Capital Inflows, Financial Cycles and Business Cycles in Asian Countries

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ABSTRACT

Southeast and South Asian countries have proved to be among the fastest growing economies in the world during the past few decades, with capital inflows and accumulation of human capital being among the most significant causes of their growth. These countries have also shown a high degree of financial instability. This thesis presents three empirical papers (Chapters 2 to 4) on the contributors to their growth, their financial and business fluctuations, and the relationship between these fluctuations. The empirical analysis is carried out for China, India, Indonesia, Japan, South Korea, Malaysia, Thailand and Vietnam.

Chapter 2 provides a quantitative assessment of the effects of various types of capital inflows (including foreign investment, foreign aid, long-term debt and openness to trade) and human capital (in the forms of education enrollment and education expenditures) on the growth process of the selected Asian countries over the period 1970 – 2010. Our empirical analysis is based on dynamic panel data, and can be categorized into three aspects: for stationary variables, we employ VAR methodology, Granger-causality, causality strength measure, impulse response functions and variance decomposition; to analyze the non-stationary variables, we employ cointegration analysis and VECM model; and to investigate the common effects shared by all these countries, we use panel data analysis. Our results show that capital inflows affect the growth process in our sample of countries both in the short and the long term. In the majority of countries, per capita real GDP and its growth rate respond positively to four of the components in capital inflows: foreign investment, openness to trade, public investment and human capital; on the other hand, capital inflows of aid and long-term debt seem has adverse or insignificant effects on economic growth in some cases. Further, our finding is that there exists significant two-way Granger-causality between capital inflows and economic growth across multiple time horizons, and that causality is strongest between foreign capital inflows and economic growth.

Besides capital inflows and human capital, the financial system plays an important role in the determination of economic growth and its fluctuations. The third chapter empirically investigates the characteristics of financial cycles using turning points and frequency-based filters analyses. Our sample of countries in this chapter covers 11 Southeast and South Asian countries over the period 1960 to 2013. We examine the frequency, duration and amplitude of the cycles in

credit, house prices and equity prices, and their synchronizations within a country as well as across countries. We find, first, that financial cycles in the Asian countries are longer and severer than the business cycle in output, but not as long as those in developed countries; second, the credit cycle displays a quite skewed shape with exceptionally longer and stronger expansions than contractions, and that, in the cycles on credit, house prices and equity prices, equity prices show the greatest volatility, the shortest cycle duration and the greatest amplitude; third, the peaks of financial cycles are closely followed by financial crises. Finally, the cycles in financial variables are highly synchronized within each country and across countries.

Since the cyclical variations in financial and business cycles tend to be highly correlated and reinforce each other, the fourth chapter investigates the features of business cycles and their relationship with those of financial cycles in our set of 11 Asian countries.[1] The data used is for the period 1980Q1 – 2013Q4. Our results show, first, that financial cycles tend to be deeper and sharper than business cycles. Second, cycles in output tend to display high-level synchronization with cycles in credit, whereas they do not feature much commonality with cycles in employment and with some of our other financial variables. Third, the dynamic correlations between business cycles and financial cycles in most countries are significantly positive at low frequencies while not being significant at higher frequencies. Finally, though Granger-causality tests generate mixed results between the financial and business variables, there exists strong two-way causality between credit and real GDP, with credit having very high predictive power for the growth of real GDP, and real GDP helping to predict the growth of credit.

Chapter 2 focuses on the effects of a broad measure of capital inflows on economic growth, rather than on a more specific category, such as FDI. It also contributes to the literatures by a sample size of 8 developing countries in Southeast and South Asia and longer historical data than previous studies. In addition to the use of the VAR approach and cointegration analysis, it attempts to estimate the strength of causality, which has never been employed to investigate the relationship between capital inflow and output growth.

Chapters 3 and 4 employ well-established statistical methodologies to identify the main features of business and financial cycles and to investigate the relationship between them. They contribute to the empirical literature in several ways. Most of the existing studies analyze this issue

[1] We added Hong Kong, Singapore and Taiwan to our sample set in Chapters 3 and 4 based on the availability of data.

for advanced economies; we do so for a sample of developing countries in Asia. Only a limited number of studies focus on the interactions between the real and financial sectors during the various phases of business and financial cycles. In cases where the existing studies on crises have used larger samples, they usually rely on annual data: this thesis employs quarterly data.

RÉSUMÉ

Au cours des dernières décennies, les pays de l'Asie du Sud et du Sud-est sont devenus les économies les plus croissantes au monde, leurs entrées de capitaux et leur capital humain en sont deux causes significatives et majeures de leur croissance. Ces pays ont également montré un haut degré d'instabilité financière. Cette thèse présente trois études empiriques (chapitre 2 à chapitre 4) sur les contributeurs à leur croissance, leurs fluctuations financières et commerciales, ainsi que la relation entre ces fluctuations. L'analyse empirique est menée sur la Chine, l'Inde, l'Indonésie, le Japon, la Corée du Sud, la Malaisie, la Thaïlande et le Vietnam.

Dans le chapitre 2, nous nous sommes penchés sur la croissance endogène afin d'examiner les effets des différents types d'entrées de capitaux sur le long-terme (y compris les investissements étrangers, les aides étrangères, les dettes à long terme et les échanges commerciaux), et des différents types de capitaux humains, (grâce au taux d'inscription à l'école et aux dépenses éducatives par exemple) sur la croissance de ces pays sur le long terme. Pour analyser les taux de croissance, nous avons utilisé le modèle VAR, la causalité de Granger, la fonction d'analyse dynamique et la décomposition des variances; et pour analyser les variables non stationnaires, nous nous sommes servis de l'analyse de co-intégration, du modèle VECM et des fonctions d'analyse dynamique de ces modèles VECM ; enfin, afin de rechercher les effets communs à tous ces pays, nous avons effectué une analyse des données de panel. Nos résultats montrent que les entrées de capitaux influent sur le processus de croissance dans notre échantillon de pays à court et à long terme. Nous pouvons conclure que, pour la majorité des pays, leur PIB réel par habitant et leur taux de croissance répondent positivement aux quatre facteurs suivants: les investissements étrangers, les échanges commerciaux, les investissements publics et le capital humain ; en revanche, les entrées de capitaux relatives aux dettes à long terme ont des effets indésirables ou anodins sur la croissance de la production par habitant. En outre, nous pouvons conclure que, entre les entrées de capitaux et la croissance économique, il existe la causalité de Granger significative et bidirectionnelle à travers de horizons multiples, et que la causalité est la plus forte entre les capitales entrées de capitaux étrangers et la croissance économique .

Hormis les entrées de capitaux et le capital humain, les systèmes financiers jouent un rôle important dans la détermination de la croissance et la fluctuation économique. Dans le troisième chapitre, nous nous penchons de façon empirique sur les caractéristiques des cycles financiers en nous basant sur les tournants historiques décisifs et les analyses basées sur leurs fréquences. Dans ce chapitre, notre échantillon est constitué de 11 pays d'Asie du Sud et du Sud-est, sur la période 1960-2013. Nous avons examiné la fréquence, la durée et l'amplitude des cycles au niveau des crédits, des prix des logements et des cours des actions, et leurs synchronisations dans un même pays ainsi qu'entre les pays. Nous nous sommes d'abord aperçus que les cycles financiers des pays asiatiques sont plus longs et plus graves que le cycle économique au niveau du rendement, mais ils ne durent pas aussi longtemps que dans les pays développés ; ensuite, le cycle du crédit affiche une forme plutôt oblique avec des expansions exceptionnelles, plus longues et plus fortes que les reculs, et pendant le cycle du crédit, les prix des logement et les cours des actions montrent la plus grande volatilité, avec une durée de cycle plus courte et la plus grande amplitude; troisièmement, les pics des cycles financiers sont suivis de près par des crises financières. Enfin, les cycles des variables financières sont extrêmement synchronisés, que ce soit dans un même pays, ou entre les pays.

Parce que les variations cycliques dans les cycles des affaires et financiers ont tendance à se corréler et se renforcer mutuellement, le quatrième chapitre nous a servi à rechercher les caractéristiques des cycles des affaires et leur relation avec les cycles financiers dans les 11 pays asiatiques sur la période 1980Q1 – 2013Q4Premièrement, nos résultats montrent que les cycles financiers ont tendance à être plus profonds et plus précis que les cycles des affaires. Deuxièmement, les cycles de rendement semblent afficher une forte synchronisation avec les cycles de crédit, alors qu'ils ne présentent pas de similarité flagrante avec les cycles de l'emploi et avec certaines variables financières. Troisièmement, pour la plupart des pays, les corrélations dynamiques entre les cycles des affaires et les cycles financiers sont nettement positives quand ils sont peu fréquents alors qu'elles le sont nettement moins quand ils sont plus fréquents. Enfin, même si les tests de causalité de Granger nous montrent des résultats mitigés quant aux variables des affaires et financières, il existe une causalité bidirectionnelle entre le crédit et le PIB réel, étant que le crédit a un

pouvoir hautement prédictif sur la croissance de l'économie, et que le PIB réel aide à prévoir la croissance du crédit.

Les chapitres 3 et 4 emploi des méthodes statistiques bien établies pour identifier les caractéristiques principales des cycles commerciales et financières et pour étudier la relation entre eux. Ils contribuent à la littérature empirique de différentes façons. La plupart des études qui ont été réalisées analysent cette question dans les cas des pays avancés; alors que nous nous sommes servis d'un échantillon de pays asiatiques en développement. Peu d'études se sont focalisées sur les interactions entre les secteurs réel et financier lors des différentes phases des cycles d'affaires et financiers. Dans les cas d'études sur les crises qui se sont servies d'échantillons élargis, celles-ci reposent généralement sur des données annuelles et elles n'examinent qu'une seule phase du cycle, alors que pour cette thèse, nous nous sommes basés sur des données trimestrielles.

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Chapter 1

Introduction

There are many factors that contribute to the economic growth. The reasons for the miracle of fast developing economies among Asian countries include the following: since the 1960s, with their relatively low incomes and well-educated workers, they had the potential for catching up with the developed economics; their geographical characteristics were favorable; demographic changes after World War II, and their economic policies and strategies; highly skilled workforce, the accumulation of capital in new forms and the adoption of new technologies (see Chang, 2006). From this long list of numerous contributors to growth, foreign capital inflows not only enhance the capital accumulation, they can also facilitate technology transfers. In addition, different types of capital inflows have different effects on economic growth.

The long-standing debate over the relationship between foreign capital inflows and economic development continues to remain an unresolved issue (see White (1992), Collier and Dollar (2004), and Addison et al. (2005)). In the theory of neoclassical growth model, foreign capital inflows augment domestic savings and increase the economic growth rate only in the transition process, but has no effect on the steady rate growth rate. However, endogenous growth theory suggests a number of channels through which FDI permanently affects economic growth (see Adams, 2009): FDI can affect output by increasing the stock of physical capital, increasing employment and technology transfers, as well as enhancing human capital through labor training, skill acquisition, and new management and organizational arrangements. As an illustration, the core part of the analytical framework of the financing gap models of the World Bank for funding structural adjustment advocates that higher investment is necessary for long-run growth (see Bacha, 1990 and Taylor, 1994).

A main objective of this study is to examine the contributions of human capital and financial capital (including flows) to growth. Productivity growth resulting from financial capital inflows and a more highly educated workforce in newly industrializing Asian countries boosts the growth of output and triggered the rise of the service and manufacture sectors, compared to the old economic structure with a mainly agriculture sector. In addition, in recent decades, these countries, except for Japan and Korea, were among the largest recipients of foreign capital among the developing countries (see Kimand and Yang, 2008). Although the growth rates in these countries

were reduced by the 2008-09 financial crises, they continued to have higher growth rates than the western developed economies.

Chapter 2, therefore, attempts to investigate the empirical relationship between foreign capital, human capital and economic growth in our selected Asian countries (China, India, Indonesia, Japan, Korea, Malaysia, Thailand and Vietnam), using data from 1960 to 2014. It tests whether permanent changes in foreign capital inflows and human capital caused permanent changes in the growth rates of real per capita output in these countries. To do so, it separates the different components of capital inflows into foreign investment (FDI and portfolio investment), long-term debt and foreign aid, and examines the separate contribution of each one to long-run growth. For the econometric analysis, it adopts stationarity test, cointegration techniques, VAR analysis, and Granger causality tests. Further, to better capture the causal relationship between the growth rate and the capital inflow, we estimate measures of the strength of causality for different time horizons.

Chapter 2 differs from existing studies in the following respects. First, this chapter decomposes capital inflows into FDI, portfolio investment, long-term debt, foreign aid and openness to trade, rather than use the general term of net capital inflows, to examine their distinctive effects on economic growth. In addition, it emphasizes the role played by human capital in the process linking capital flows and growth. Second, it has a sample size of 8 developing countries in East Asia and longer historical data than used in previous studies. Further, in addition to the use of the VAR approach and cointegration analysis, it attempts to estimate the strength of causality provided by the magnitudes of the causal relationship.

Granger-causality statistics examine whether lagged values of one variable help to predict another variable and establish the direction of causality. It is only significance test for non-causality and has limitation to interpret the dynamic relationship, for example, it may not allow to test the causality across multiple horizons, and it may not proper to compare the different levels of linkages. Conversely, the measure of the causality strength provides an investigation to determine the dynamic links between different component of capital inflows and economic growth in terms of strength, direction and time horizon, therefore, it determines how strength of these relationships and how long the causal effect can last.

Besides capital inflows and human capital, financial systems play an important role in boosting economic growth, and increasing savings and investment, as well as contributing to

economic fluctuations. To understand the core features of financial systems, it is essential to study the fluctuations of financial markets, which usually exhibits cycles with booms and busts. To illustrate, in the early 1990s, Japan experienced a large housing bubble and a massive asset market crash; in the second half of the 1990s, many developing countries in East Asia experienced financial crises after prolonged credit booms; and the USA and many European countries had credit and housing booms from 2003 to 2007 and then underwent severe financial disruptions (see Radelet, 1998). Therefore, a comprehensive empirical overview of financial cycles is critical to understanding the historical behavior of financial markets and their impact on the economy. To illustrate, Levine and Zervos (1998) find that stock market liquidity and banking development in 47 countries over the period 1976-1993 had a positive effect on economic growth, capital accumulation and productivity. Moreover, Fase (2001) finds that the development of the financial system has a greater impact on growth in a developing country than in mature economies.

Chapter 3 measures financial cycles in credit, house prices and equity prices. In general, prices in financial markets tend to occur in a cyclical pattern, along with a close connection between asset prices and credit availability. On the latter, when credit supply increases, the credit constraint on households and firms is loosened, which in turn increases asset demands and prices. Conversely, as the values of assets, which act as collateral and an indicator of credit-worthiness, increase, banks become willing to supply more credit.[3] This process is further intensified by increasing optimism. From a slightly different perspective (see Goodhart, 2008), credit expansion, which feeds into asset prices, lowers the cost of capital, stimulates investment and subsequently leads to an economic boom. Eventually, the investments do not generate the expected profits and the whole structure collapses, with the economy moving from boom to bust, often followed by banking or/and currency crises. Hence, asset prices in financial markets are subject to cycles with an expansion ending in a financial crisis, which is followed by a downturn that ends in a trough. Consequently, movements in asset prices are often associated with cycles in the availability and cost of credit (see Stock and Watson, 2003b).

So far, very few studies have focused on the aspects of financial cycle in East Asian countries. Chapter 3 addresses several questions related to the financial cycle in these countries. First, it examines whether there exists a financial cycle in Asia and, if so, examines its main

[3] This process is sometimes reinforced, as in recent decades, by structural and regulatory changes (Sir John Gieve, 2008 speeches, the financial cycle and the UK economy, http://ssrn.com/abstract=1275790).

characteristics, such as frequency, duration, amplitude and slope. Second, given that financial markets are relatively fragile and immature in most Asian countries, this chapter examines their similarity —and distinctiveness -- to those of the developed countries. Third, it examines the synchronization of financial cycles within each country and across countries. Finally, the most common measure of co-movement between financial cycles is the classical correlation; however, this static analysis fails to capture any dynamics in the movements between different financial markets. Therefore, we employ dynamic correlation analysis to investigate the details of the synchronization in the frequency domain.

To summarize, the main contribution of the Chapter 3 is to fill the gaps in the study of the financial cycle in Asian countries. It extend the literatures in several ways. First, we combine and compare the two analytical approaches – turning-point analysis and frequency-based filter to draw more robust conclusions. Second, we explore several variables and quarterly data, rather than the annual data typically used in other studies that could extract the characteristics of financial cycles. Third, we consider the full cycle and compare short-term and medium-term. Fourth, we employ extensive investigations on synchronization and dynamic correlation across multiple financial markets and countries.

In Chapter 4, we investigate the relationship between financial cycles and business cycles in our selected set of Asian countries. Business cycles are usually captured by fluctuations in real variables such as output and employment. Correspondingly, fluctuations in asset prices, credit and interest rates have been used to describe fluctuations in financial markets. The cyclical variations in both financial and real variables are often closely associated with each other. Financial crises or credit crunches usually result in downturns of the business cycle, while many business cycle upturns have been accompanied by ample credit and a rising stock market. For instance, the 2007-09 financial crisis in the USA led to a deep and synchronized global downturn, accompanied by a severe contraction in output, trade and financial activities. It is widely presumed in economic theory, especially the modern classical approach, that finance is largely a sideshow to macroeconomic fluctuations. However, the 2007-09 crisis demonstrated this presumption to be wrong. In the past few years, all advanced economies and many emerging economies have experienced recessions due to financial disruptions, including severe contractions in credit and declines in asset prices. Among other studies, Caballero (2010) and Woodford (2010) illustrate the debate on the links between finance and the real economy.

Chapter 4 contributes to the empirical literature in several ways. First, most of the existing studies analyze this issue for advanced economies; we do so for a sample of developing countries in Asia. Second, only a limited number of studies focus on the interactions between the real and financial sectors during the various phases of business and financial cycles. In addition, in cases where the existing studies on crises have used broader samples, they usually rely on annual data and examine only a single phase of the cycle: this thesis uses quarterly data. Third, this chapter employs well-established methodologies to identify the main features of business and financial cycles and investigates the relationship between them.

