate that apart from bank credit, all other monetary policy variables included in the study do have a causal relationship with either level of prices or output. This indicates the fact that many of the financial and economic variables that are announced by RBI have a certain deterministic degree to estimate policy indicators, under the new monetary policy framework by apex bank. Among the variables, stock prices, in particular, seemed to have played a significant role, as it can be inferred out that stock prices portray important casual relation for determining expected values of level of prices and output. However, M_3

as a monetary aggregate seems to have a weaker predictive role, in objective variables.

RBI continues to announce forecast for rate of growth of M_3, even after changing the monetary policy targeting framework as RBI considers it to be a measure to determine future price movements. Taking into account the empirical results of the studies, it may be concluded that RBI should take information content on monetary aggregates M_1 and M_2 along with other variables for monetary policy formulation.

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Chapter 8
Business Ecosystem and Internet of Things (IoT): Learnings from an Experimental Ecosystem Approach in Norway

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Abstract Internet of Things (IoT) and artificial intelligence (AI) technologies support digitalization and innovative services and products, as well as more cost-efficient production processes. New technologies alone are, however, not sufficient to succeed with digital innovations; there are both organizational and commercial challenges that must be overcome and a high degree of uncertainty for the stakeholders involved. Telenor Group is an international mobile telecommunication operator in Scandinavia and Asia and drives digitalization through technologies and open innovation and ecosystems. One learning experience from working with digital innovations is the Start IoT ecosystem concept that Telenor established for research and experimentation in Norway. The Start IoT concept is based on open innovation in clusters of industrial companies, public actors, and small business entrepreneurs. In this paper, we first describe ongoing digitalization and IoT/AI trends; then, we introduce business model and ecosystem theories to make sense of the empirical data from the Norwegian experimental business ecosystem; and finally, we discuss how the Start IoT concept from Norway can be transferred to Asian business units.

Keywords Internet of Things · Open innovation · Ecosystem · Business model · Telenor

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1 Introduction

The wave of digitization sweeps over us and within a short time connection and interaction between things and objects will surpass the interaction between people. These are physical objects that process or monitor something and use wireless Internet to communicate, e.g., sensors in cars, boats, machines, houses, and buildings. IoT will contribute with increased values ⍰⍰for many areas and industries by solving problems in a more innovative and productive manner or producing products and services in a more cost-effective manner. An explosive increase in the number of IoT devices is expected – some estimates say that there will be nearly 30 billion IoT units by 2020. According to the consulting firm Arthur D. Little (Arthur D. Little 2017), the Nordic countries are the world leaders within IoT partly because of the good 4G coverage. However, despite the positive envisioning of IoT, we still await the large growth. We suggest that this discussion is about the better IoT architecture, but even more the business models that enhance innovation and collaboration, and how the roles for mobile operators and other partners will emerge. Thus, this article asks: How does a mobile operator act in order to affect the evolution of a complex IoT ecosystem. This article kicks off with a review of systematic approaches to the evolution of IoT, continues with a description of IoT and artificial intelligence (AI) technology trends, and ends with a presentation and discussion of the emergence of a Norwegian IoT. The article is based on a single case study (Yin 2014) collected through discussions with the core ecosystem actors in workshops related to joint collaboration activities and projects during 2017, 2018, and 2019. Secondary data were gathered through studies of industry reports and market surveys. The discussion is consistent with the framework for mobile service ecosystem health (Iansiti and Levien 2004) and Moore's ecosystem development stages (1993); hence, transferability to similar ecosystems is made possible.

2 Business Models, Open Innovation, Ecosystem, and Triple Helix

A business model describes how one particular firm does business (Ritter and Lettl 2018). A review of the business model concept lead to five different perspectives on business models (Ritter and Lettl 2018): business model activities, business model logics, business models archetypes, business model elements, and business model alignment. These perspectives are complementary and offer a comprehensive understanding of organizations and their strategic options. Activities, logics, and elements represent concrete lower levels of aggregation, while archetypes and alignment represent an overall approach detailing the connection between parts. Osterwalder