Chapter 2

The Effects of Capital Inflows and Human Capital on Economic Growth

2.1 Introduction

In the past decades, we witnessed a dramatic increase in international capital flows to developing countries. Foreign capital started to flow into Asian countries at accelerating rates in the 1990s -- after a large drop during the 1980s. The net private capital flows to developing nations increased from around US$36 billion per year during 1987–89 to US$230 billion per year during 1995–97 (see World Bank 1998; Baharumshah and Thanoon, 2006). Over the past 25 years, gross capital inflows to emerging East Asia have also increased very significantly. Indeed, they recently surpassed the peak reached just prior to the 1998 Asian financial crisis. Gross capital inflows to these economies had reached over $300 billion by 2010—from slightly over $140 billion in 1996. In the 1980s and early 1990s bank loans and foreign direct investment (FDI) were the primary sources of capital flows into emerging Asia, accounting for more than half of all private capital inflows. The share of FDI inflows relative to other capital flows has increased since the 1980s, constituting slightly less than 30% of the world capital inflows in the 1990s. Between 1993 and 1998, FDI represented an annual average of 40% of the net resource flows to the ASEAN countries[4] (see Kimand and Ynag, 2008). However, more recently, portfolio investments have grown to take up a large portion of the total. Foreign capital inflows not only fill the saving–investment gap but also facilitate the transfer of technology, first to the exports sector and later to the non-export sectors of the economy through its spillover effects (see Baharumshah and Thanoon, 2006).

Several factors have contributed to this rapid growth in capital flows to developing countries in recent decades. These include the liberalization of financial markets in the developing countries and the availability of low-cost labor, as well as sustained growth, which made them

[4] Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam

attractive to international investors. The composition of international capital flows[5] to developing economies has also become more diverse in the last decade or so. The international balance of payments statistics[6] divide international capital flows into four categories: short-term investment, long-term investment, portfolio investment and direct investment. There has been a shift from long-term debt to short-term loans, and from bank to non-bank sources such as direct investment flows and portfolio investments. This indicates we need to decompose capital inflows into FDI, portfolio investment and banking capital, rather than use the general term of net capital inflows, to examine the effects on economic growth.

Although free financial flows are desirable, because they lead to a more efficient global allocation of capital, thereby increasing long-run growth through investment and technology spillovers, the surge of foreign capital also carries potential problems (see Ito, 1999). It may bring about an appreciation of exchange rate, inflation pressures and exposes the recipient country to external shocks. The short-term capital flows can increase the fragility of the financial system and destabilize the economy. An important lesson learned from the Asian 1997–1998 crisis is that foreign capital, especially short-term capital, can exit as easily as it enters in an open economy (see Chowdhry and Goyal, 2000). In contrast to short-term capital inflows, FDI is less volatile. It is usually seen as a safer form of financing investment since it involves long-term commitments to a country. Borrows also found that they could lower their financing costs by borrowing in dollar rather than local currency.

Many studies have focused on the role of FDI in the growth process of emerging markets. In our study, we make a distinction between the types of capital movement (FDI, portfolio investment, long-term debt, foreign aid and openness to trade). Specifically, we test for the interdependence of human capital on economic growth. Do different types of foreign capital have different impacts on economic growth?

The effectiveness of foreign capital in accelerating growth is associated with the level and the quality of both infrastructure and human capital. A better quality of infrastructure and education of the labor force enables developing countries to fully exploit the benefits of private capital formation and capital inflows. The idea that human capital facilitates technological

[5] Federal Reserve Bank of San Francisco, the composition of international capital flows: http://www.frbsf.org/economic-research/publications/economic-letter/2000/june/the-composition-of-international-capital-flows/

[6] https://www.imf.org/external/np/sta/bop/bop.htm

development is based on Romer (1990). In this specification, a higher level of human capital leads to more innovations and higher efficiency, which causes a higher growth rate of the aggregate economy output. Miyamoto (2003) points out that human resource development (HRD) and foreign direct investment (FDI) are among the key drivers of growth in developed and developing countries. While HRD and FDI independently affect growth, they also reinforce each other through complementary effects. In general, enhanced HRD increases incoming FDI by making the investment climate attractive for foreign investors. This is done through a direct effect of upgraded skill level of the workforce, as well as via indirect effects such as improved socio-political stability and health (World Bank, 2003; UNESCO and OECD, 2003). On the other hand, FDI contributes to HRD since multinational enterprises (MNEs) themselves can be active providers of education and training, bringing new skills, information and technology to host developing countries.

There are a number of theoretical and empirical studies dealing with the effects of capital inflows, and some of them analyze the significance tests of the predictive relationship between the capital inflows and other different variables, however, none of these studies considers the magnitude of prediction improvements using measures of the strength of causality. The significance tests for non-causality is merely yes or no causality test between different time series. By contrast, the measure of the causality strength allows determination of the dynamic links between different component of capital inflows and economic growth in Asian countries in terms of strength, direction and time horizon.

Our set of selected Asian countries is China, India, Indonesia, Japan, Korea, Malaysia, Thailand and Vietnam. These countries provide an interesting case to study the effect of foreign capital inflows. They have become more integrated with the world economy since the early 1990s (see Chang, 2006): their industrial tariffs fell and foreign direct investment flows reached new heights, partly as a consequence of their market reforms and the enhanced openness of their economies to foreign trade and investment. In the last few decades, some of these countries were among the largest recipients of foreign capital among the developing countries and pursued economic strategy with different degree of openness in their trade regime. Before the 1997 Asian financial crisis, these countries had been proud of their economic achievements: fast growth, low inflation, strong fiscal position, high savings rates, open economies and strong export sectors.

This chapter studies the relationship between capital inflows, human capital and growth in the period of 1970 – 2010. It examines the effects of the different types of long-term capital inflows

and human capitals on the long-term growth performance of the selected Asian countries. Capital inflows can foster a more efficient allocation of resources, provide opportunities for risk diversification, and help promote financial development. In the pursuit of such benefits, many governments opened their economies to free capital markets and capital account liberalization.

The remainder of this chapter is organized as follows. Section 2 describes the theoretical and empirical literature on the impact of capital inflows and human capital on the economic growth. Section 3 constructs an endogenous growth model for testing the hypothesis under consideration. Section 4 describes the data sources. Section 5 explains how we identify the effects of different factors using econometric analysis via VAR, Granger-causality, measures of the strength of causal links, cointegration techniques and VECM model, and draws out the implications for China, India, Indonesia, Japan, Korea, Malaysia, Thailand and Vietnam respectively. Section 6 adopts panel data analysis, and Section 7 concludes.

2.2 Theories and Empirical Evidence

The impact of foreign capital inflows on the growth of developing countries remains controversial. In the framework of a neo-classical model, pioneered by Solow (1956) and Swan (1956), capital inflows only increase domestic saving, which increases investment. Because of diminishing returns to physical capital, the higher saving rate affects the level of income but does not change the steady state growth rate. Therefore, capital accumulation and capital inflows speed up the transition to the steady state. On the other hand, endogenous growth theory argues that capital inflows could enhance growth (Lucas, 1990; Grossman and Helpman, 1991). Foreign capital allows the recipient country to have access to a variety of assets that increase its knowledge of production techniques. In endogenous growth theory, an increase in knowledge can cause constant or increasing returns in production. Moreover, the new knowledge created or acquired by a firm is likely to have spillovers that increase the knowledge of other firms.

For developing countries, trade and foreign capital can accelerate long-term growth by increasing the rate of capital accumulation, as well as technology transfers from the advanced economies to the developing ones. However, empirical evidences on this point is mixed and complicated. Barro, Mankiw and Martin (1995) analyze capital mobility in open economies and conclude that capital mobility tends to raise the rate at which poor and rich economies converge,

but the quantitative impact is small. Kohli (2003) finds that the inflow of foreign capital has a significant positive impact on the domestic money supply and stock market growth, liquidity and volatility in India from 1986-2001. Kraay (1998), Gounder and Xayavong (2001), and Carkovic and Levine (2002), using 1960-1995 data, find no significant relationship between capital inflows and growth. Prasad et al. (2006) investigate data from 21 industrial, 20 emerging and 30 other developing countries over the period 1985-2004, and conclude that there is no robust relationship between capital account liberalization and economic growth. Mazumdar (2005) suggests that capital inflows have not contributed towards either industrial production or economic growth in India, and have not had much impact on its export growth or productivity from the 1970s to 2000. In addition, Prasad et al. (2007) get mixed conclusions for 56 nonindustrial countries, 22 industrial countries and 21 transition countries from 1970 to 2004: the positive correlation between current accounts and growth is found primarily in poor countries, while a negative correlation occurs for rich countries. Further, nonindustrial countries that have relied on foreign capital have not grown faster than those that have not.

Empirical evidence suggests that the effects of international capital movements tend to differ depending on the types of capital flows. Studies by Dooley (1988) (using the data from seven countries[7] during 1977-1984), Goldstein, Mathieson, and Lane (1991)[8], and Edwards (1991)[9] find that capital flows are accompanied by fewer problems when they are long-term direct investment induced by the domestic growth prospects of the recipient countries. However, capital flows that take the form of portfolio investment and originate from external shocks, such as changes in foreign interest rates, tend to be short term and increase the difficulty of economic stabilization in capital-recipient countries. Stallings (2007) claims that portfolio investment and remittance inflows are other forms of capital inflows that play a central role in the economies.

A majority of capital flows to East Asia took the form of foreign direct investment (FDI) rather than portfolio investment. Foreign direct investment is often said to be a preferred form of investment for host countries. Compared with bank credit, bank deposits, or bonds, it is more difficult and costly to withdraw investments that have become factories and other real assets. Moreover, direct investment brings foreign management and technology transfers, which are

[7]Argentina, Brazil, Chile, Mexico, Peru, the Philippines, and Venezuel
[8] Industrial and developing countries during the 1970s and 1980s based on IMF's payment of balance Yearbook, international financial statistics, and international banking statistics.
[9] Chile during 1970s and 1980s

expected to contribute to raising the industrialization levels of the host country. When foreign capital flows are in the form of direct investment, it has at least two positive effects on the economy. First, it adds to domestic saving to become funds for investment. Second, it often comes with technology spillovers. Recent studies, such as Belderbos, Capannelli, and Fukao (2000) and Urata and Kawai (2000), show significant technological spillovers to the subsidiaries in East Asia from Japanese manufacturing firms.

In empirical studies, the effect of FDI on economic growth has been far from conclusive. A large number of applied papers have looked at this topic, such as Markiw, Romer, and Weil (1992), De Mello (1997)[10], Flexner (2000), Zhang (2001, 2006)[11], Khawar (2005), and Li and Liu (2005)[12]. Empirical studies that report a positive impact of FDI on growth include Borensztein, Gregorio, and Lee (1998)[13], Zhang (2001), and Baldwin et al (2005)[14]. Moreover, Bengoa and Sanchez-Robles (2003) show that, while FDI is positively correlated with economic growth, it requires the host country to have human capital, economic stability and liberalized markets in order to benefit from long-term FDI. More recently, Johnson (2006) demonstrates by cross section and panel data analysis that FDI inflows boosted economic growth in developing countries, but not in advanced nations. However, there are a number of studies that do not support the view that FDI promotes economic growth. Carkovic and Levine (2002) use two databases of the World Bank and the IMF of 72 countries over the period of 1960–95 to analyze the relationship between economic growth and FDI and report that FDI does not exert a robust influence on economic growth. In a case of study on Sri Lanka, Athukorala (2003) also finds no robust link between FDI and growth. Using data on 80 countries for the period 1979–98, Durham (2004) also fails to find a positive relationship between FDI and economic growth.

Though a large proportion of studies stress the particular role of human capital for FDI to be beneficial to host countries, the contribution of human capital to growth is also controversial.

[10] De Mello argues that FDI can increase the growth rate by increasing production through technology transfers, productivity spillovers and externalities in the endogenous growth models.

[11] Zhang (2001) provides an analysis of FDI effects on growth in China.

[12] Li and Liu (2005) investigate whether FDI affects economic growth using panel data for eighty-four countries over the period 1970–99.

[13] Borensztein, Gregorio, and Lee (1998), using cross section data, conclude that whether FDI increases the economic growth through the magnitude of its effects depends positively on the level of human capital available in the host country.

[14] Baldwin et al. (2005) use industry-level data from seven OECD countries.

Using data from the 48 contiguous United States from 1978–97, Ford, Rork and Elmslie (2008) demonstrate that FDI is more productive than domestic investment in the presence of a minimum level of human capital. Liu and Stengos (1999) employ an additive semi-parametric partially linear model to uncover the way that initial output and schooling levels affect growth rates. Kalaitzidakis et al. (2001) use mean years of schooling to measure human capital and find a nonlinear effect on economic growth. Mamuneas et al. (2006) argue that the level of education of workers plays a primary role in domestic firms to accept and adopt foreign technology through FDI. Urata and Kawai (2000) find that education, measured by the secondary school enrollment ratio, is important in determining technology transfers from Japanese firms' FDI to five other Asian countries. Borensztein, DeGregorio, and Lee (1998) conclude that FDI is more productive than domestic investment when the host country meets a minimum level of human capital. Xu (2000) finds that US multinational firms have a positive impact on growth above a minimum human capital threshold level.

To understand the causal mechanism between economic development and capital inflows, numerous studies have employed Granger-causality, introduced by Granger (1969) to predict at horizon one the value of a variable from its own past and the past of another variable. For instance, Frimpong et al. (2005) study the causal link between FDI and GDP growth for Ghana by the Granger no-causality test. Baharumshah et al. (2006) demonstrates the effect of FDI and trade on Turkey's economic growth by investigating a Granger causal relationship from 1987 to 2002. However, none of the existing studies consider the strength of the causal linkage among capital inflow and economic growth. Dufour and Renault (1998) suggest that predictability may depend on the time horizon and use multiple horizons in order to avoid spurious causations. They also introduce indirect causality with auxiliary variables

This chapter helps to fill the gap in the literature by the following aspects. First, much of the empirical work studies only some types of financial inflows. We classify capital inflows into different components, and investigate their relationship with economic growth in the presence of human capital, and examine the extent to which capital inflows contribute to growth after controlled for the effects of human capital formation. Second, our empirical models use autoregression and cointegration techniques. Third, in addition to the pure non-causality test, we consider the strength of the underlying linkages between economic growth and the different

components of capital inflow (foreign direct investment, portfolio investment, aid capital and long-term debt capital) at multiple time horizons in both directions(see Dufour and Taamouti, 2010).

2.3 Data

This chapter provides the econometric analysis for China, India, Indonesia, Japan, Malaysia, South Korea, Thailand, and Vietnam, employing annual data from 1970 to 2010. Data on real GDP, real GDP per capita growth rate, public capital, aid capital to real GDP ratio, school enrollments, imports and exports are from the 'World Development and Social Indicators' database, while equity capital and long-term debt capital are from the World Bank 'Global Development Finance' database. Data on public investment comes from 'International Food Policy Research Institute'.[12] Normally, the information on capital flows is in terms of net inflows, which is inflows less outflows. However, our study focuses on gross inflows of FDI, portfolio investment, aid capital and long-term debt into a country. We use this concept because capital outflows from these countries are unlikely to have significant effects on growth over our sample period.

We use the following symbols and calculations for our variables:

A. YGR (Real GDP per capita growth rate): annual percentage change in the ratio of real GDP divided by the labor force.
B. GDP (Real GDP per capita): the natural logarithm of its value.
C. EKY (Equity capital to GDP ratio): sum of foreign direct investment and portfolio investment, divided by GDP.
D. AKY (Aid capital to GDP ratio): sum of pure grants (grants plus technical cooperation) and official development assistance (ODA) divided by GDP
E. LDKY (Long-term debt capital to GDP ratio): sum of private and official long-term debt outstanding in each year, divided by GDP. Long-term debt is defined as debt with a maturity period of at least one year.
F. TRDY (Trade capital to GDP ratio): a measure of openness, computed as the sum of imports and exports of goods and services divided by GDP.
G. SKY (Social capital to GDP ratio): a measure of public infrastructure computed as the ratio of public investment divided by GDP. It provides an index of the quantitative

[12] http://www.ifpri.org/book-39/ourwork/programs/priorities-public-investment/speed-database?print

amount of resources allocated to public investment projects each year. Note that it does not incorporate information on the quality of the infrastructure.

H. SER (Secondary enrollment rate): secondary school enrollment among the population.

I. TER (Tertiary enrollment rate): total enrollment, regardless of age, in post-secondary institutions as a percentage of the population within five years of the age at which students normally graduate from high school.

J. EEY (Education expenditure to GDP ratio): total public expenditure (current and capital) on education expressed as a percentage of the GDP in a given year. Public expenditure on education includes government spending on educational institutions (both public and private), education administration, and transfers/subsidies for private entities (students/households and other private entities).

Many factors contribute to the rapid growth in these developing countries, including the liberalization of financial markets and the availability of low-cost labor, as well as environmental and climatic conditions. For developing countries, the most essential factors to growth are likely to be the high-level workers and accumulation of capital. Then foreign capital inflows not only enhance capital accumulation, they can also promote the level of workers, and facilitate technology transfers. Therefore, our study concentrates on the impact of capital inflows and human capital on growth for the rapidly-growing Asian countries.

2.4 Empirical Analysis

The preceding theoretical and empirical literature reviews imply that long-term growth is affected by many explanatory factors, including public capital (infrastructure) and human capital. Therefore, we specify long-term growth to be a function of foreign capital, human capital, public capital and other growth determinants. Foreign capital is decomposed into equity capital, foreign aid and long-term debt capital. Equity capital is defined as the sum of foreign direct investment and portfolio investment. Foreign aid is the sum of pure grants, technical cooperation and official development. Long-term debt is taken to be debt with a maturity of a year or more. Public capital is defined as the stock of social infrastructure, mainly accumulated through government fixed capital investments. Education capital is represented by enrollment rates of primary education, secondary education and education expenditure per capita.

Based on these growth determinants, we specify the growth estimation function as:

$$g_t = \alpha_0 + \phi' X_t + \varepsilon_t \quad (1)$$

Where g_t is the growth rate of GDP per capita, $\phi'$is the vector of parameters, X is the vector of growth determinants, ε_t serves as a mean-zero stationary random term and t refers to the time period. The vector X consists of foreign aid, equity capital, long-term debt capital, public capital, openness to trade, secondary enrollment rate, tertiary enrollment rate and public education expenditure. The model in Eq. (1) is assumed to be dynamically stable. A specification that captures short-term divergence and the process of convergence to long-run values is the error-correction model:

$$\Delta g_t = \psi(ec_{t-1}) + \sum_{i=1}^{q} \delta_i \Delta g_{t-i} + \sum_{i=1}^{q} \mu'_i \Delta X_{t-i} + \omega_i \quad (2)$$

Where ω_i is an independent and identically distributed (i.i.d.), zero-mean and the stationary variable, $ec_{t-1}$is the lagged error-correction (ECM) term defined as $ec_{t-1} = g_{t-1} - \alpha_0 - \alpha\phi' X_{t-1}$, which is estimated by the divergence of the actual from the estimated equilibrium value obtained from Eq. (1).