(2004), Chesbrough and Rosenblom (2002), and Bouwman et al. (2008) relate their understanding of business models to activity and element perspectives (Ritter and Lettl 2018). The value chain is a specific logic for how value is created within one firm (Porter 1985). Despite the stickiness of the value chain concept, it has long been recognized that the telecommunication sector is not well illustrated by the linearity of a value chain. Instead, the nonlinear value network model has been suggested (Stabell and Fjellstad 1998). Value networks are including not only vendors in a value chain but also actors that are providing complementary products and services. The principle is relying on positive network externalities (Katz and Shapiro 1985; Shapiro and Varian 1999). A business model concept can include the value creating logic from both the value chain and network. Data-driven business models increase company output and productivity through increased customer insight and service improvements (Brownlow et al. 2015). Key activities are acquiring, processing/analyzing, and virtualizing data. New revenue streams stems from advertising, usage, and subscription, and barriers are big data personnel and data quality.

After a long history of doing innovations in a closed context, enterprises have learned that access to new product ideas and technologies from outside has been necessary for further growth and competitiveness. Open innovation relates to innovation processes where knowledge and innovation develop between different actors recruited from enterprises as well as publicly funded research environments (Nesse 2008). In the case of platform ecosystems, the insight from open innovation is highly applicable.

The concept of ecosystems reflects dynamics between roles and actors in the larger market. The ecosystem actors share customer and system focus and the potential technologies (Peltoniemi 2004). They both collaborate and compete in the development of a new product or service (Vargo and Lusch 2016, Moore 1993, Bouncken and Kraus 2013) and must balance the tension between common innovation development and ensuring their own financial return. The first requires openness, while the latter requires protection (Laursen and Salter 2014). Such an ecosystem can often consist of a core actor and several smaller players in the market. The core actor is often called "keystone" or platform leader (Vargo and Lusch 2016, Iansiti and Levien 2004b, Gawer and Cusumano 2014), while the smaller actors are called niche or complementary players (Hallingby and Do 2013). The keystone or the platform leader contributes to the ecosystem's health (Makinen and Dedehayir 2012) which can be measured by its degree of performance, robustness, and diversity (Iansiti and Levien 2004). Performance refers to financial performance for the ecosystems actors, e.g., return on investment capital or more subjective goals (Franco 2011). Robustness is the ecosystem's ability to survive major and unexpected changes (disruptions), while diversity refers to the ability to create new innovative niche products and services.

One important ecosystems approach that builds on the presence of one core actor is the platform ecosystem (Gawer and Cusumano 2002; Gawer 2014). Actor(s) in control of one technological platform offers the platform capabilities through open interfaces. This is the basis for innovation and delivery done by many other actors in the ecosystem. These actors integrate the platform into their software, applications,

products, and services (Tiwana 2014; Gawer 2014). The platform enables innovation across the ecosystem and solutions adapt through opening their interfaces toward others (Gawer 2014). A platform with a more central role must also allow other roles to profit in order to maintain the sustainability of the ecosystem. Competition between the core platform and complementors can be mitigated with a collaborative governance model which motivates complementors to innovate to the best of the platform and the total ecosystem (Peltoniemi 2004; Gawer 2014). Thus, the evolution of an ecosystem does depend not only on easy observable business and technological relationships but also on other socioeconomic factors such as legitimation and feeling of community.

Furthermore, ecosystems are not static, but develop over time. According to Moore (1993), the ecosystem will develop through four distinct phases – birth (establishment), expansion, leadership, and self-renewal. A manager of a potential core platform who seeks to grow an ecosystem must cater to different aspects throughout these phases. The establishment phase is characterized by a lack of knowledge about the new technology and its possible applications. The focus of the platform owner is to define the value proposition for the customer and partners and find the best way to deliver the product together with the partners, e.g., by developing proof of concept/prototypes that show the technology used in different application areas, the so-called use cases. In addition, agreements with critical suppliers, customers, and distribution channels must be secured to protect the product from competing ideas. In this phase, it is more important to ensure cooperation and value co-creation and involvement among the roles and actors, rather than actively defeat competition (Bouncken and Kraus 2013). In the final phase, the self-renewal phase, the ecosystem must relate to emerging ecosystems and disruptive innovations due to changes in technology, regulation, and other macroeconomic conditions. In practice, it is challenging to carry out because they are related to processes that have to do with legitimization, institutionalization, trust building, and cooperation (Bergek et al. 2008a) (Ozcan and Santos 2015).

An ecosystem is a part of a larger context, and thus innovation and business development are interacting and dependent on factors beyond those described above (Ghanbari et al. 2017). For instance, standardization bodies, regulators, and policy makers are also included (Muegge 2011; Angraeni 2007). Concepts such as the triple helix model (Etzkowitz and Leydesdorff 2000) and technological innovation systems (Bergek et al. 2008b) describe how innovation was created in processes between three key sectors of society: business, government, and academia. The partnership creates a win-win solution for all parties – academia achieves financial support for student recruitment on new research programs, while industry secures a subsidized approach to valuable research results. In addition, the government ensures economic growth, advanced industries, and a competent workforce. According to Reve, the triple helix model is inadequate in order to foster regional innovation and economic growth (Reve 2017). He claims that there are five key stakeholder groups necessary to mobilize in such innovation ecosystems. In addition to academia, industry, and governments, there is a need for entrepreneurs starting new businesses and risky private investors who take the financial risk of the new

businesses. These findings are based on a framework developed by MIT REAP program where the aim is to accelerate the number of successful start-ups by extra focus on entrepreneurs and risk capital in the different regions. In the framework, it is important that these start-ups are innovation driven and have global ambitions. This fits well with the Norwegian industrial context where studies show that during a 10-year period from 2003 to 2014, as much as 2 of 3 new full-time jobs come from new and young companies, not established companies (Reve 2017).

IoT is a complex technology and falls into the group of technologies that has been analyzed according to approaches such as platform ecosystems. The focus and challenges remain the same. Heini et al. (2018) suggest three necessary IoT ecosystem roles or archetypes: ideators, designers, and intermediators. The ideators articulate service needs, designers develop and deliver the service and the intermediators enable access to and control the platform. A similar approach is developed by Klein et al. (2017) and Saarikko et al. (2017): engagers, enablers, and enhancers. Engagers develop, integrate, and deliver IoT services; enablers develop technologies facilitating the engagers, while the enhancers utilize the service and solutions from engagers. Papers and Plfaum (Papert and Pflaum 2017) stress the importance of the solution integrators role in the ecosystem building the complete IoT service/solution and governing the relationship between the ecosystems members. The IoT platform should exhibit open interfaces in order to integrate a portfolio of smart products. This also co-aligns with the work of Leminen et al. (2018) who proposed platform business models as an emerging business model type with IoT often from dominator actors providing existing solutions from its partners to the customers through open interfaces and standards.

Obstacles for the introduction of IoT are previously identified (Markendahl 2017). Specific IoT solutions tend to be a small part of the overall solution and may be too small for a standalone business. However, if clustered together with a network of multiple devices in a connected environment that can be viewed as an entity with specific needs and tasks, the added value can differ substantially. This connected entity is most often controlled by one actor, e.g., the manufacturer or owner of a car, truck, home, or office facility. Moreover, the single IoT solutions have initially often been developed using a single firm business model, and in order to survive or grow, some kind of networked business model is needed. Dijkman et al. (2015) discuss business models specifically for IoT. The findings indicate that value proposition is the most important building block in the IoT business models, followed by customer relationships and key partnerships. Communities and co-creation are important with respect to customer relationships. Software developers, hardware partners, and data analysis partners are the most important ecosystem stakeholders to partner up with. Another study concludes that IoT research is mainly focusing on technology, that IoT business models are relatively unexplored, that data analytics may become an essential element of IoT services, and finally that open ecosystems may help companies to provide more integrated services and values to their customers (Ju et al. 2016).

Others propose an integrated 6C framework (Context, Cooperation, Construct, Configuration, Capability, and Change) to understand IoT-based business

ecosystems (Rong et al. 2015). Their background is that the emergences of IoT technologies enable more and more businesses to be involved, creating a business ecosystem perspective instead of just a supply network. The authors argue that efficiency and innovation can be exploited to a higher extent in an IoT-driven ecosystem where openness of the platforms allows more and more business partners to connect with each other and create more value for end users.