2.4.1 Econometric Analysis for China[15]

We use China to introduce our econometric analyses, illustrate the implementation of the statistical techniques and derive our results. Then, we conduct similar econometric analyses for each country in our data set and present our findings.

Figure 2.1 depicts the evolution of China's GDP growth, physical capital and human capital from 1960-2011. The steady increases in the international trade to GDP ratio and in secondary and tertiary enrollment rates are salient in this figure. Aid capital accounts for a very small proportion of GDP: it changed only from 0.02% to 0.9% during the sample period. Foreign Direct Investment began to flow into China starting from the 1980s, which is 10 years after China's start of trade liberalization. Over our sample period, imports and exports increased impressively from no more than 6% of GDP to almost 60%. Aid capital, however, plays a relatively less important role than other forms of capital. Social capital and long-term debt capital exhibit opposite changes over time.

[15] China experienced the fastest growth during the sample period, and it is typical and largest country in our selected sample countries. It is chosen as an example to demonstrate statistical analysis.

From 1980-2010, public investment declined initially but increased after 1995. Long-term debt capital increased at first and then declined.

Fig. 2.1 also shows the evolution of education over time. Although expenditure on education was very stable during the last decades, school enrollment rates in secondary and tertiary were increasing. After a sharp decrease during the years 1977-1984, secondary enrollment rate rose rapidly after 1985, which was the start of the implementation of nine years of compulsory education in China. With the extension of universities in China in 1999, the tertiary enrollment rate rose fast, which contributed to the human capital needed for the development of the economy.

Fig.2.1 GDP growth, Physical Capitals and Human Capitals to GDP ratios

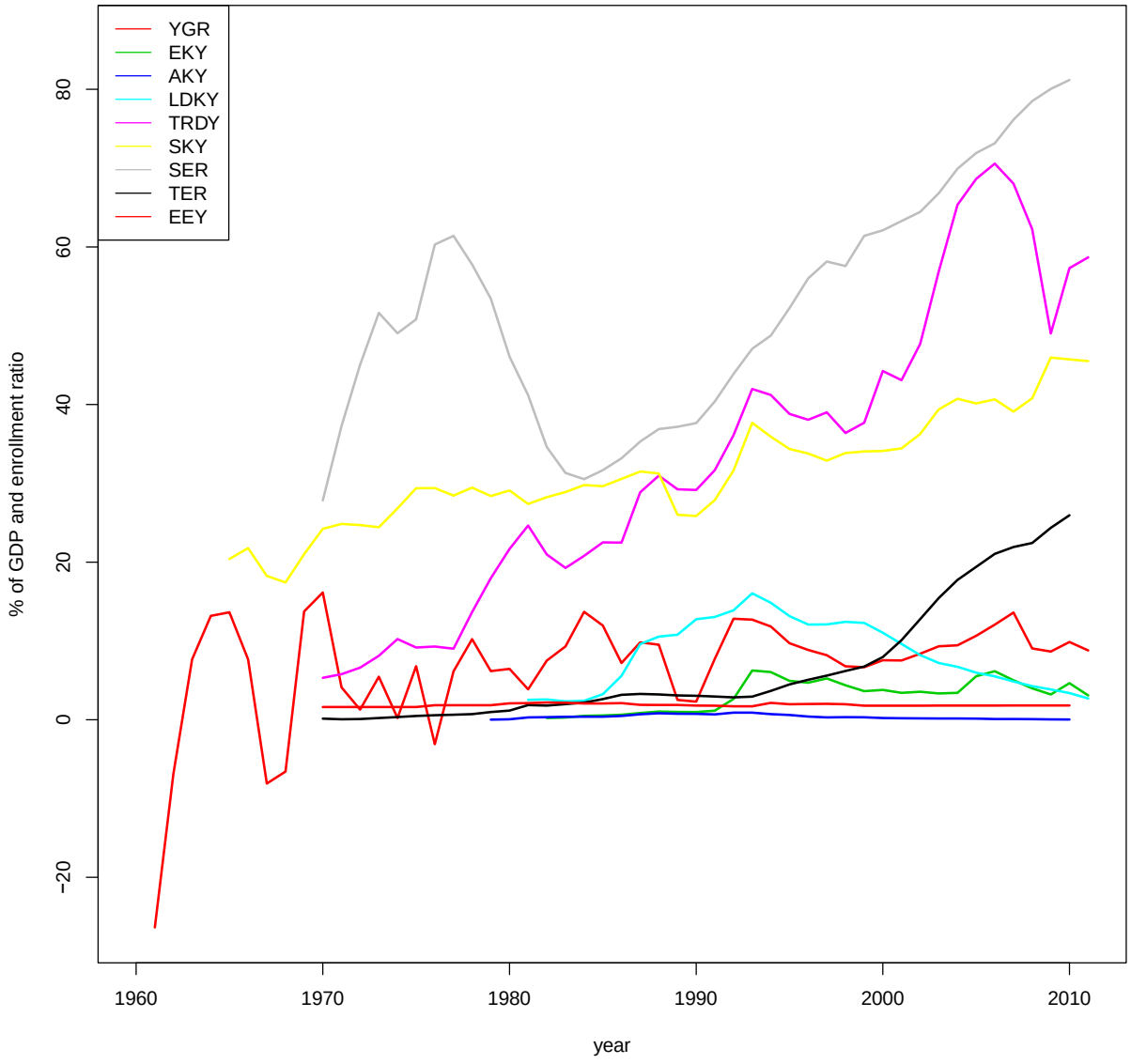


Figure 2.1 shows the trends of the level values of our variables in our model. YGR is real GDP per capita growth rate, EKY, AKY, LDKY, TRDY and SKY indicate equity capital, aid capital, long-term debt capital, trade capital and social capital to GDP ratio. SER and TER indicate secondary and tertiary enrollment rate. EEY is education expenditure to GDP ratio.

Fig.2.2 Growth rate of per capita GDP, Physical Capitals and Human Capitals

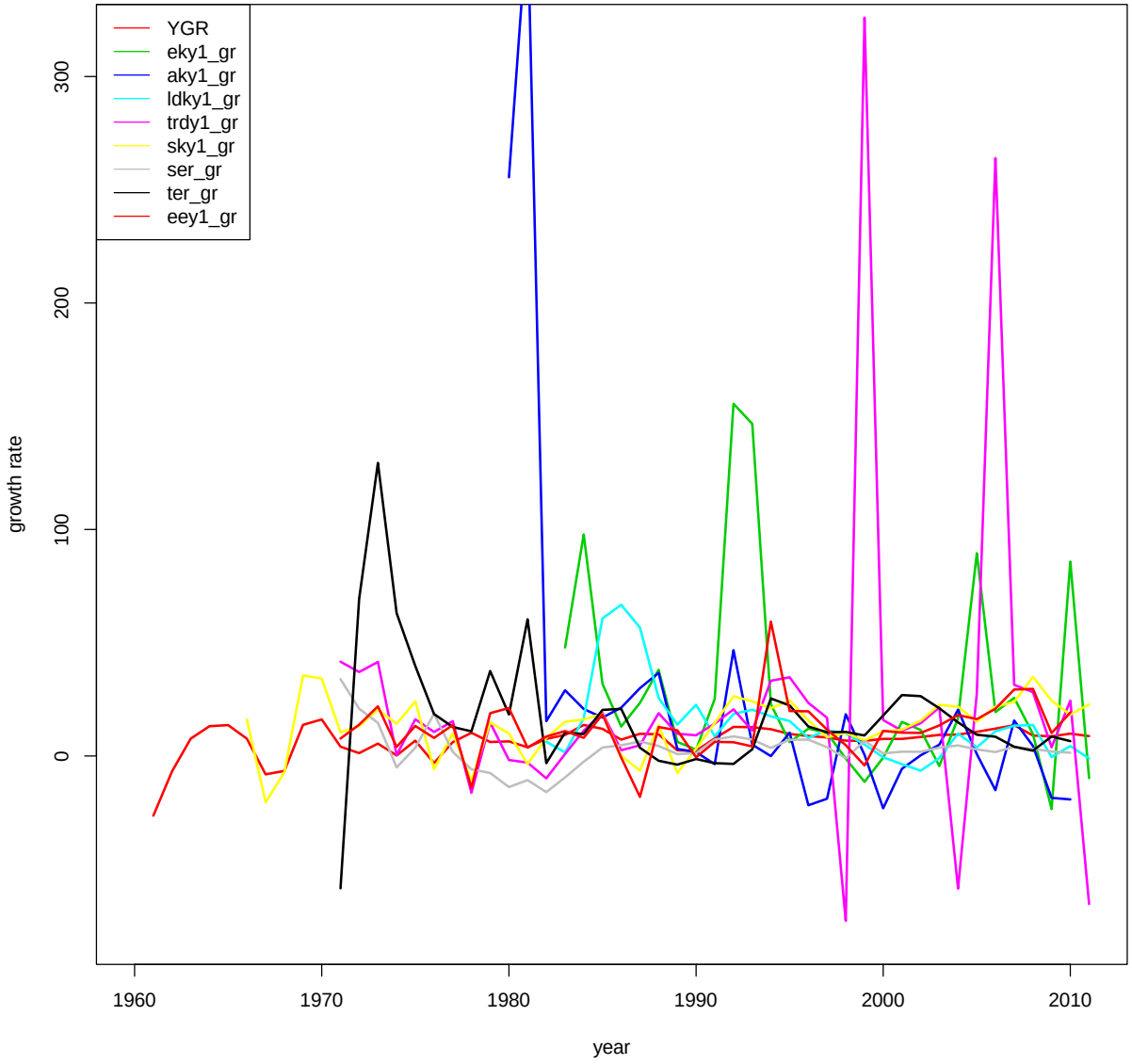


Figure 2.2 shows the growth rate of our variables from 1960 to 2013. YGR is real GDP per capita growth rate, eky1_gr, aky1_gr, ldky1_gr, trdy1_gr and sky1_gr indicate the growth rates of equity capital, aid capital, long-term debt capital, trade capital and social capital to GDP ratio. And ser_gr and ter_gr indicate the growth rates of secondary and tertiary enrollment rate; eey1_gr is the growth rate of education expenditure to GDP ratio.

Fig. 2.2 shows the growth rate of per capita GDP, physical capital and human capital. The growth rate of aid capital fell from a very high ratio to a lower but stable value as the economy matured. The growth rate of trade capital changed dramatically along with the adjustment of policies on international trading. However, the growth rates of other variables had comparatively smooth changes.

Stationary Test for China

We begin our analysis by providing the univariate properties of the variables of interest using the standard Augmented Dickey – Fuller (ADF) and Phillipes – Perron (PP) unit root tests.

We apply two stationary tests to test the unit root of these variables in our model, the Augmented Dickey-Fuller test (ADF) and the Phillips-Perron (PP) test. The more negative its value is, the stronger is the rejection of the hypothesis that there exists a unit root at some level of confidence. The Phillips-Perron test examines the null hypothesis that a time series is integrated of order 1. In addition to these tests, we also use the Breusch-Godfrey serial correlation LM test for autocorrelation in the errors in a regression model.

Table 2.1 shows the results of stationary tests for China. Both the ADF and PP tests indicate that the real per capita GDP growth rate (YGR) is stationary, so that the long-term value of the growth rate of per capita GDP is equal to its mean. However, several of the other variables, including GDP per capita, equity capital, aid capital, long-term debt, trade capital, social capital to GDP, secondary enrollment rate (SER), tertiary enrollment rate (TER) and education expenditure to GDP ratio are non-stationary and have a unit root. Based on the results of the serial correlation LM test, the greater the number, the stronger is the serial correlation. Our estimates indicate that TER has the strongest correlation, followed by SER, while YGR has the smallest serial correlation.

As a result, except for the growth rate of GDP per capita, these tests fail to reject the null hypothesis of a unit root for all variables in the levels. Then we convert all the variables into their growth rates and test for their stationarity. The null hypothesis is overwhelmingly rejected for each of growth rates. Since the growth rates of all these variables are integrated of the same order, in the following analysis, we classify our set of variables into two categories: one is I(0) variables, which are the growth rates of all the non-stationary variables; the other one is I(1) variables. We proceed with the cointegration technique.

Table 2.1: Time Series Properties of Growth Variables in China

Variable	ADF		PP		Serial Correlation LM Test
	With trend	Without trend	With trend	Without trend	
GDP	5.858(1)	6.046(1)	16.295(3)	20.711	0.154
GDP(ln)	0.217(1)	2.600(1)	-0.343(3)	3.905(3)	0.557
YGR	-7.587(1)**	-6.609(1)**	-7.070(3)**	-6.978(3)**	2.846
EKY	-1.268(2)	-1.801(2)	-1.708(3)	-1.859(3)	1.283
AKY	-2.663(1)	-1.413(1)	-2.264(3)	-1.331(3)	5.579
LDKY	-3.897(7)*	-1.872(7)	-1.068(3)	-1.233(3)	11.293
TRDY	-3.389(1)	-1.023(1)	-2.763(3)	-0.885(3)	2.313
SKY	-3.783(1)	-0.797(1)	-2.734(3)	-0.454(3)	2.174
SER	-1.565(2)	-0.863(2)	-1.419(3)	-1.052(3)	14.578
TER	-0.338(2)	0.941(2)	0.321(3)	3.132(3)	21.075
EEY	-2.170(1)	-2.264(1)	-2.287(3)	-2.422(3)	0.214

ADF and PP stand for the Augmented Dickey-Fuller and the Phillips-Perron unit root test statistics. LM refers to the Bruesch Godfrey Lagrange multiplier test for serial correlation. The lag number in the ADF test is based on the Schwarz information criteria (SIC) and those in the PP test statistics are the Bartlett Kernel based Newy-West truncation lags. *(**) indicates significance at the 5% (1%) level.

Vector Autoregression

After analyzing the ADF, PP and LM tests for the Chinese data, we found a mixed order of integration among our variables. To better capture the interdependencies among our time series, we adopt the Vector Autoregression (VAR) model, which assumes that all the stochastic processes in the autoregressive system are variance-covariance stationary. If this condition is not met, little confidence can be placed in the VAR regression results. Variables that are I(1) are converted into I(0) by generating their growth rates.

Let $Y_t = (y_{1t}, y_{2t}, \dots, y_{nt})'$ denotes a $(n \times 1)$ vector of time series variable. The basic p-lag vector autoregressive (VAR (p)) model has the form:

$$Y_t = c + \prod_1 Y_{t-1} + \prod_2 Y_{t-2} + \cdots \prod_p Y_{t-p} + \varepsilon_t \quad (3)$$

Where Π are $(n \times n)$ coefficient matrices, and ε_t is an $(n \times 1)$ unobservable zero mean white noise vector process (serially uncorrelated or independent) with the time invariant

covariance matrix $\sum$. If we make additional technical assumptions, we can derive another representation of the VAR in (3), and rewrite Y_t as:

$$Y_t = \mu + \sum_{i=0}^{\infty} \prod_i x_{t-i} + \sum_{i=0}^{\infty} \phi_i u_{t-i} \quad (4)$$

Where μ is the $(n \times 1)$ time-invariant mean of the process, Π and ϕ_i are $n \times r$ and $(n \times 1)$ matrices of parameters, respectively. This equation states that the process by which the variables in Y_t fluctuate about their time-invariant means, is completely determined by the parameters in Π and ϕ_i, the (infinite) past history of the exogenous variables x_t and the independent and identically distributed (i.i.d.) shocks or innovations, $u_{t-1}, u_{t-2} \ldots$

In our model, the VAR variables consist of the real per capital GDP growth rate (YGR), the growth rate of equity capital to GDP ratio (EKY), aid capital to GDP ratio (AKY), long-term debt to GDP ratio (LDKY), trade to GDP ratio (TRDY), social capital to GDP ratio (SKY), secondary enrollment rate (SER), tertiary enrollment rate (TER) and education expenditure to GDP ratio (EEY). The estimated VAR is of order 2, with the lag length of p = 2 selected on the basis of the Akaike information criterion (AIC).

Parameter estimation and summary statistics for the VAR model are presented in Table 2.2. Looking at the estimated coefficients, we find that in the second column (the growth equation), equity capital, human capital (tertiary enrollment and education expenditure), long-term debt, trade capital and social capital at both lag one and two make significant positive contributions to the growth rate of output, while aid capital has a negative effect on the growth rate. Many of the coefficients in the equations for the other variables are not statistically significant.

2.4.2 Measures of the Causality Strength and Non-Causality Test

What is causality?

Mill (1854) and Marshall (1890) defined causality as: X causes Y if, holding everything else constant, 'manipulations' of X change the value of Y. In an early study on measuring causality by statistical means, Haavelmo (1943) used the model:

$$Y = \alpha_0 + \alpha_1 X + U \quad (5)$$

Where X is a measured variable and Y is a measured outcome, and (α_0, α_1) are coefficient vectors, and U is an error term.

Granger causality (Granger, 1969) extends this procedure and requires the estimation:

$$y_t = \alpha_0 + \sum_{j=1}^{k} \alpha_j x_{t-j} + \sum_{j=1}^{k} \beta_j y_{t-j} + \nu_t \quad (6)$$

A chi-squared test on the restriction $\alpha_j = 0\ (j = 1, \dots, k)$ provides information on whether Granger-causality runs from X to Y. Similarly, causation from Y to X can be tested by running a regression of X on the lagged values of X and Y and testing the null of zero coefficients of the lagged values of Y.

However, Granger-causality does not necessarily provide information on true causality. To illustrate, while observations of the readings on a thermometer and the weather are statistically associated, 'manipulation' of the readings on the thermometer cannot change the weather (see Florens, 2003). Granger-causality only examines whether the lagged values of one variable help to predict another variable; if they do so, it establishes the direction of causality in the Granger-causality sense. The Granger non-causality test can identify that they are not statistically independent, but it cannot distinguish correlation from manipulation, which should be the true indication of causality (see Florens, 2003).

Further, even from a purely statistical viewpoint, the Granger-causality test may produce misleading results, as in the case of omitted variables in the estimated equation (see Hsiao, 1982). For instance, in equation (6), if both X and Y are independent of each other but are driven by a common third time series Z, estimation without inclusion of Z may fail to reject dependence between X and Y, even though manipulation of one of them cannot change the other. This would represent "spurious regression".

In time series analysis, inference about causal relationships is still predominantly based on the concept of Granger-causality for the simple reason that it can be easily estimated and tested in time series models (Eichler, 2011). Eichler (2005) suggests transforming the series into stationary ones and using the vector autoregression (VAR) technique.