In sum, it is safe to say that IoT is a technological concept that can be discussed as an ecosystem. IoT and its stakeholders are connected in both technological and social complex relationships. It is often observed and implied that one central platform will emerge in, for instance, an IoT ecosystem. However, the literature emphasizes the challenge of spurring all the other involved technologies and actors. The only way to address the value proposition of the user is to create value together. A more central actor, the platform, must cater to the other actors so that they invest their time and money both in innovation and operation. Indeed, open technological interfaces are important in this respect. Just as important are the sharing of knowledge and beliefs in business opportunities, building of trust, and legitimacy. Moreover, this is a process that happens over time going from a scarcely diffused solution to potential high, exponential growth. Finally, such evolution does not happen in isolation. From the earliest seed to the final implementation, the involvement of societal actors such as universities, regulators, and industries affects evolution.

3 Internet of Things and Artificial Intelligence

The concept of the Internet of Things arose in the late 1990s. The rapid development of communication technology, sensor technology, battery technology, and small powerful computers helped making IoT possible. The Internet of Things is about smart things and devices that automatically generate information or can be monitored and managed over the Internet. Many things can be smart when they are equipped with sensors (which measure temperature, position, pressure etc.), processes (which make calculations on the measurements from the sensors), network connection (which makes it possible to transfer data from the sensor), storage device (which stores the measurement data), and finally batteries that have the energy to carry out and send the measurements (Teknologirådet 2015).

There are various network technologies available for wireless communication from devices and sensors, e.g., Wi-Fi, Bluetooth, ZigBee, mobile 2G/3G/4G, and several different LPWAN (low-power wide-area network) technologies, using licensed or unlicensed spectrum. NB-IoT/Cat-M1 (narrow band IoT) is a mobile network technology designed to connect large amounts of sensors and items online, where the thing sends small amounts of data and has the least battery-consuming use of network connections, such as parking sensor buried in the asphalt, water measurement, mailbox notification, smart locks, and air sensors. The two technologies are complementary to each other and address different types of use cases. NB-IoT fits well for use cases that do not acquire massive data transmissions capabilities

such as utility meters and smart building sensors, while typical use cases for Cat-M1 include wearable devices, trackers, and connected vehicles allowing greater data rates, lower latency, and more accurate device positioning.

With access to data from billions of physical things or devices located almost everywhere, there will be a challenge in analyzing all these data points. However, this can be remedied using techniques for artificial intelligence (AI) where computers can be trained to do complex tasks (Mc Afee and Brynjolfsson 2017). Machine learning and deep learning are building blocks in artificial intelligence that enables the computer itself to extract experience from large amounts of data and make choices based on this knowledge. In this way, the computer can independently develop analysis models and look for traces of large amounts of data, without being told exactly what to look for, such as pattern and language recognition. Since large amounts of data interact between many IoT things or devices, it can make information security vulnerable to hacking and security breaches. Data containing sensitive personal information and stored in the cloud across borders must be protected by legal restrictions. It is, therefore, necessary to develop secure mechanisms for encryption of access control for things online.

4 IoT Experimental Ecosystem in Norway

In the IoT context, the telecommunication company Telenor has taken action to spur its diffusion and growth. This has mainly been done along two paths. First, Telenor has engaged with the IoT innovation system, facilitating the development of a new ecosystem for research and experimentation. Second, Telenor has facilitated an experimental IoT ecosystem, involving commercial development within the IoT in Norway. Figure 8.1 describes actors in the experiment- and research-based IoT ecosystem that Telenor cooperates together with partners in three regions in Norway: the Trondheim region (Mid Norway), the Oslo region (South-East Norway), and the Tromsø region (Northern Norway).

The innovation system has had its center in the mid-Norway region, where two research laboratories have been established, an AI lab in the spring of 2017 and the IoT ProtoLab in the spring of 2018, both as a result of cooperation with Telenor and the Norwegian Scientific and Technical University (NTNU) in Trondheim. Telenor sponsors the open national AI lab over 5 years for research and innovation programs on artificial intelligence and advanced analysis methods. In the summer of 2018, the lab was reinforced with participation from large national enterprises such as Equinor, DNB, DNV, Kongsberg group, and Digital Norway. In the autumn of 2018, the third inspirational day at the AI lab was carried out where companies and other stakeholders "pitched" their ideas for NTNU's academic environment and students for further analyses in master's /doctoral theses or research projects. Telenor also participates in the newly established EU forum "AI for Europe" where the purpose is to promote Europe's competitiveness in research and development within AI and

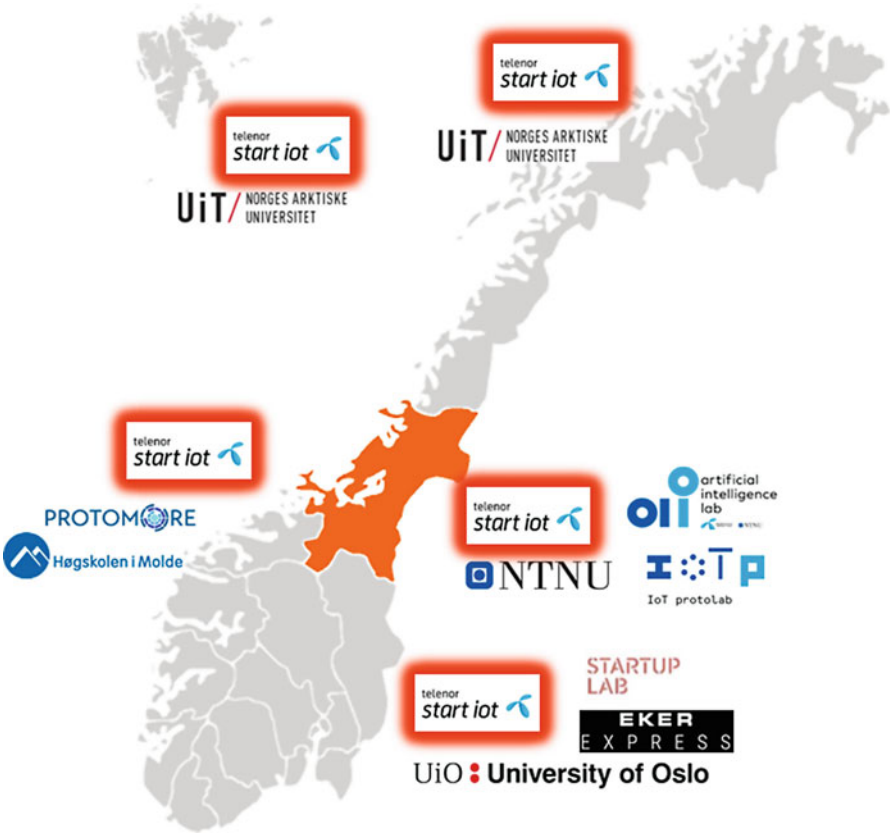

Fig. 8.1 Telenor experiment-based IoT ecosystem partners in Norway

its impact on business and society. NTNU currently has over 100 employees who research and teach within IoT and AI.

The experimental IoT ecosystem has centered around a IoT ProtoLab which is open to students and start-ups who want to develop and test prototypes using next-generation low-cost IoT technologies. It may apply to the communication quality of the sensors, or the actual certification of the physical product. Here, they can also connect to an LPWAN test network in Trondheim area. The lab is co-located with the incubator FAKTRY just off NTNU campus in central Trondheim. 20 IoT-based start-up companies are affiliated with FAKTRY. BRIKS is one of the start-ups helping the fertility clinic Medicus in their development of a new method of monitoring critical infrastructure during transport using IoT and sensors. Smart Cylinders is another start-up that offers an IoT-based service for gas suppliers and restaurants. Sensors measure the contents of the gas cylinders and notify them before they have to be replaced. In this way, the logistics can be much better for both customer and supplier. Wireless Trondheim is responsible for the setup and daily operation of the IoT ProtoLab. Telenor funds partly the IoT lab's equipment and

activities, and in November 2018, the country's first NB-IoT hackathon was arranged. Here, the team was monitoring air quality inside and outside, and 35 students from different study programs at NTNU participated in the hackathon. Using Telenor's dedicated IoT network in Norway (NB-IoT/Cat-M1), development platform, and "state-of-the-art" development tools, the students developed various IoT solutions for better indoor and outdoor air quality. Digital Norway, which is a cross-industry initiative aiming to speed up the digitization of small- and medium-sized companies in Norway, was one of the organizers together with Telenor, NTNU, and Wireless Trondheim. Telenor is one of the 15 member companies in Digital Norway.