All regressions suffer in one way or another from an inherent failure to distinguish between true causation and correlation. To get at true causality, one has to embody intuition and prior knowledge in a model that dictates which is to be the dependent variable and which are the independent ones in the regressions carried out. To illustrate using the preceding example of the readings on a thermometer and weather, intuition suggests using the weather as the independent variable and the readings on the thermometer as the dependent one – not the other way around. Granger-causality estimated from this model can then be used as indicating true causality running

from the weather to the readings. But, while using the weather as the dependent variable in a regression on the readings would yield corresponding Granger-causality estimates, estimates of Granger-causality from such a regression would not reflect the direction of true causality. Further, even if the correct model is used, its estimations need to guard against econometric problems such as those caused by omitted variables, serial correlation, etc.

The Strength of Causality and Empirical Results

The results from the Granger Non-causality tests given in Table 2.3 point to several interesting results about the causal relation in the Asian countries: first, there is sufficient evidence to support the hypothesis that foreign capital (FDI and portfolio investment) Granger-cause economic growth in both directions. Second, bidirectional causalities are detected among social capital, human capital and economic growth. Third, there is a unidirectional causality from aid capital and long-term debt and trade to output growth.

However, the non-causality test could not capture the dynamic causality between different time series in the following aspects: first, the power of prediction may depend on the time horizon and Granger's test may be not appropriate for providing how long the causal effect can last. Second, we are more interested in the relatively strongest link across multiple directions and time horizons. Because in some cases, even if non-causality is rejected, there may be still a very weak causality link, while in other cases, although we can detect causality, it would be useful to know the strength of causality. Therefore, we need incorporate the point estimate and confidence interval across different horizons.

For estimating the strength of causality, we use the methodology of Dufour and Taamouti (2010) and Zhang et al. (2015). In their procedure, for non-causality at horizon h, Y does not cause X at horizon h, given I -- the reference information set -- iff

$$P[X(t+h)|I_X(t)] = P[X(t+h)|I_{XY}(t)] \quad (7)$$

Where P is probability and I(t) denote the information available as of time t. $I_X(t)$ refers to the information set that excludes X. The mean-square causality from Y to X at horizon h given I is defined as follows, which is in a similar form from X to Y.

$$C_L(Y \to X|I) = ln\left[\frac{\det\{[\sum X(t+h)|I_X(t)]\}}{\det\{[\sum X(t+h)|I_{XY}(t)]\}}\right] \quad (8)$$

The higher the value of the measure, the stronger is the causal relationship. In the context of linear VAR model with order k, the causality measures can be represented as:

$$W(t) = \pi_0 + \sum_{i=1}^{k} \pi_i W(t-i) + u_k(t) \quad (9)$$

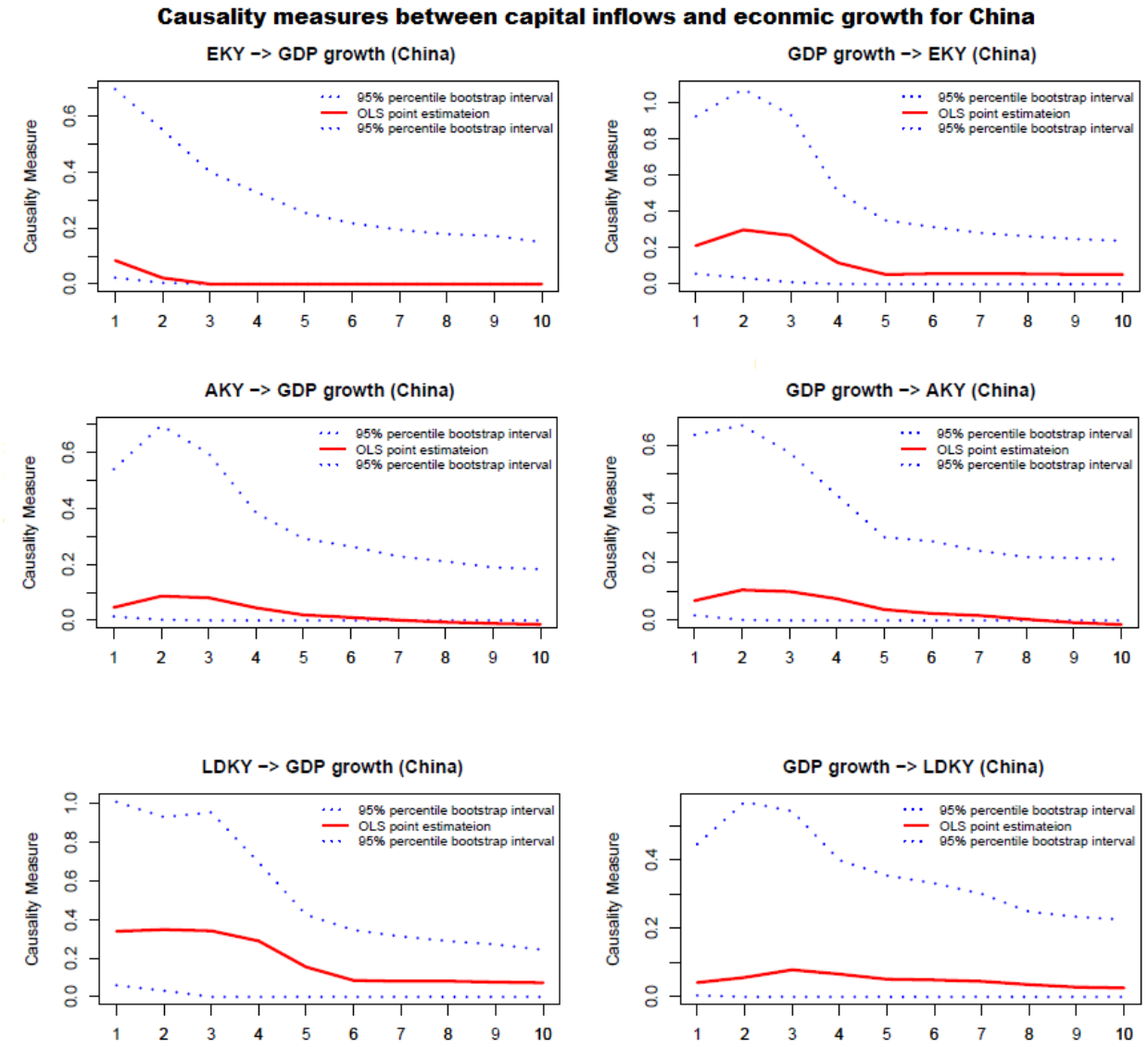
The estimator of the causality measure from Y to X conditional on I at horizon h is given by:

$$\hat{C}_L\left(Y \underset{h}{\rightarrow} X \,\middle|\, I\right) = \ln\left[\frac{\sum_{j=0}^{h-1} J_0 \widehat{\Psi}_{jk'} J_0'}{\sum_{j=0}^{h-1} J_1 \widehat{\Psi}_{jk'} J_1'}\right] \quad (10)$$

Based on the methodology, we estimate the causality measures between different components of capital inflows (foreign investment, aid capital and long-term debt) and economic development up to horizon ten. We assess the strength of these underlying linkages using both point estimates of causality measures and bootstrap confidence intervals. In VAR framework, as in equation (9), the value of k is selected by the Akaike information criterion (AIC). And a causality measure is statistically significant when the range of the confidence interval excludes zero. In the figures we present a large set of results on measurement of the strength of causality and these figures show broad patterns of their dynamic relationships.

Figure 2.3 presents the results on the measurement of the strength of causality and shows the pattern of their dynamic relationships. We find, first, that Granger non-causality does not support that aid helps to predict GDP growth, while the strength measures suggest all the causalities in each direction are significant from 0, and the strength decreases with increasing prediction horizon. Second, the causality running from GDP growth to equity capital is stronger than in the opposite direction at the first 3 horizons. Third, Granger non-causality only shows that long-term debt helps to predict economic growth but not the reverse; however, the measures do detect bidirectional causality relationship with different strengths and the strength of causality is stronger from long-term debt to economic growth than in the reverse direction.

Figure 2.3 Causality measures between capital inflows and economic growth at horizon ten (conditional) for China



Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Table 2.2. Vector Autoregression for China

	ygr	eky_gr	aky_gr	ldky_gr	trdy_gr	sky_gr	ser_gr	ter_gr	eey_gr
ygr(-1)	-.4255* [-2.04]	4.4288 [0.83]	-2.9066 [-1.15]	-0.3190 [-0.19]	9.3726 [0.48]	-0.6225 [-0.47]	-0.8905** [-3.18]	1.4906* [2.02]	2.9535 [1.86]
ygr(-2)	-1.568** [-10.68]	-21.058** [-5.61]	-3.2051 [-1.80]	-0.2394 [-0.20]	-7.4077 [-0.54]	-3.5702** [-3.81]	-1.4353** [-7.26]	2.2550** [4.32]	-0.6069 [-0.54]
eky_gr (-1)	.051** [5.37]	-0.0444 [-0.18]	0.1046 [0.90]	0.1561* [1.97]	0.1286 [0.14]	0.0554 [0.91]	0.0261* [2.02]	-0.0092 [-0.27]	-0.0989 [-1.36]
eky_gr (-2)	.041** [4.53]	-0.0760 [-0.33]	0.4182** [3.80]	0.0168 [0.22]	-0.2797 [-0.33]	0.1968** [3.39]	0.0700** [5.71]	-0.0425 [-1.31]	0.2835** [4.09]
aky_gr (-1)	-.0007 [-0.05]	0.788* [1.99]	-0.1709 [-0.91]	-0.1777 [-1.39]	1.3686 [0.95]	0.1199 [1.22]	0.0786** [3.77]	-0.1218* [-2.22]	-0.0145 [-0.12]
aky_gr (-2)	-.051** [-2.66]	0.1284 [0.26]	-0.8020** [-3.47]	-0.0131 [-0.08]	0.0177 [0.01]	-0.2011 [-1.65]	-0.0508* [-1.97]	0.1867** [2.75]	0.2682 [1.85]
ldky_gr (-1)	.090** [4.83]	0.9648* [2.02]	0.3750 [1.65]	0.7839** [5.06]	-0.5239 [-0.30]	-0.1536 [-1.29]	0.0649* [2.57]	-0.2084** [-3.13]	-0.6252** [-4.38]
ldky_gr (-2)	.085** [3.63]	0.1079 [0.18]	0.4709 [1.65]	0.0208 [0.11]	0.4065 [0.18]	0.1506 [1.00]	0.0822* [2.58]	-0.2721** [-3.24]	-0.0058 [-0.03]
trdy_gr (-1)	.0169** [6.13]	-0.0154 [-0.22]	-0.0399 [-1.19]	-0.0227 [-0.99]	0.0518 [0.20]	0.0230 [1.31]	0.0055 [1.47]	-0.0227* [-2.31]	-0.0204 [-0.97]
trdy_gr (-2)	.0083** [3.06]	0.0088 [0.13]	0.0385 [1.17]	0.0047 [0.21]	-0.2679 [-1.06]	0.0473** [2.73]	0.0130** [3.56]	-0.0009 [-0.09]	0.0384 [1.86]
sky_gr (-1)	.257** [6.57]	0.9637 [0.96]	0.3073 [0.65]	-0.2903 [-0.90]	-1.0702 [-0.29]	0.3705 [1.48]	0.2054** [3.89]	-0.2772* [-1.99]	0.0268 [0.09]
sky_gr (-2)	.297** [7.94]	3.5710** [3.72]	0.7866 [1.73]	0.4870 [1.57]	1.0258 [0.29]	0.6046* [2.53]	0.1322** [2.61]	-0.4019** [-3.01]	-0.2839 [-0.99]
ser_gr (-1)	-.493** [-5.18]	1.9455 [0.80]	0.3294 [0.29]	-0.1628 [-0.21]	-19.6020* [-2.21]	-0.2512 [-0.41]	-0.0913 [-0.71]	1.0430** [3.08]	0.8182 [1.13]
ser_gr (-2)	-0.065 [0.72]	0.7000 [0.30]	-2.9649** [-2.73]	-2.6943** [-3.63]	10.4055 [1.24]	-0.6845 [-1.19]	-0.1765 [-1.46]	-0.0825 [-0.26]	0.2445 [0.36]
ter_gr (-1)	-.1053** [-2.73]	0.1090 [0.11]	-1.5480** [-3.31]	-0.2514 [-0.79]	0.8181 [0.23]	-0.6849 [-2.78]	-0.0532 [-1.02]	1.2452** [9.07]	-0.3703 [-1.26]
ter_gr (-2)	.282** [5.59]	-1.0509 [-0.81]	1.9191** [3.14]	0.2620 [0.63]	-0.9094 [-0.19]	0.7460 [2.32]	0.2162** [3.18]	-0.7788** [-4.34]	0.3204 [0.83]
eey_gr (-1)	0.038* [2.01]	0.3826 [0.78]	0.1853 [0.80]	0.2910 [1.83]	-0.1332 [-0.07]	0.2228 [1.82]	0.0840** [3.24]	-0.3360** [-4.91]	-0.4018** [-2.74]
eey_gr (-2)	-0.015 [-0.71]	-0.1344 [-0.25]	-0.8536** [-3.34]	-0.1806 [-1.04]	1.3209 [0.67]	0.0712 [0.53]	0.0395 [1.39]	-0.0164 [-0.22]	0.2830 [1.76]
c	12.954** [12.53]	92.3489** [3.49]	34.6781** [2.77]	9.6599 [1.13]	46.6015 [0.48]	28.886** [4.38]	11.8599** [8.51]	-8.5546* [-2.33]	-4.9627 [-0.63]
R^2	0.9312	0.8232	0.7686	0.8987	0.3204	0.7946	0.8482	0.9319	0.8450

Sample period: 1985-2010, Z-statistics are in the brackets [] below the coefficients. * Significant at 5% level, ** significant at 1% level. For education data, there are some missing data.

Table 2.3. Pair-wise Granger Causality, Block Exogeneity Wald tests for China

Dependent variable ygr				Dependent variable eky_gr			
Exclude	$\chi 2$	DF	p-value	Exclude	χ^2	DF	p-value
eky_gr	40.1380**	2	0.0000	ygr	32.6850**	2	0.0000
aky_gr	7.4200*	2	0.0240	aky_gr	4.0171	2	0.1340
ldky_gr	59.4090**	2	0.0000	ldky_gr	5.1790	2	0.0750
trdy_gr	38.1120**	2	0.0000	trdy_gr	0.1001	2	0.9510
sky_gr	76.2530**	2	0.0000	sky_gr	14.2540**	2	0.0010
ser_gr	35.9140**	2	0.0000	ser_gr	1.0939	2	0.5790
ter_gr	43.3520**	2	0.0000	ter_gr	1.7131	2	0.4250
eey_gr	4.2863	2	0.1170	eey_gr	0.6329	2	0.7290
all	173.7400**	16	0.0000	ALL	88.4360**	16	0.0000
Dependent variable aky_gr				Dependent variable ldky_gr			
Exclude	$\chi 2$	DF	p-value	Exclude	$\chi 2$	DF	p-value
ygr	4.4042	2	0.1110	ygr	.07007	2	0.9660
eky_gr	14.4030**	2	0.0010	eky_gr	3.9603	2	0.1380
ldky_gr	8.9656*	2	0.0110	aky_gr	1.9895	2	0.3700
trdy_gr	4.5652	2	0.1020	trdy_gr	1.4031	2	0.4960
sky_gr	3.0031	2	0.2230	sky_gr	5.3044	2	0.0700
ser_gr	8.1744*	2	0.0170	ser_gr	16.3370**	2	0.0000
ter_gr	11.4280**	2	0.0030	ter_gr	0.6214	2	0.7330
eey_gr	11.3670**	2	0.0030	eey_gr	4.0501	2	0.1320
ALL	77.4780**	16	0.0000	ALL	61.4750**	16	0.0000
Dependent variable trdy_gr				Dependent variable sky_gr			
Exclude	χ^2	DF	p-value	Exclude	χ^2	DF	p-value
ygr	.55221	2	0.7590	ygr	14.6320**	2	0.0010
eky_gr	0.1615	2	0.9220	eky_gr	11.5110**	2	0.0030
aky_gr	0.9498	2	0.6220	aky_gr	5.4339	2	0.0660
ldky_gr	0.0956	2	0.9530	ldky_gr	1.9443	2	0.3780
sky_gr	0.2918	2	0.8640	trdy_gr	7.5260*	2	0.0230
ser_gr	5.0348	2	0.0810	ser_gr	2.3575	2	0.3080
ter_gr	0.0518	2	0.9740	ter_gr	7.7293*	2	0.0210
eey_gr	0.4528	2	0.7970	eey_gr	3.8320	2	0.1470
ALL	9.8686	16	0.8730	all	60.3360**	16	0.0000
Dependent variable ser_gr				Dependent variable ter_gr			
Exclude	χ^2	DF	p-value	Exclude	χ^2	DF	p-value
ygr	60.8130**	2	0.0000	ygr	22.0100**	2	0.0000
eky_gr	33.0690**	2	0.0000	eky_gr	1.7301	2	0.4210

aky_gr	22.8200**	2	0.0000	aky_gr	16.1940**	2	0.0000
ldky_gr	21.8820**	2	0.0000	ldky_gr	33.4410**	2	0.0000
trdy_gr	12.7160**	2	0.0020	trdy_gr	6.1139*	2	0.0470
sky_gr	16.4070**	2	0.0000	sky_gr	9.7793**	2	0.0080
ter_gr	18.6930**	2	0.0000	ser_gr	10.5580**	2	0.0050
eey_gr	13.5780**	2	0.0010	eey_gr	24.7240**	2	0.0000
ALL	129.8100**	16	0.0000	ALL	127.6000**	16	0.0000
Dependent variable eey_gr							
Exclude	χ^2	DF	p-value				
ygr	3.8657	2	0.1450				
eky_gr	22.4830**	2	0.0000				
aky_gr	3.7283	2	0.1550				
ldky_gr	22.8580**	2	0.0000				
trdy_gr	6.8125*	2	0.0330				
sky_gr	1.2838	2	0.5260				
ser_gr	2.0329	2	0.3620				
ter_gr	1.7345	2	0.4200				
ALL	133.3500**	16	0.0000				

* Significant at 5% level, ** significant at 1% level.

Interaction among variables:

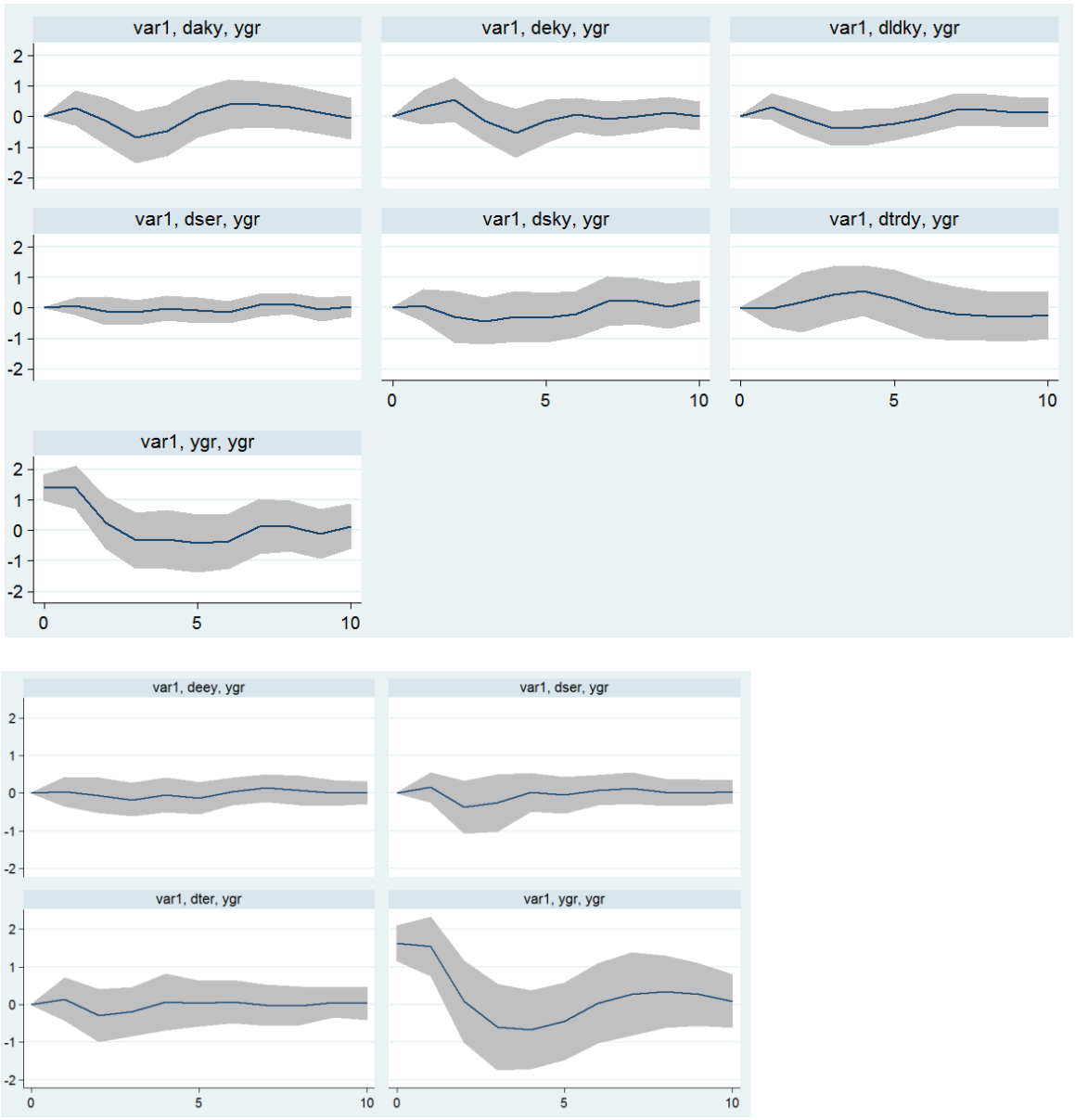
Impulse response function and variance decomposition

VAR embeds economic theory within time series models, providing a convenient and powerful framework for economic analysis. For further investigation, we adopt impulse response function and variance decomposition to examine the interaction among the variables. Impulse response function (IRF) reveals how a sudden and unexpected change in one variable impacts another over time. Because the disturbances may be contemporaneously correlated, these functions do not explain how a variable reacts to a one-time increase in the innovation to another variable after some periods, holding everything else constant. To explain this, we must start with orthogonalized innovations so that the *ceteris paribus* assumption is reasonable. Recursive VARs use a Cholesky decomposition to orthogonalize the disturbances and thereby obtain structurally interpretable IRFs (see Swanson and Grange, 1997).

While the impulse response functions reveal the interaction among the variables in the VAR in response to the various shocks, variance decompositions breaks down the variance in a variable into the component shocks to the VAR. It provides information on the relative importance of each random shock in affecting the variables in the VAR. For instance, the variation in the growth rate of output is separated into variations due to random innovations in each of the other variables in the VAR. Therefore both computations are useful in assessing how shocks to economic variables reverberate through a system.

The blue lines in Fig. 2.4 represent the impulse response functions and the grey bands are the 95% confidence interval for the IRFs. All these sub-figures in Figure 2.4 are responses of per capita growth rate of output to the impulses from other variables in the VAR model. Notice that the response of YGR in every sub-figure dies out gradually. The second sub-figure shows that an unexpected increase in equity capital tends to provide a positive jolt to output growth rate about 2 years later (every step represents 1 year), followed by a downward jump. After the initial increase in growth, there is another small spike in growth 4 years later as some of the feedback effect of the initial shock reverberate throughout the economy; after that, it follows a gradually declining path. The response of growth to the impulse from aid capital is similar to the one from equity capital. Looking at the sub-figure with the shock to long-term debt capital, an increase in long-term debt may cause more investment and the growth in the economy, which can be seen from this figure. The large confidence interval that includes zero indicates that after an unexpected increase in long-term debt, this increase in growth may or may not materialize. As shown in the rest of the sub-figures for TRDY and SKY, the shocks in these impulse variables are shown to increase growth in the short run, but the results are not statistically significant.

Figure 2.4: Per capita growth rate of output responses to innovations in China

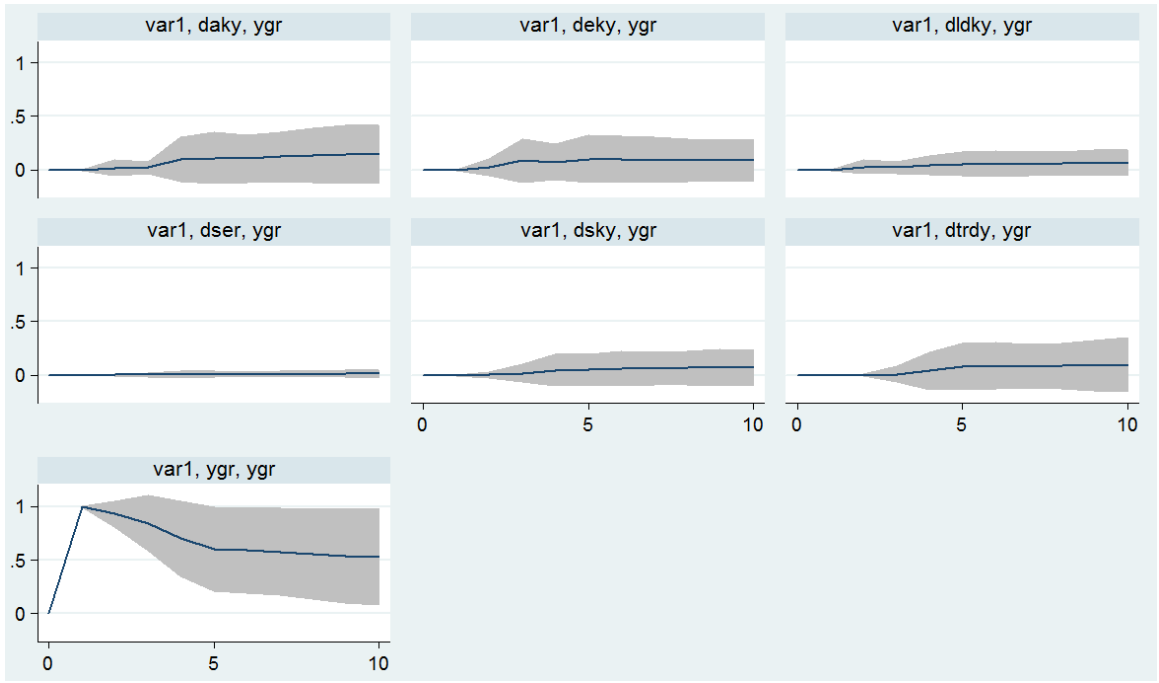


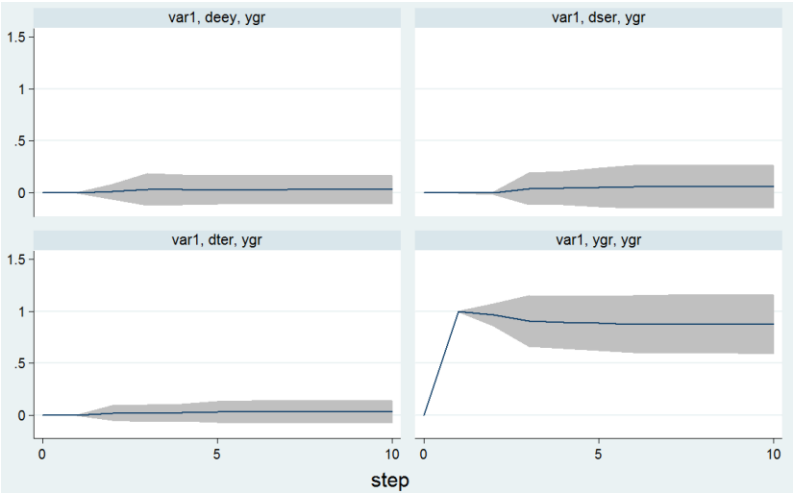
Note: Figure 2.4 are responses of per capital growth rate of output to the impulses from other variables in the VAR model up to 10 year. Each step on the horizontal axis represents one year. daky, deky, dldky, dser, dsky, dtrdy, ygr, deey, dser and dter are aid capital, equity capital, long-term debt capital, trade capital, per capita output growth, education expenditure, secondary school enrollment and tertiary enrollment rate. The grey areas are 95% confidence intervals.

Figure 2.4 demonstrates the variance decomposition graphs for output. The percentage variation in the grow5ah rate of output caused by the shocks to output growth declines over the ten-year horizon. However, the percentage variations due to equity, aid and trade capital increase

and gradually grow to a stable point over the given horizon. The aid capital variable also contributes to the variation in the growth rate of per capita output more than the trade, equity, long-term debt, public capital and secondary enrollment rate variables. The variations accounted for by aid capital, openness to trade, equity capital, public capital, long-term debt, and secondary enrollment rate are approximately 14, 10, 9, 7, 6 and 1 percent respectively. The rest is accounted for by the variation in YGR itself. The last four sub-figures are the decompositions of the variation in YGR resulting from the secondary and tertiary enrollment rate, and education expenditures. It implies that the contributions to the variation from these three variables are only 6, 7, and 3 percent respectively.

Figure 2.5a Variance Decomposition of real per capita output growth rate in China





Note: Figure 2.5a demonstrates the variance decomposition graphs for output. It shows the percentage changes over time. Each step on the horizontal axis represents one year. daky, deky, dldky, dser, dsky, dtrdy, ygr, deey, dser and dter are aid capital, equity capital, long-term debt capital, trade capital, per capita output growth, education expenditure, secondary school enrollment and tertiary enrollment rate. The grey areas are 95% confidence intervals.

Cointegration analysis for China

Since after testing by the Augmented Dickey-Fuller and Phillips-Perron stationary tests, all the explanatory variables are I(1), we employ the Johansen maximum likelihood procedure[16] for our cointegration analysis. The Johansen vector error-correction approach is highly popular, promising as it does to tease out long-run equilibrium relationships among time series that may appear individually to be random walks. However, the data sets of secondary enrollment and tertiary enrollment rates in China are not complete and have some points missing. Hence, we use "local polynomial regression fitting"[17] to fill in these vacancies. The existence of cointegration vectors has been tested by trace and max statistics, and the results are reported in the Table 2.4. From the trace statistics at the 1% level, these results reject the hypothesis that there are at least 3 cointegration equations, but fail to reject the hypothesis that there are at least 4 cointegration vectors. At the 5% level, there are more than 5 cointegration equations, while max statistics imply only 2 equations. These results imply that foreign capital, aid capital, long-term debt, trade capital, social capital and human capital share a stable long-term relationship with economic growth.

Table 2.4: Johansen's Test of Cointegration for China
No. of variables=9 (gdp, eky, aky, ldky, trdy, sky, ser, ter and eey); Number of lags=1; with trend: constant

No. of cointegration equations	Eigenvalue	Trace Statistics	5% Critical Value	1% Critical Value
R=0		292.2474	192.89	204.95
R≤1	0.93373	216.2568	156	168.36
R≤2	0.89271	153.7544	124.24	133.57
R≤3	0.79673	109.1438	94.15	103.18
R≤4	0.74126	71.2902*1	68.52	76.07
R≤5	0.66638	40.5528*5	47.21	54.46
R≤6	0.50397	20.9214	29.68	35.65
No. of cointegration equations	Eigenvalue	Max Statistic	5% Critical Value	1% Critical Value

[16] Johansen (1988), Johansen and Juselius (1990), Dickey and Rossana (1994) and Charemza and Deadman (1997).

R=0		75.9906	57.12	62.8
R≤1	0.93373	62.5024	51.42	57.69
R≤2	0.89271	44.6106*1	45.28	51.57
R≤3	0.79673	37.8536	39.37	45.1
R≤4	0.74126	30.7374	33.46	38.77

Notes: Trace Test: H0: No. of cointegrating vectors is less than or equal to r; H1: H0 is not true. Max. Eigenvalue Test: H0: No. of cointegrating vectors is r; H1: r+1 cointegrating vectors. Critical values are from Johansen and Juselius (1990). *5(*1) indicates the significance at the 5% (1%) level.

Cointegrating equations

Engle and Granger (1987) consider the problem of testing the null hypothesis of no cointegration between a set of I(1) variables. They estimate the coefficients of a static relationship between these variables by ordinary least squares and apply well-known unit root tests to the residuals. Rejecting the null hypothesis of a unit root is evidence in favor of cointegration. If the variables are cointegrated, they will share a common trend and form a stationary relationship in the long run. Furthermore, under cointegration, due to the properties of super converge, the estimated parameters can be viewed as correct estimates of the long-run steady state parameters, and the residual can be used as an error correction term in an error correction model (ECM). Compared with Engle-Granger (EG) procedure, Johansen's test has two major advantages: one is allowing for more than one cointegrating relationships, another is the joint procedure with testing and maximum likelihood estimation of the vector error correction model and long run equilibrium relations. However the weakness of the test is that it relies on asymptotic properties, and is therefore sensitive to specification errors in limited samples. Therefore, it is commonly acknowledged that the statistical properties of the Johansen procedure are generally better and the cointegration test is of higher power compared to the EG one. The Johansen procedure test for cointegration only identifies the number of stationary vector among the variables. It is, therefore, necessary to test the vectors in order to identify them. The Johansen (1988, 1991) procedure is based on the maximum likelihood estimation of the Vector Error Correction Model (VECM), which is a category of multiple time series models that directly estimate the speed at which a dependent variable returns to equilibrium after a change in an independent variable. VECMs are useful for estimating both short-term and long-term effects of one time series on another.

The vector error-correction model (VECM) in general contains a mechanism for capturing short-run dynamics related to deviations from long-run equilibrium. Table 2.5 reveals the stability of the long-run relationship among the variables of real GDP per capita, GDP share of equity capital, aid capital, long-term debt, trade capital and public investment, as well as human capital: secondary enrollment, tertiary enrollment and GDP share of expense on education. It reports the parameters in the cointegrating equations and the adjustment coefficients. Since we are more interested in the long-run relationship of GDP with other variables in the model and how they change from the deviations to the equilibriums, we show the cointegration equation for real GDP as follows:

$$GDP = \beta_1 AKY + \beta_2 LDKY + \beta_3 TRDY + \beta_4 SKY + \beta_5 EKY + \beta_6 EEY + \varepsilon \quad (11)$$

Where β_i(i = 1, 2, 3…6) are the cointegration vectors in the first column of Table 2.5, and we rewrite equation (6) with the estimated values of these parameters as:

$$GDP = (-6.43)AKY + 0.31LDKY + 0.045TRDY + 0.318SKY + (-0.19)EKY + (-3.96)EEY + \varepsilon \quad (12)$$

Overall, the output results indicate that the model fits well. The coefficients on all these variables in the cointegrating equation are statistically significant. The adjustment parameters, on TRDY and SER are at the 5% significant level, and the ones on GDP and AKY are at the 10% significance. The two sets of coefficients represent the long-run and the short-run relationships, respectively. The sign of the adjustment coefficient implies the direction toward or away from the equilibrium, while the value of the parameter in the cointegration equation shows the adjustment speed of that variable deviated from long-run equilibrium. For instance, when the prediction from the cointegrating equation is positive, GDP, LDKY, TRDY and SKY are above their equilibrium values because the parameters of them are positive. Since the estimate of the adjusted coefficient on GDP is 0.19, GDP will not get back to its long run value. Yet LDKY, TRDY and SKY quickly fall back toward their equilibrium values due to the negative adjustment coefficients. We interpret the results of the cointegration equations as indicating the existence of an equilibrium relationship between the economic growth and the other explanatory variables.