In the Oslo region, Telenor collaborates with the incubator StartupLab at the Research Park in Oslo (Mathisen 2017). Telenor has sponsored selected business ideas through an IoT accelerator program. In total, we find roughly 100 technology-based start-ups that are affiliated with the incubator, and in 2018, a hardware and IoT lab was established at the StartupLab. Telenor in Norway has also established a commercial IoT portfolio where they offer network and solutions in collaboration with partners from different industries to customers in corporate markets, e.g., aquaculture, transport and logistics, cities and buildings, and health and care (TelenorNorge 2018). In total, Telenor had by 2018 approximately 80% revenue market share of a total of 1.7 million M2M (Machine to Machine) subscriptions in Norway by 2018 connected to the mobile network in Norway and about 13 million globally. Recently, Telenor offered the commercial NB-IoT network providing more power efficient and better coverage than conventional 4G for buried and inaccessible sensors.

To lower the threshold for IoT innovations, Telenor is offering an IoT start-up package free of charge, including a hardware and software tool box targeting developers, students, and start-up companies (TelenorStartIoT 2018). This offering is managed from the Tromsø region. The package includes free use of Telenor's development platform MIC (Managed IoT Cloud) which is built on top of Amazon Web Service IoT capabilities. MIC handles the basic functionality that most LPWAN IoT services need and provides a dashboard editor with clicks and drags widget functionality. Moreover, the package includes a temperature sensor and a humidity sensor on a breakout board easily connected to the main device. The start-up package aims at being network connectivity agnostic within the LPWAN segment. Today, over 200 developers, students, small-, and medium-sized enterprises are registered users of the start-up package using the LoRaWAN test network facilities. When the offering is re-launched in 2019, the Start IoT start-up package will include free use of the NB-IoT/Cat-M1 network in addition to the deployed LoRaWAN networks in Tromsø, Trondheim, and Oslo regions. The start-ups can choose between three development kits, and they will receive up to four IoT on 4G-enabled SIM cards for 12 months given that they do not exceed 50 Mbyte IoT on 4G traffic. After 12 months or when the quota is reached, the start-ups may be contacted by Telenor for a commercial offering. By ordering a Start IoT devkit the start-ups become part of the Start IoT community and may benefit from knowledge and ideas shared by other IoT developers. Start IoT tutorials have been compiled and curated by our community of IoT developers into learning modules arranged by

easy, medium, or advanced levels of complexity. Tutorials, discussion forum, and the possibility to publish showcases at an open website are the basis of the self-driven IoT community. As a service in return for the start-up package, Telenor gets user insights on basic IoT challenges and how initiatives like Start IoT may help start-ups and developers. Several use cases and "proof of concepts" for various areas of application have been created, e.g., monitoring of avalanche-exposed areas on Svalbard and air quality in Tromsø city, or even monitoring of plants and vegetables in greenhouses (TelenorStartIoT 2018). This is done in close collaboration with the University of Tromsø and Flow, a co-working for innovation and entrepreneurship.

5 Discussion

The innovation system for IoT that we see being established in Norway has similarities with the triple helix model (Etzkowitz and Leydesdorff 2000) in which business, academia, and the public sector cooperate in partnership. In mid-Norway region, Telenor, NTNU, and Wireless Trondheim and Trondheim municipality have entered into agreements that regulate the collaboration between these main actors. In the Oslo and Tromsø regions, cooperation with the start-up lab at the University of Oslo and the University of Tromsø is central. This initiative has been regarded as a success, mainly indicated by the recent participation by other large Norwegian enterprises. Partnering with Trondheim municipality is highly relevant since digitalization of municipalities through IoT, AI, big data, and 5G is expected to make the delivery of services and execution of tasks the coming years more efficient. According to a study by the consulting firm Menon Economics, the potential for savings from digitalization of Norwegian municipalities is estimated to 100 billion NOK from 2017 to 2028 (Mellbye and Gierløff 2018). The estimates are conservative and based on accounting data from the municipalities. The average municipality can save between 250 and 600 million NOK during the next 10 years, mostly within the health and care sector followed by education and social welfare, property management, and technical areas such as water and waste water management, etc. In the experimental IoT ecosystem, the IoT offerings in the three regions are characterized by open innovation (Nesse 2008) with experimental IoT and AI lab phases where students, entrepreneurs, start-up companies, and established businesses can openly experiment with their ideas. Furthermore, we see that IoT start-up package offering and IoT ProtoLabs in Trondheim and Oslo have many of the same characteristics that we find among global players such as Telefonica/Huawei and Ericsson. The IoT activities are largely research based, with a focus on experimenting with various solutions in different application areas, such as the free-of-charge access to development tools and IoT networks offered by the start-up package. IoT hackathons where students and start-up companies prototype various applications are also useful in increasing the pace of innovation together with UX workshops bringing together more experienced users to collect their impressions on Start IoT offerings (Raatikainen et al. 2013).