Table 2.5 *Long-run cointegrating vectors for China*
Johansen normalization restrictions imposed
No. of variables=9 (gdp, eky, aky, ldky, trdy, sky, ser, ter and eey); lag(1) rank(2);
Sample: 1983 - 2010; Log likelihood = -320.7518

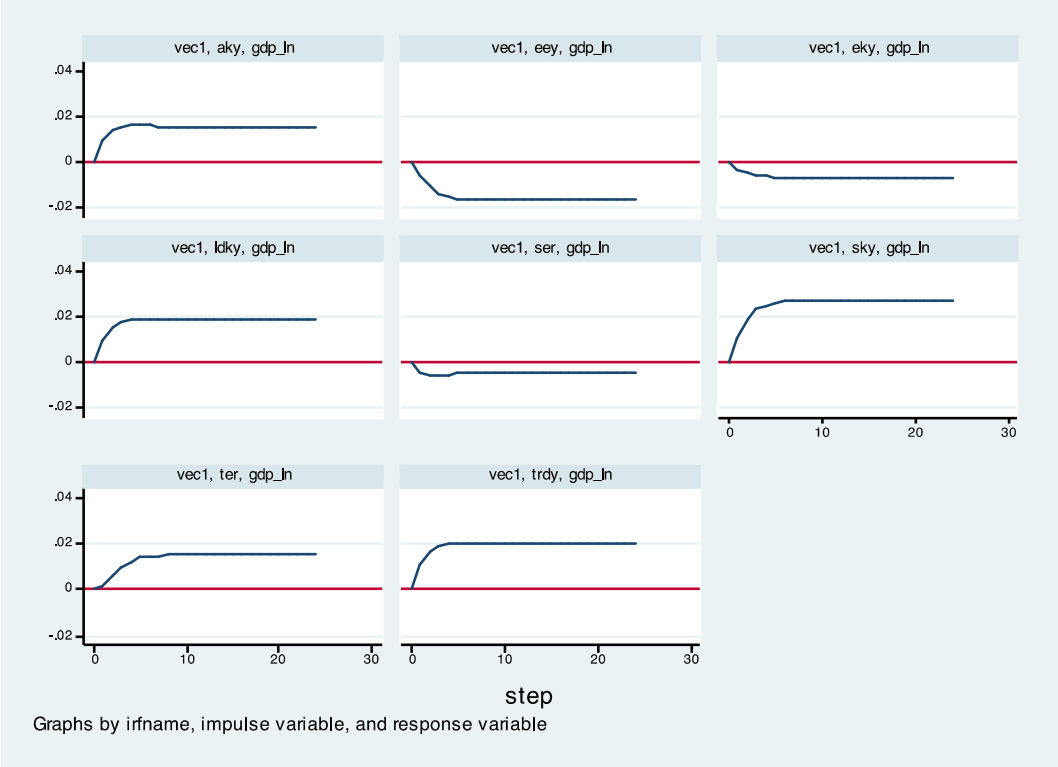
Variables	Cointegration equation parameters				Adjustment coefficients			
	ce1	p	ce2	p	ce1	p	ce2	p
GDP	1*	.	0.000	.	.1922881**	0.067	-.012687	0.127
TER	(omitted)		1	.	-.097042	0.920	.0619743	0.419
AKY	-6.430094*	0.000	-94.44733*	0.000	-.229542**	0.060	.0178402	0.064
LDKY	0.3141224*	0.000	4.673436*	0.000	-.1504181	0.931	-.0320984	0.815
TRDY	0.0454323*	0.000	0.2952247*	0.047	-16.30761*	0.001	1.492193*	0.000
SKY	0.3181706*	0.000	3.976091*	0.000	-.8207406	0.786	.0475929	0.842
SER	-0.229076*	0.000	-2.576144*	0.000	5.183937*	0.003	-.3455012*	0.011
EKY	-0.191339*	0.015	-2.37887*	0.017	-.51911	0.706	.0588262	0.589
EEY	-3.960345*	0.000	-52.49234*	0.000	.1847958	0.177	-.0103932	0.337
cont	1.980168	.	97.11752	.				

Note: Each column presents parameter estimation, the first two columns contain the estimated parameters of the cointegrating vectors for this model, and cei (i=1,…n) represent the cointegration equations; the last two columns contain the estimates of the short-run parameters along with their p values. Lags have been selected by the sequential likelihood-ratio (LR) test and ranks applied from Johansen's test. *(**) indicates the significance at the 5% (10%) level.

Impulse–response functions for VECMs

Whereas IRFs from a stationary VAR die out over time, IRFs from a cointegrating VECM do not always die out. Because each variable in a stationary VAR has a time-invariant mean and finite, time-invariant variance, the effect of a shock to any one of these variables must die out so that the variable can revert to its mean. In contrast, the I(1) variables modeled in a cointegrating VECM are not mean reverting, and the effects of some shocks will not die out over time. These two possibilities give rise to new terms. When the effect of a shock dies out over time, the shock is said to be transitory. When the effect of a shock does not die out over time, the shock is said to be permanent. Obviously, from Fig. 2.5b we believe that all these orthogonalized shocks to EKY, AKY, LDKY, TRDY, SKY, SER, TER and EEY have permanent effects on GDP. It shows that the unexpected shocks to AKY, LDKY, SKY, TER and TRDY cause GDP increase 1.6%, 1.86%, 2.62%, 1.5% and 2% permanently, while the shocks to EEY, EKY and SER result in 0.6%, 1.6% and 0.46% decrease in GDP.

Figure 2.5b Impulse Response Function for VECMs of China



Note: Figure 2.4 shows responses of per capital growth rate of output to the impulses from other variables in the VECMs up to 30 year. Each step on the horizontal axis represents one year. aky, eky, ldky, ser, sky, trdy, eey, ser and ter are aid capital, equity capital, long-term debt capital, trade capital, education expenditure, secondary school enrollment and tertiary enrollment rate. gdp_ln is the natural log value of per capital output.

Conclusions for China

Confirmed by both the ADF and the PP unit root tests, the per capita GDP growth rate is stationary; however, all the other variables are I(1). As a result, on the one hand, we first convert these I(1) variables into I(0) by generating their growth rates and then utilize VAR analysis. On the other hand, for these I(1) variables, we employed the cointegration technique. Based on the results from VAR and Granger-causality tests, the growth rates of equity capital, long-term debt, openness to trade public investment and human capital have significantly positive effects on the growth of per capita output, while aid capital has negative influences. In conclusion, while the equity capital, long-term debt capital, public capital, trade and human capital to GDP ratios experienced permanent changes over the sample period, the growth rate of per capita real GDP remained stationary during the same period. Therefore, the permanent changes in these variables

failed to bring about permanent changes in the economic growth. Based on the estimation of the VAR of order two and pair-wise Granger causality tests confirm causality, with exception of aid capital and expenditure on education, from each of the explanatory variable to economic growth. As indicated from VECMs results, there are at least two cointegration equations among these selected variables, and real GDP may not fall back to the equilibrium after the unexpected shocks to other variables.

2.4.3 Analysis for other Asian Countries

The full panel consists of annual data from eight Asian countries and the data were selected based on the availability for all the variables for the period from 1960 to 2011. Fig. 2.6 shows GDP in the 8 Asian countries from 1960 to 2011. From the 1960s to the 1980s, Japan showed the high growth rates characterizing an 'economic miracle'. Around 2010, China supplanted Japan, became the largest economy in Asia and the second largest economy in the world. Figure 2.7 demonstrates the per capita growth rates in the 8 countries during the sample period. From the 1960s to 1980s, the growth rate of Japan was 5.6 percent, the highest average growth rate among the countries, followed by Korea, Thailand and Malaysia, with 5.5, 4.6, 4.4 percent respectively. India had the lowest growth rate, which was merely 1.2 percent. However, from 1981-2000, China achieved first place, with the growth rate at 8.5 percent. Korea kept its growth rate of 6.3 percent. The corresponding figures for Thailand, Vietnam, Malaysia, India, and Indonesia were 4.8, 4.5, 3.8, 3.6 and 3.4 percent, while the growth rate of Japan dropped to 2.5 percent, which was the lowest one over the period. In the most recent decade from 2000 to 2009, China increased its real GDP to 9.8 percent. The growth rates of India and Vietnam ranked in the second place, with 5.9 and 5.8 percent respectively.

Foreign capital started to flow into Asian countries at accelerating rates in the 1990s after a large drop during the 1980s (Baharumshah and Thanoon, 2006). These countries attracted international investors because of their good macroeconomic fundamentals, including small fiscal deficits, stable exchange rates, high savings rates, and a highly regarded workforce. Another important domestic factor that has contributed to the huge inflows of foreign capital is the widespread liberalization of financial markets in these countries.

Although these eight countries all have high capital inflows, they had different paths to sustain their developments because of widely different resource endowments, human capital accumulation, population, and political systems (see Chang, 2006). Korea has a relatively small economy with few natural resources and a well-educated workforce. It relied first on a revolution in agriculture, then switched to export production with controlled international capital flows. Indonesia, Malaysia, and Thailand are larger countries, with abundant natural resources but a smaller human capital base. They adopted much more protectionist industrial policies under the control of state enterprises and became important traders in international markets. Malaysia welcomed foreign direct investment more than the other two countries. China's growth path has been somewhat different. After a long period of heavy intervention on price, quantity and ownership of enterprises by the government, China has welcomed private enterprises and foreign direct investment. It has a low cost yet educated labor. India began its economic transformation almost a decade after China and created world-class businesses in knowledge-based industries. For Japan, in the 1980s, limited productive investment and loose monetary policies created a financial bubble, which burst in the early 1990s that slowed its growth.

Figure 2.6 per capita GDP of 8 Asian countries

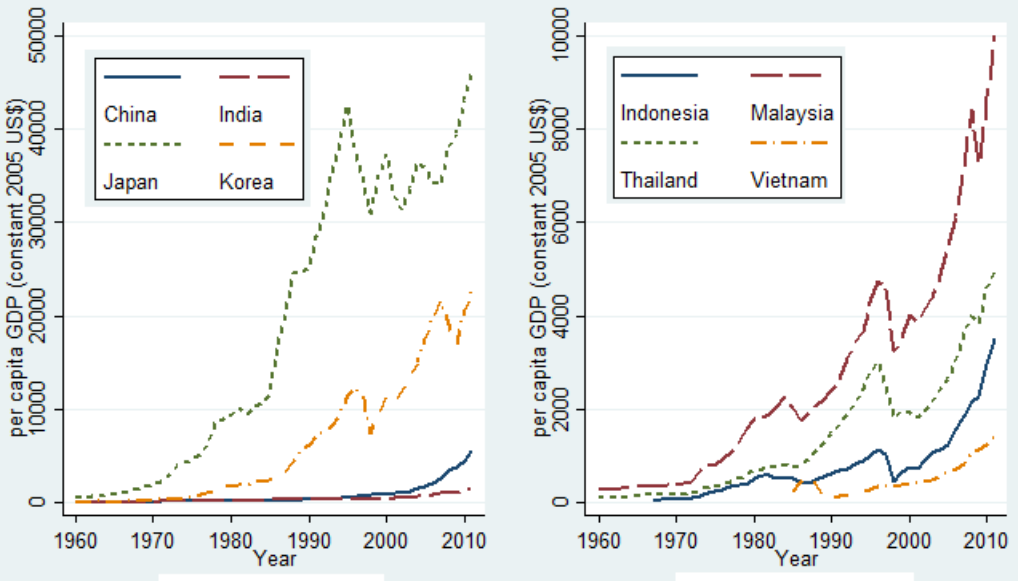


Figure 2.6 shows per capita GDP for 8 Asian countries from 1960 to 2011. For comparison, y-axis is in the unit of constant 2005 U.S. dollars. The 8 curves are organized into 2 figures for better visualization.

Figure 2.7 per capita GDP of 8 Asian countries

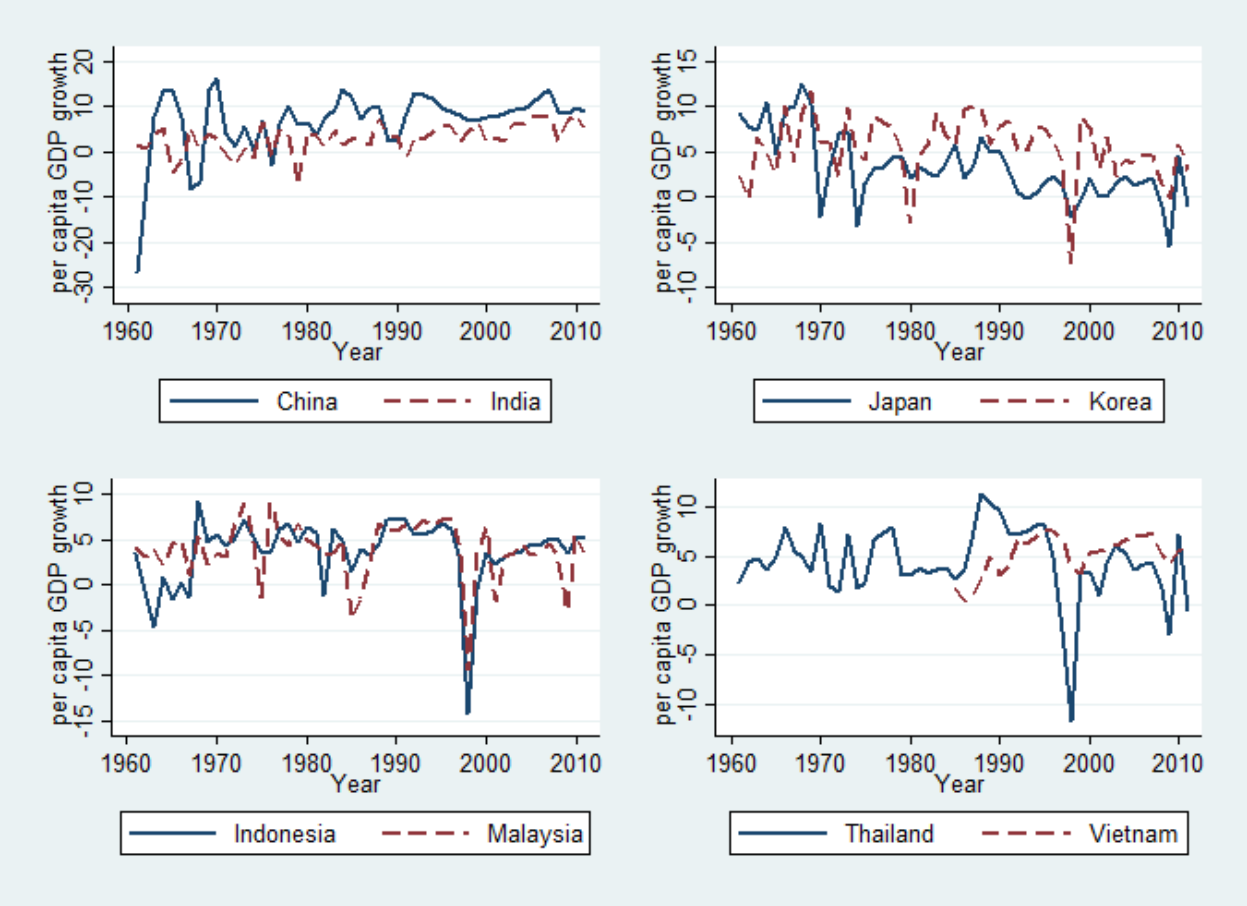


Figure 2.7 shows the per capita GDP growth for 8 Asian countries from 1960 to 2011. The different colors in the graph represent each country. The 8 curves are organized into 4 figures for better visualization.

Stationary Test for the 7 Asian countries

Once variables have been identified as integrated of order I(0), I(1), I(2) etc., it is necessary to test for cointegration to check the significant relationships in the model. If variables have different trends processes, they cannot stay in a fixed long run relation to each other, implying that there is usually no valid base for inference based on standard distributions.

When the variables are stationary, VAR model could be employed; in the case of not stationarity, cointegration would be considered to be the proper technique of analysis. Cointegration analysis involves three steps. First, the stationarity of each variable has to be tested. Second, we need to test for cointegrating vectors among the variables. Finally, if a cointegration relationship exists, an ECM model can be estimated for the cointegrating relationship.

We use the Augmented Dickey-Fuller test, the Phillips-Perron test and the Breusch-Godfrey serial correlation LM test to identify the stationarity property of these variables for India, Indonesia, Japan, Korea, Malaysia, Thailand and Vietnam. The per capita GDP growth rate is stationary in all of these countries except for Vietnam. And the other variables, per capita GDP, equity capital, aid capital, long-term debt capital, trade capital, public capital, secondary enrollment rate, tertiary enrollment rate and expenditure on education are I(1) processes.

VAR for 7 Asian countries

Giving the stationary results by the Augmented Dickey-Fuller and the Phillips-Perron tests, we convert these non-stationary variables into stationary ones by taking the growth rate from their level values. In a recursive VAR model, our 9 variables are assumed to form a recursive dynamic structural equation model in which in which the variable is a function of its own lagged variables and the lags of other variables. VARs allow researchers to investigate whether one variable is useful in predicting another variable. The relationships between the per capita output and other explanatory variables are shown in Table 2.6 for the 7 Asian countries.

India

Since our purpose is to explore the effects on economic growth from other potential variables, we focus on the equation of the growth rate of per capita GDP. Given the results from YGR equation, growth rate of trade capital and human capital impact GDP growth rate positively at the 10% significant level, and growth rate of equity capital at lag two contributes negative effects at 10% significant level to GDP growth. Most of the coefficients in the equations for the other variables are not statistically significant. As a result, openness to trade, foreign equity capital and human capital play relatively more significant roles on the growth.

Japan and Korea

For Japan, since the data of the aid capital and long-term debt are not available for Japan, we exclude them from VAR model. We find that growth rate of equity capital, public investment

and human capital make significant positive contributions to the growth rate of per capita output, while equity capital and openness to trade have significantly negative influences.

For Korea, from the VAR estimation, growth rate of human capital in the forms of secondary enrollment rate, tertiary enrollment rate and expenditure on education have positive impacts on per capita output growth. However, neither aid capital nor equity capital enters the per capita output function significantly.

Indonesia, Malaysia, Thailand and Vietnam

Malaysia, Thailand and Vietnam are in the Association of Southeast Asian Nations (ASEAN), and they are more closely correlated with each other in geographical and political environments. Motivated by potential production base, rapid expansion of consumption and infrastructure buildup, ample natural resources and reforms, their economies develop very quickly from low-income countries to mid-income countries during the sample time. Especially, they are also the largest recipients of foreign capital among the developing countries. In 2011, foreign direct investment (FDI) in ASEAN rose 25.7 percent year-on-year to reach a record-high of $116.5 billion. In labor-intensive industries, their competitiveness has already surpassed China's, offering a sufficient supply of young, low-cost workers. And the working-age population is expected to show rapid growth until 2025. Having recovered from the 1997-98 Asian currency crises, they had built up the foreign currency reserves and signed currency swap deals with other countries, strengthening their financial system. Therefore, they were able to stand in the storm of 2008 crisis and resume stable growth.

From the results of VAR, growth rate of equity capital, openness to trade and social capital at lag one and two, long-term debt at lag two, secondary and tertiary enrollment at lag one in the YGR equation make positive influence on growth rate of GDP at the 1% significant level. While aid capital is negatively related with economic growth rate.