Telenor can be considered as keystone or intermediator in this experimental IoT providing the core technology (Iansiti and Levien 2004b, Gawer and Cusumano 2014, Heini et al. 2018; see Table 8.1). Telenors IoT development platform, LPWAN and NB IoT/LM-CAT 1 network together with the IoT development toolbox are key resources for linking developers, customers and other niche players in the ecosystem. The MIC development platform is cloud-based agnostic with respect to networking technologies enabling niche players or complementors to experiment with applications and service prototypes. The IoT ProtoLab offers the opportunities for such prototyping testing and debugging of these energy efficient sensor nodes free of charge and at a low risk of failure due to assistance of competent lab engineers. Here pick and place machines, battery drain and power analysis, antenna testing and electromagnetic interference, and capability testing along with 3D printing and prototype circuit board (PCB) printing facilities are available for the start-ups. Although this experimental ecosystem is mainly focused on testing and prototyping, the context of universities and a wider innovation system supports its further diffusion. This co-aligns with other findings that IoT drives for business ecosystems with openness of platforms and standards allowing more and more business partners to connect with each other and create more integrated and value-added services for customers (Rong et al. 2015) (Leminen et al. 2018). Data-driven business models enabled through analytics of data gathered from the different devices and sensors are seen as essential element of future IoT services (Ju et al. 2016). Software developers, hardware partners, and data analysis partners are here suggested as the most important ecosystem stakeholders to partner up with (Dijkman et al. 2015).

Table 8.1 Open platform IoT ecosystem elements

Elements	Platform ecosystem	Start IoT ecosystem Norway
Technology architecture	Core platform and complementing technologies	Open cloud-based IoT platform with agnostic network technologies
Roles	Core actor(s) control platform together with complementors	Telenor is keystone together with university complementors from industry actors
Business logic	Important to kick-off positive self-reinforcing effects	Low-risk IoT development on free-of-charge experimental platform
Delivery	Comprehensive solution delivered to users from interdependent actors	Solution deployed from complementors through platform and network
Innovation	Open interfaces motivate complementors to innovate on platform	Open IoT ProtoLab and AI lab and IoT start-up package/portal for academia and start-ups
Business models	Revenue sharing between actors to ensure ecosystem sustainability	Experimental proof of concepts free of charge. Platform- and data-driven business models
Competition	Competition between platform and niches hinders ecosystem growth	Low competition due to IPR to complementors. Trustful community feeling
Governance	Platform governs ecosystem innovation and reduces competition	Proof of concept developed and tested on IoT platform jointly by complementors

Considering the health of the experimental IoT ecosystem in terms of performance, robustness, and innovation, it is in an early phase and challenging to measure. However, the cooperation agreements between Telenor and the universities indicate that the trust so far between the main players is good (Bergek et al. 2008a) (Franco 2011). Regarding the ecosystem's robustness, which is linked to the ecosystem's ability to survive large and unexpected technical changes (disruptions), it seems strong. According to an overview from the GSMA, the majority of the 66 mobile commercial IoT networks launched worldwide so far is the NB-IoT network (GSMA 2017). Telefonica and Huawei established their first joint NB-IoT lab in 2017 providing access for start-ups to their R&D facilities, resources, and know-how (Telefonica 2017). Ericsson provides a similar offering for developers within the smart cities, transport, and production verticals. However, the portfolio of new commercial IoT products and services within different application areas is currently limited. Despite the low degree of engagement so far, this does not discourage the continued belief in building and spurring the focus further. Establishing ecosystems around technology-based platform innovations (Gawer and Cusumano, Industry platforms and ecosystem innovation 2014) is challenging, including the fear of "free-riding," meaning that some are disproportionately low in investment compared to what they receive (Foros et al. 2009). Therefore, it is important that the core players in the coming ecosystem phases continue to invite openness about innovation and add business models that ensure profit sharing between platform owners and the other players in order to secure a sustainable ecosystem (Hanseth and Lyytinen 2010). Today, costs for proof of concept development are free of charge for the start-ups in the experimental IoT ecosystem. However, in a commercial context, different business models should be assessed. Continuing the role as a platform leader with their managed IoT cloud (MIC) development platform, Telenor could make use of the two-sided model, facilitating interaction between complementors and customer groups. However, if the ecosystem shall continue to be healthy, legitimation and fair distribution of cost and revenues among the actors are necessary. This is challenging, but possible thanks to the trust, feeling of community among the ecosystem actors from collaboration in an experimental context (Gawer and Phillips 2013). Applying this governance structure in a networked type of business model should also be assessed going beyond the focus of the gains of the single actor (Markendahl et al. 2017).

Telenor Group is an international mobile telecommunication operator with subsidiaries in four different countries in Scandinavia and five different countries in Asia – Pakistan, Bangladesh, Malaysia, Myanmar, and Thailand. If Telenor were to transfer the Start IoT concept to the Asian markets, the objectives would be similar to the ones in the Norwegian market – to build active IoT developer communities around Telenor platforms and services and ecosystem partners, to test and demonstrate IoT technology architecture and customer journeys, and to improve IoT proof of concepts in pilots and consequently scale up and operate commercial offerings (see Fig. 8.2) (TelenorStartIoT 2018).

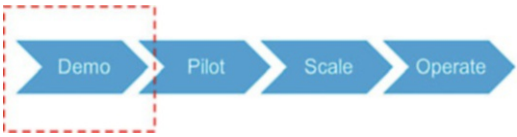

Fig. 8.2 Start IoT experimental ecosystem concept supporting commercial operations

The ways Asian business units (BUs) can demonstrate and make use of the Start IoT experimental concept are at least twofold: They can use the setup in Norway with the development portal, MIC instance, tutorials, customer journeys, and community building procedures in addition to support from Telenor Group experts. Alternatively, they can copy the concept and execute a local setup tailored to network and local market with additional support from Telenor Group.

The Start IoT concept is previously characterized as being a regional innovation system, i.e., the triple helix approach (Etzkowitz and Leydesdorff 2000). This approach refers to innovations occurring in a certain geographical context where local factors and actors such as universities, industry, and governmental policies influence the innovation ability and speed for the commercial actors (Asheim and Coenen 2005). The expanded triple helix will also include start-ups and private investors (Reve 2017). In this regional context, innovations are viewed as localized depending on the technological infrastructure, ecosystem, and market characteristics. Locally, there would be major challenges in executing the innovation system elsewhere. Transferring the Start IoT concept to Asian BUs will imply that Telenor Group should look for ways to facilitate for local needs and challenges that have to be resolved. This would most often be related to business and customer use cases; the presence of knowledge and scientific excellence; degree of co-creation between local start-ups, partners, and governmental organizations; as well digitalization, IoT, and AI maturity. Several of these factors may differ from what we find in Norway; hence, a setup flavoring the local characteristics should be analyzed going forward experimenting the Start IoT concept in the Asian BUs.

6 Conclusion

The Internet of Things and artificial intelligence are two key technologies that influence much of the way products and services are developed and business created. We raised the question of how a mobile operator acts in order to affect the evolution of a complex IoT ecosystem and provided insight from the Norwegian market. In Norway, Telenor has taken a central role in the evolution of IoT and has chosen two paths to build the future ecosystem. First, Telenor has a key role in the ecosystem in close cooperation with research and educational institutions in several regions in Norway within AI and IoT. Second, it has been a driving force in a Norwegian experimental ecosystem for the Internet of Things in an early start-up phase.

Successful transfer of the Start IoT concept to Asian BUs implies adaption to local needs, ecosystem partners, and infrastructures. Follow-up analyses will be needed to assess the implementation of the next phases of the IoT ecosystem development and the factors that enabled this development. Moreover, surveys and in-depth studies from Telenor Group's Asia BUs should be executed adding the different local needs and requirements for transferring the Norwegian regional innovations system to these markets.

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