In Malaysia, equity capital and openness to trade, long-term debt, and public investment make significant positive contributions to the growth rate of output per capita. And aid capital, on the other hand, contributes to GDP growth rate negatively. For Thailand, only social capital promotes the economy. Look at Vietnam, equity capital and human capital influence growth positively

Table 2.6. Vector Autoregression for 7 Asian countries

	India	Indonesia	Japan	Korea	Malaysia	Thailand	Vietnam
	ygr	ygr	ygr	ygr	ygr	ygr	ygr
ygr(-1)	0.3292 [1.66]*10	-3.7655 [-75.38]**	0.6682 [3.44]**	-0.1313 [-0.43]	-1.7879 [-3.43]**	0.4623 [1.53]	1.2142 [3.96]**
ygr(-2)	-0.0213 [-0.13]	-0.1445 [-3.59]**	-0.3787 [-1.61]*10	0.0379 [0.11]	-1.7592 [-4.85]**	0.4597 [1.59]	-0.0111 [-1.68]*10
eky_gr (-1)	0.0022 [0.60]	0.0055 [11.91]**	-0.0003 [1.69]*10	-0.0006 [-0.21]	0.0143 [2.41]*	-0.0132 [-1.14]	0.0168 [1.06]
eky_gr (-2)	-0.0072 [-1.8]*10	0.0169 [50.68]**	0.0003 [2.19]**	0.0086 [0.87]	0.0236 [3.42]**	0.0059 [0.61]	-
aky_gr (-1)	-0.0040 [-0.21]	-0.0211 [-27.24]**	-	0.0002 [1.47]	-0.0176 [-2.85]**	-0.0040 [-1.51]	0.0168[1.06]
aky_gr (-2)	0.0129 [0.64]	-0.0759 [-88.60]**	-	0.0000 [-0.23]	-0.0087 [-1.36]	0.0032 [0.97]	-
ldky_gr (-1)	0.0950 [1.24]	-0.0943 [-7.55]**	-	-	-0.0374 [-0.75]	0.0581 [1.23]	0.0233[1.79]*10
ldky_gr (-2)	-0.1176 [-1.54]	0.2398 [37.03]**	-	-	0.1788 [3.12]**	-0.0217 [-0.48]	-
trdy_gr (-1)	0.1164 [1.65]*10	0.4938 [62.95]**	-0.1508 [-3.26]**	-0.1545 [-1.96]*	0.7033 [6.11]**	-0.0663 [-0.85]	0.0068[0.36]
trdy_gr (-2)	-0.0513 [-0.88]	0.2158 [29.29]**	-0.0602 [-1.15]	0.1076[1.15]	0.2142 [1.88]*10	0.0877 [1.01]	-
sky_gr (-1)	-0.0934 [-1.28]	0.5906 [96.85]**	-0.0692 [-1.15]	0.0828 [0.97]*	-0.0860 [-0.63]	0.1481 [1.76]*10	-0.0679[-1.09]
sky_gr (-2)	0.0923 [1.55]	0.1384 [12.47]**	0.1585 [2.10]*	-0.1815 [-2.14]*	0.3112 [3.37]**	-0.1400 [-1.72]*10	-
ser_gr (-1)	0.1168 [0.75]	0.3131 [21.68]**	0.7959 [-1.83]*	1.1865 [1.90]*10	-0.4293 [-1.77]*10	0.0694 [0.59]	0.1340[1.30]
ser_gr (-2)	0.2689 [1.83]*10	-1.0608 [-65.66]**	-0.1349 [-0.37]	-0.2451 [-0.58]	-0.0742 [-0.31]	-0.2320 [-2.02]*	-
ter_gr (-1)	-0.0531 [-0.83]	0.1322 [6.52]**	-0.1785 [-1.85]*10	-0.8943 [-4.45]**	0.0511 [0.60]	0.0081 [0.40]	-0.0374[-3.98]**
ter_gr (-2)	0.1248 [1.89]*10	-0.1457 [-16.41]**	0.2197 [1.84]*10	0.4342 [2.24]*	0.0881 [1.20]	0.0007 [0.03]	-
eey_gr (-1)	0.0126 [0.26]	-0.1084 [-33.38]**	0.1410 [2.21]*	0.0149 [0.15]	0.0164 [0.30]	-0.1058 [-1.46]	0.0189[0.70]
eey_gr (-2)	-0.0308 [-0.63]	-0.1420 [-33.98]**	-0.0181 [-0.35]	0.0667 [2.68]**	-0.0326 [-0.74]	-0.2274 [-2.99]**	-
c	1.0911 [0.77]	9.3392 [41.77]**	1.7325 [2.30]*	8.9725 [3.11]**	0.8942 [0.62]	3.8212 [2.60]**	-0.5455[-0.40]
R^2	0.5609	0.9994	0.8860	0.6305	0.7409	0.6899	0.7562

Notes: sample period: 1978 – 2010, Z-statistics are in the brackets [] below the coefficients.
*Significant at 5% level, ** significant at 1% level.

Measures of the Causality Strength and Non-Causality test

Table 2.7 Paire-wise Granger Causality, Block Exogeneity Wald Tests

	Causality direction	χ^2 (P-values)	Causality direction	χ^2 (P-values)
India	EKY→GDP growth	4.049 (0.132)	EKY←GDP growth	2.339 (0.311)
	AKY→GDP growth	0.521 (0.771)	AKY←GDP growth	17.046***(0.000)
	LDKY→GDP growth	20.718***(0.000)	LDKY←GDP growth	2.442(0.295)
Indonesia	EKY→GDP growth	37.39***(0.000)	EKY←GDP growth	0.528 (0.768)
	AKY→GDP growth	83.83***(0.000)	AKY←GDP growth	17.94***(0.000)
	LDKY→GDP growth	13.75***(0.000)	LDKY←GDP growth	69.70***(0.000)
Japan	EKY→GDP growth	10.509* (0.005)	EKY←GDP growth	0.878 (0.645)
Korea	EKY→GDP growth	1.049 (0.592)	EKY←GDP growth	0.579 (0.749)
Malaysia	EKY→GDP growth	13.074***(0.001)	EKY←GDP growth	14.321***(0.001)
	AKY→GDP growth	9.171***(0.010)	AKY←GDP growth	11.616***(0.003)
	LDKY→GDP growth	12.15***(0.002)	LDKY←GDP growth	0.830(0.660)
Thailand	EKY→GDP growth	1.681(0.431)	EKY←GDP growth	4.142(0.126)
	AKY→GDP growth	3.941(0.139)	AKY←GDP growth	0.382(0.826)
	LDKY→GDP growth	1.691(0.430)	LDKY←GDP growth	1.600(0.449)
Vietnam	EKY→GDP growth	2.814*(0.093)	EKY←GDP growth	5.882**(0.015)
	AKY→GDP growth	1.125(0.289)	AKY←GDP growth	0.099(0.754)
	LDKY→GDP growth	3.206*(0.073)	LDKY←GDP growth	0.492(0.483)

Note: Sample period: 1978-2010. Arrows indicate the direction of the causalities between capital inflows and economic growth based on the test of null hypothesis of Granger non-causality. χ^2 and P-values of tests are reported in the table. * Significant at 10% level, **significant at 5% level, and *significant at 1% level.

Table 2.7 provides the information about the causal relationship between these variables and point to several interesting results about the causal relations in the 7 Asian countries: first, there is sufficient evidence to support the hypothesis that EKY (FDI and portfolio investment) inflows Granger-cause economic growth, excepting Indian, Korea and Thailand. Second, a bidirectional causality relationship is detected between economic growth and aid capital inflows only in Indonesia and Malaysia. Third, there exist a unidirectional causality between long-term debt and economic growth in India, Malaysia and Vietnam. In general, foreign investment is growth enhancing and the evidence suggests that aid capital and long-term debt capital tend to lead the growth of economy, but not the reverse.

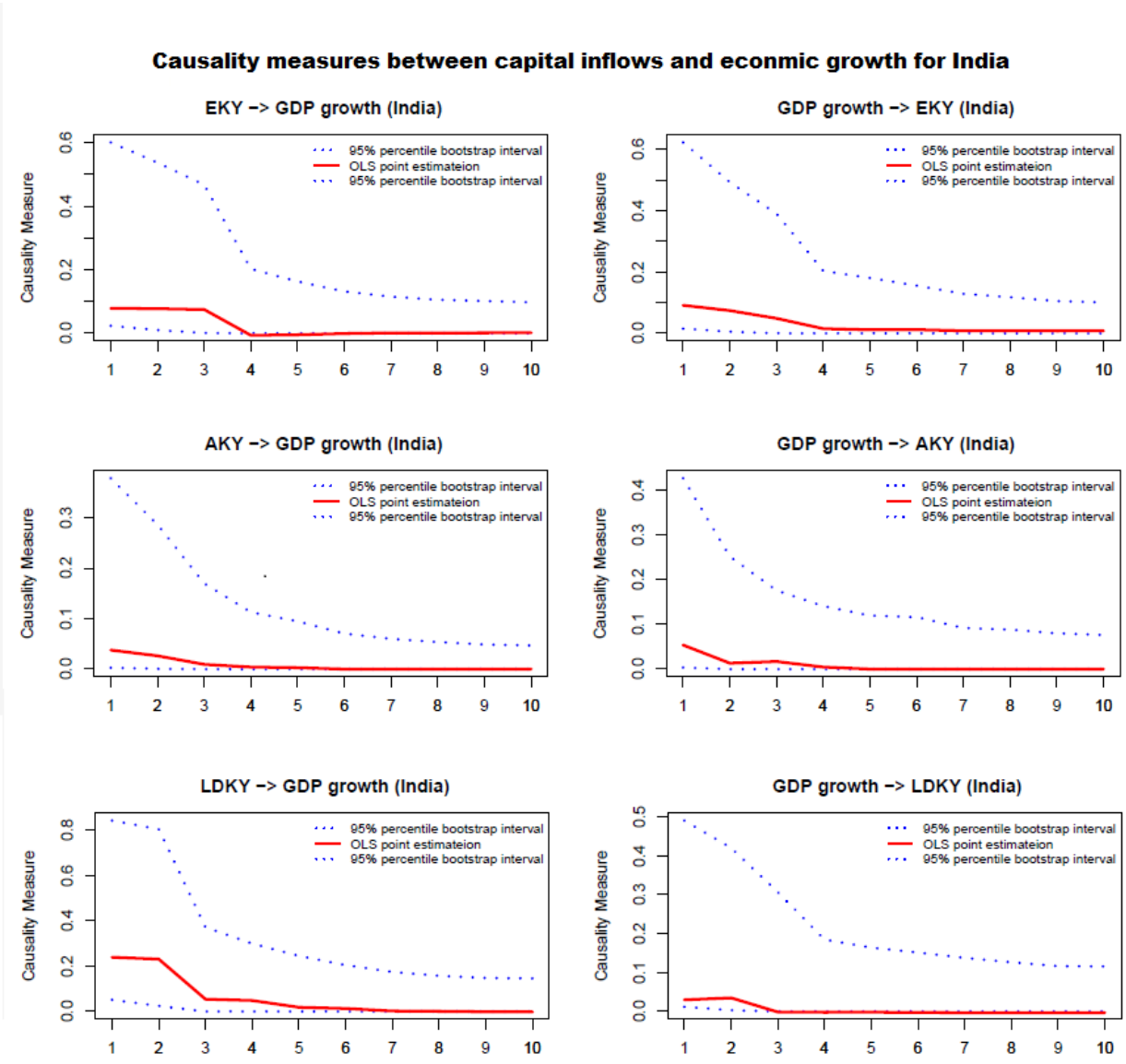
However, Granger-non-causality is restricted to significance test and horizon one, and it could not provide more information on how strong the causality could be and how long the effect can last. In Table 2.7, some cases we cannot reject the non-causality hypothesis in both direction, the test may hide the weak relationships and in some cases even we reject the hypothesis, it may not such strong links between these variables. Therefore, we employ the methodology in section 2.5.1 to measure the magnitudes of these effects across multiple direction and horizons.

The measures of the strength of the causality between capital inflows and economic growth are presented in Figures 2.8 – 2.14. We found broad patterns extracted by the graphs: first, all of the linkages across multiple directions at the horizon one are significant with the confidence interval that does not include the value zero; second, although some of these significances are not detected by the Granger-non-causality test, there are still weak but observable causality showed in our figures. Third, causality measures always have the highest value at the beginning then gradually decrease to 0 after about 5 years. Fourth, in the case that Granger-non-causality detect unidirectional causality relationship between two variables, the measures could distinguish the strength and usually the one has been proved to be significant in Granger-non-causality always has stronger causality measure than the opposite one.

Figure 2.8 – 2.14[19] also indicate that causal relationship is strongest and last the longest time between foreign investments (FDI and portfolio investment) than other forms of capital inflows, which suggests that foreign capital inflows is the most efficient way to improve the economy as proved by many literatures. In particular, in Japan, Korea, Malaysia and Thailand, the causality running from foreign investments to economic growth is stronger than in the opposite direction at horizon one. Except Malaysia, all aid capital in other countries has very weak causality links with economic growth.

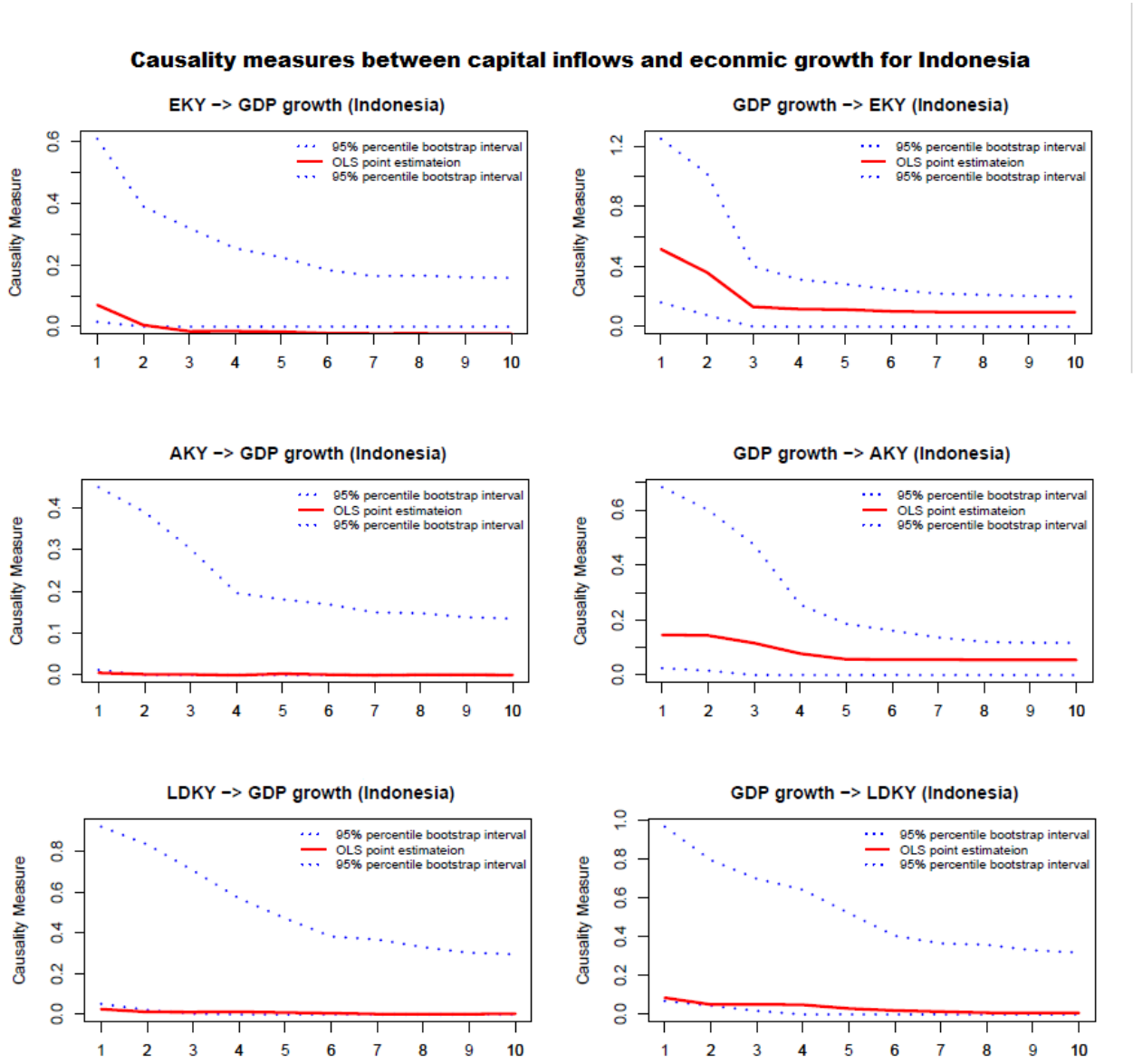
[19] See appendix.

Figure 2.8 Causality measure between capital inflows and economic growth for India



Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Figure 2.9 Causality measure between capital inflows and economic growth for Indonesia



Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Cointegration analysis for 7 Asian countries

We begin our analysis by providing the univariate properties of the variables of interest using the standard Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests. The tests allow for both the presence of a constant and a constant deterministic drift. Both the ADF and PP tests fail to reject the null hypothesis of a unit root for all variables in the levels. To determine whether the non-stationary variables identified above are cointegrated, the multivariate cointegration technique developed by Johansen (1988) and its extension in Johansen and Juselius (1990) have been employed.

We apply the trace and max statistics to identify the existence and the number of cointegration. The tests reveal that the null hypothesis of no co-integration is rejected and more than one cointegrating equations exist. In addition, we observe the eigenvalue and which thereby confirms that there exits at least one unique cointegrating relationship in the system. The cointegration test presented above implies that the nine variables are bounded together by some long-run relationship.

Cointegration Equations for 7 Asian countries

We estimate the parameters in the cointegrating equations for these series to identify the long-run relationship among per capita real GDP, equity capital, aid capital, long-term debt, openness to trade, social capital, secondary enrollment rate, tertiary enrollment rate and expenditure on education, as well as their departures from the equilibrium. This analysis is performed by the Johansen (1988) and Johansen and Juselius (1990) cointegration technique, which is based on the maximum likelihood estimation of a multivariate vector autoregressive (VAR) model.

We focus on the cointegration equation that includes per capita real GDP as follows:

$$GDP = \beta_1 EKY + \beta_2 AKY + \beta_3 LDKY + \beta_4 TRDY + \beta_5 SKY + \beta_6 SER + \beta_7 TER + \beta_8 EEY + \varepsilon \qquad (13)$$

Generally, the error-correction model contains a mechanism that collect the short-run dynamics related to deviations from long-run equilibrium.

Table 2.8 Cointegration vectors in 7 countries

	India		Indonesia		Japan		Korea		Malaysia		Thailand		Vietnam	
GDP	1.00 [-]	-0.109* [-2.24]	1.000** [-]	-.642** [-2.84]	1.000 [-]	.001 [0.08]	1 [-]	.176*10 [1.54]	1 [-]	-.25*10 [-1.91]	1 [-]	.011 [0.17]	1 [-]	-.033 [-0.69]
EKY	-.09*10 [-1.64]	-1.74** [-7.51]	-0.19** [-118.3]	-.60*10 [-0.29]	-1.00** [-6.50]	.202*10 [1.65]	-.0662* [-2.06]	.162 [0.22]	.175** [6.20]	-3.09 [-1.14]	.0127 [0.44]	-1.92* [-2.12]	.174** [4.44]	3.21 [0.89]
AKY	.302* [2.34]	-0.043 [-0.28]	0.165** [31.68]	.920 [1.77]	-	-	-	-.14*10 [-1.52]	.592** [2.84]	-.195 [-0.50]	-.302* [-2.33]	-.099 [-0.49]	.030 [0.41]	-.801 [-1.14]
LDKY	-.035 [-0.52]	3.014** [2.95]	-0.01** [-28.0]	51.5* [2.31]	-	-	-	-	-	11.5*10 [1.63]	-	-4.68* [-1.97]	-.01*10 [-1.81]	-6.40 [-0.70]
TRDY	-.092** [-6.23]	1.547 [1.36]	0.002** [6.90]	19.5 [1.36]	0.436** [9.74]	-1.02** [-3.65]	-.021** [-3.87]	-3.06 [-0.64]	.014** [4.42]	-29.8* [-2.48]	.0127** [2.72]	6.93 [1.54]	-.059** [-5.12]	16.45* [2.17]
SKY	.072** [2.57]	-0.841 [-1.08]	-0.02** [-27.41]	-4.89* [-2.38]	-0.69** [-5.49]	-.287** [-3.48]	-.130** [-11.80]	5.015** [3.70]	-.043** [-3.30]	-3.14 [-0.63]	-.092** [-14.35]	.761 [0.42]	-.304** [-4.32]	3.038* [2.13]
SER	- 	0.516 [0.69]	0.031** [48.95]	.318 [0.11]	0.486** [3.83]	-.081 [-0.93]	-.013** [-2.91]	-1.07 [-0.74]	-.206** [-10.05]	4.73*10 [1.65]	-.068** [-8.26]	3.399** [2.92]	.222** [4.23]	1.011 [0.85]
TER	.090** [2.64]	-0.716* [-2.31]	0.014** [7.59]	-1.96* [-2.49]	-0.56** [-9.86]	.071 [0.47]	-.022** [-9.39]	-3.617* [-2.34]	.0647** [4.00]	7.06** [5.46]	-.033** [-3.70]	2.557 [1.53]	-.013 [-0.44]	-2.03* [-1.97]
EEY	-.575** [-4.38]	0.364* [2.30]	-0.679 [-87.46]	.736* [2.05]	-4.98** [-8.33]	.069** [4.01]	-.283** [-6.36]	1.905** [3.60]	.780** [8.42]	.787 [1.35]	1.01** [6.66]	-.466** [-3.72]	- 	.004 [0.07]

Note: Each column presents parameters estimated for different countries, represents the estimated parameters of the cointegrating vector for this model in the long-run relationship; is the adjustment coefficient, estimating the departure from equilibrium, along with z statistics in the []. Lags have been selected by sequential likelihood-ratio (LR) test and ranks applied from Johansen's test. *(**) indicates the significance at the 5% (1%) level.

Table 2.6 shows the cointegrating equation in each country. We conclude that the long-term relationship between per capita output to other variables is statistically significant according to the coefficients of β_i, as are and the adjustment parameters α_i. Take India for example, per capita output has a stable long-run relationship with financial capitals, openness to trade, investment and human capitals, and the equation is as follows:

$$GDP = -0.09EKY + 0.302AKY - 0.035LDKY - 0.092TRDY + 0.072SKY + 0.09TER - 5.75EEY + \varepsilon \quad (14)$$

The estimates have the correct signs and imply rapid adjustment toward equilibrium. When the predictions from the cointegrating equation are positive, GDP is above its equilibrium value because of the positive coefficient in the cointegrating equation. Then it will fall back to the equilibrium value due to the negative adjustment parameter -0.109. Other variables are also will adjust their value in the long-run relationship accordingly. Overall, the output indicates the model fits well.

Impulse Response Functions for VECMs for 7 Asian countries

Once the VECM has been estimated, short-run dynamics can be examined by considering the impulse response functions (IRF). These functions show the response of each variable in the system to a shock in any of the other variables.

The results illustrate the response of GDP to the shocks in other variables and show that the estimated IRF converges to a positive or negative asymptote, which indicates that an orthogonalized innovation to the other variables in each country has a permanent effect on the GDP. In India, unexpected shocks to TRDY, EEY, and EKY cause 0.05, 0.05 and 0.14 increase of GDP permanently, while unexpected shocks to AKY, SER and SKY result in -0.018, -0.025 and -0.022 decrease of GDP permanently. In Indonesia, GDP increases 11.6, 3.7, 2.7 and 1.7 percentage responding to shocks in EKY, TER, LDKY, and AKY respectively, yet decreases 4.5 percentage responding to shocks in SER. Japan's GDP responds strongly to shocks in EEY, TRDY and SER with 8.2%, 7.3% and 6.1% increase permanently, but 6.8% dropping to a shock in EKY. IRF results in Korea suggests only the shock in AKY induces 0.55% increase of GDP, shocks in other variables (TRDY, SKY, SER and EKY) incur decrease in GDP permanently. For Thailand, GDP responds strongly to shocks in EKY and SER with permanently increase of 5.3% and 4.7%. And Thailand's per capita output increases 0.27%, 0.16% and 0.11% responding to the shocks in EEY, SER and EKY respectively, while decreases 0.13% and 0.11% caused by shocks in LDKY and TRDY.

2.4.4 Panel Data Analysis

Panel data allows us to control variables that cannot be observed or measured, or variables that change over time but not across entities i.e., it examines individual heterogeneity that is exceedingly common to confront data that are grouped (Torres-Reyna, 2007). By applying two panel data models, we can investigate the common effects of different variables throughout the 8 Asian countries. On the one hand, fixed effects explore the relationship between the predictor and per capita output within a country, which has its own individual characteristics that may or may not influence the predictors. When using fixed effects we assume that something like culture, political environment and economic policies may impact or bias the predictor or per capita output and we need to control this. On the other hand, the rationale behind random effects model is that,

unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables in the mode.

Panel data analysis with 6 Asian countries[20] with full set of variables

The pooled regression estimates are presented in Table 2.9 for the 'restricted model' or 'random effects', i.e., with the same value for the constant term across the countries. To test whether this restriction of an identical constant term is valid, an unrestricted model with a different constant term for each country (fixed effects) is also estimated. The results are reported in Table 2.10. An F test on the restrictions indicates that the hypothesis of the same country effects is rejected at the 5 percent level, which indicates that the slopes and intercepts are not simultaneously homogeneous among different countries.

The results from specification - Fixed effects are generally consistent with expectations. The regression estimation in Table 2.10 implies that equity capital, social investment, and human capitals positively affect output, while aid capital and trade decrease per capital GDP over the specified period. The ratio of long-term debt to GDP enters the output equation positively but is not significantly different from zero. In order to understand the interaction of foreign investment and human capital, we attempt to introduce an additional variable to our specification. The correctly signed and statistically significant coefficient on the interaction term is consistent with the literature (see Ford, Rork and Elmslie, 2008; Mamuneas et al., 2006; Kawai, 2000; Borensztein, DeGregorio, and Lee, 1998; Xu, 2000). This suggests that the level of education of workers may play a primary role in domestic firms to adopt foreign technology through foreign investment, and help to promote economy. It also suggests that the foreign investment is more productive and efficient with higher level of education than lower one.

[20] 6 Asian countries are China, India, Indonesia, Malaysia, Thailand and Vietnam. Since the unavailability of data on foreign aids capital and long-term debt capital in Japan and Korea, we excluded the two countries from the pooled regression, which has the full variables set.

Restricted model (Random Effects) defines:

Equation:

$$ygr_{it} = c + \beta_1(eky_{it}) + \beta_2(aky_{it}) + \beta_3(ldky_{it}) + \beta_4(trdy_{it}) + \beta_5(sky_{it}) + \beta_6(ser_{it}) + \beta_7(ter_{it}) + \beta_8(eey_{it}) + \varepsilon_{it} \quad (15)$$

Table 2.9 Pooled Regression for 6 Asian Countries (Random Effects)

	Coefficients	z-values
EKY	0.0759*	3.20
AKY	-0.2543*	-12.01
LDKY	0.0082	5.62
TRDY	-0.0064**	7.93
SKY	0.0343**	9.90
SER	0.0076**	3.35
TER	0.0232**	7.50
EEY	0.2013**	5.48
EKY*EEY	0.0320	2.86
Const.	4.3016**	25.78

*Note: *(**) indicates significant at 5% (10%) level.*

Unrestricted model (Fixed Effects)

Equation:

$$ygr_{it} = c_i + \beta_1(eky_{it}) + \beta_2(aky_{it}) + \beta_3(ldky_{it}) + \beta_4(trdy_{it}) + \beta_5(sky_{it}) + \beta_6(ser_{it}) + \beta_7(ter_{it}) + \beta_8(eey_{it}) + \varepsilon_{it} \quad (16)$$

Table 2.10 Pooled Regression for 6 Asian Countries (Fixed Effects)

	Coefficients	z-values
EKY	0.0955**	5.02
AKY	-0.0843*	-2.57
LDKY	0.0007	0.75
TRDY	-0.0045**	-4.34
SKY	0.0378**	14.12
SER	0.0227**	10.13
TER	0.0363**	10.71
EEY	-0.0425	-1.28
EKY*EEY	0.0275**	4.46
Const.	4.7215**	28.72

Note: F test that all =0: F(5, 157) =89.13, Prob > F = 0.000
**(**) indicates significant at 5% (10%) level.*

To further identify the selection of random effects and fixed effects, we employ Hausman test because the error terms are correlated where fixed effects is not suitable. Consequently, from Table 2.11 random effects would be rejected, that means, the 6 Asian countries differentiate themselves with different constant variables.

Table 2.11 Hausman test for 6 Asian countries in Fixed effects and Random effects models

H_0	Random Effects would be consistent and efficient
H_1	Random Effects would be inconsistent (fixed effects would certainly be consistent)
Result	κ^2=119.80 (Prob>chi2 =0.0000)

Panel data analysis with 8 Asian countries with incomplete set of variables[22]

In order to include all 8 countries, we exclude aid capital and long-term debt in the variable set because they are not available for Japan and Korea. The pooled regressions for the 8 countries are shown in Tables 2.12 2.13 and 2.14. As indicated in the Hausman test, the random effects cannot be rejected significantly, and it is preferred to fixed effects. From Table 2.13, all the variables significantly impact per capita output at the 1% level, and all the effects except from trade and education expenditure are positive. Like the result in Table 2.10, the coefficient on interaction between foreign investment and education expenditure is positive and significant, which seems to imply that with a higher level of education, the foreign investment tends to have stronger effect on output growth of the host's country than the one with lower education level.

Restricted model (Random Effects)

Equation:

$$ygr_{it} = c + \beta_1(eky_{it}) + \beta_2(aky_{it}) + \beta_3(ldky_{it}) + \beta_4(trdy_{it}) + \beta_5(sky_{it}) + \beta_6(ser_{it}) + \beta_7(ter_{it}) + \beta_8(eey_{it}) + \varepsilon_{it} \quad (17)$$

Table 2.12 Pooled Regression for 8 Asian Countries (Random Effects)

	Coefficients	z-values
EKY	-0.2272**	-4.24

[22] Excluding foreign aids and long-term debt capital variables because of unavailability for Japan and Korea.

TRDY	-0.0022**	-1.97
SKY	0.0357**	6.04
SER	0.0351**	12.94
TER	0.0193**	6.94
EEY	0.1854**	3.22
EKY*EEY	0.0599**	3.38
Const.	3.5564**	16.10

*Note: *(**) indicates significant at 5% (1%) level.*

Unrestricted model (Fixed Effects)

Equation:

$$ygr_{it} = c_i + \beta_1(eky_{it}) + \beta_2(aky_{it}) + \beta_3(ldky_{it}) + \beta_4(trdy_{it}) + \beta_5(sky_{it}) + \beta_6(ser_{it}) + \beta_7(ter_{it}) + \beta_8(eey_{it}) + \varepsilon_{it} \quad (18)$$

Table 2.13 Pooled Regression for 8 Asian Countries (Fixed Effects)

	Coefficients	z-values
EKY	0.0731**	3.09
TRDY	-0.0037**	-4.08
SKY	0.0349**	11.24
SER	0.0316**	14.63
TER	0.0246**	18.61
EEY	-0.0861**	-2.89
EKY*EEY	0.0203**	2.84
Const.	4.6123**	38.14

Note: F test that all =0: F(7, 226) =218.06, Prob > F = 0.(**) indicates significant at 5% (1%) level.*

Table 2.14 Hausman test for 6 Asian countries in Fixed effects and Random effects models

H_0	Random Effects would be consistent and efficient
H_1	Random Effects would be inconsistent (fixed effects would certainly be consistent)
Result	κ^2=202.20 (Prob>chi2 =0.0000)

2.6 Conclusions

In this chapter, we investigate the effects of financial capitals and human capital on economic growth in 8 Asian countries: China, Indian, Indonesia, Japan, South Korea, Malaysia, Thailand and Vietnam during the period of 1960 to 2011.

Numerous studies have found positive relationships between foreign capital and economic growth. In our analysis, we extend the previous studies by identifying the different types of capital inflows using a longer length of historical data.

After testing for stationarity, the growth rate of output per capita is found to be I(0), while equity capital, aid capital and long-term debt, openness to trade, social investment and human capital (secondary enrollment rate, tertiary enrollment rate and education expenditure) are integrated of order 1. Therefore, although equity capital, openness to trade and social investment capital exhibit permanent changes, such changes may not bring permanent changes in growth. Then, we convert all independent variables into I(0) by calculating their growth rate and employ a vector autoregression (VAR) approach of order two. We use Granger-non-causality tests and measures of the strength of the causality for further examination of the relationship between these variables. We also employ impulse response functions and variance decomposition analysis to examine the response to shocks and contribution to variance.

In addition, cointegration shows that there exists more than one cointegrating equation for each country and that capital inflows affect the growth process in the Asian countries both in the short and long term.

We find that the growth rate of foreign investment capital seems positively and significantly impacts economic growth in these countries except Korea and Vietnam. Hence, overall, the evidence found in this study suggests that FDI and portfolio investments may have positive spillover effects on the economy and increase domestic productivity and promote growth. Specially, the positive linkage between foreign investment and growth could through enhancement of domestic capital accumulation or technology transformation propagation. The effect of FDI on growth for these Asian countries is consistent with the findings of earlier studies for the countries in this region, both in each country as well as in panel data.

We also found that long-term debt contributes to the economic growth positively in the lower income countries, while aid capital in some cases affects economic growth in an adverse way. This suggests that during the process of development, the lower income countries may need more capital help than the higher income ones with a mature economic environment. The literature (see Burnside and Dollar, 2000) shows that aid may contribute to growth in countries who make better use of it while aid may have no effect on countries who abuse it. Therefore, our results may imply that these Asian countries didn't employ aid capital in an efficient and productive way.

Openness to trade seems as the major contribution to the growth of economy in China, India, Indonesia and Malaysia, yet in Japan and South Korea, the effects of trade on economic growth are not significant. The positive relationship is consistent with the literatures by Grossman and Helpman (1991) and Edwards (1993). From their point of view, openness to trade allows developing countries to absorb technology from the advanced countries.

Furthermore, we apply the concept of multiple horizon causality measures to compare the strength of the causal relationships to go beyond the non-causality tests and provide more information about the time that these effects will last. The evidence shows: (1) the Granger causality between capital inflows and economic growth in both directions across multiple horizons; (2) the causality is strongest between foreign investments and economic growth comparing with other forms of capital inflows; (3) the strength of the causality is relatively higher at horizon one and then drops off at higher horizons.

The estimation of coefficient on interaction between foreign investment and education expenditure is positive and significant. It is consistent with the literature (see Ford, Rork and Elmslie, 2008; Mamuneas et al., 2006; Kawai, 2000; Borensztein, DeGregorio, and Lee, 1998; Xu, 2000). This suggests that the level of education of workers may play a primary role in domestic firms and the foreign investment is more productive and efficient with higher level of education than lower one.

We could have several implications from the analyses in this chapter. First, the empirical result of the positive causation running from foreign investment to growth imply that governments could create favorable conditions and provide more incentives for foreign investment. Second, the adverse effect of aid and long-term debt should warn them to regulate the foreign funds to ensure the efficient utilization. Third, liberalization of international trade can benefit long-term growth, governments could encourage the openness of trade by reducing tariff and constrains on the policies of trade. Fourth, with relatively high level of workforce, foreign technology can be adopted by domestic country through foreign investment. Therefore, government should undertake reforms on education and enhance the education investment.

To sum up, our analyses imply strong positive effects from foreign direct investment, portfolio investment, openness to trade and human capital to economic growth. Our analysis also

detects a positive Granger-causal relationship that runs from FDI to economic growth, which suggest that it may be inappropriate to impose capital controls that deter FDI inflows.

Chapter 3

Financial Cycles in Asian Countries

3.1 Introduction

Financial cycles seems critical to the study of business cycles and the related analytical and policy challenges, so that macroeconomics may need to incorporate financial behavior in a sufficiently realistic manner. Doing so requires an understanding of the basic characteristics of financial cycles. The objective of this chapter is trying to establish these characteristics.

Similar to business cycles, which refer to economy-wide fluctuations in production, trade and economic activity, financial cycles are defined as the waves in financial markets over several months or years. According to Borio (2012), the financial cycles denote self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts. In other words, it generally refers to swings in perceptions and attitudes about financial risk.[16] These interactions result in cycles, amplifying real activities and possibly leading to financial distress or even crisis.

By contrast with the financial markets in developed countries, the financial markets in most Asian countries are in early stages of liberalization and development, so that they tend to be more turbulent and fragile, as well as subject to greater intervention and control by governments. Further, in these economies, banking tends to be highly concentrated and dominates the financial markets; only recently have Asian economies become less-bank centered and developed equity and bond markets (see Levine and Zervos, 1998).

In the previous studies, there are numerous studies have addressed the business cycles in developed economies and only limited empirical work that study the financial cycle indirectly: Borio et al (1994), Detken and Smets (2004) and Goodhart and Hoffman (2008) document the behavior of the relationship between credit, asset prices and real economic activity. Borio and Lowe (2002) and Alessi and Detken (2009) develop leading indicators for financial distress. And

[16] See Ng, 2011

some of studies examine the implications of only booms in asset prices and credit, rather than considering full cycles in financial markets.

Our study extend the literatures in several ways. First, we fill the gaps in the study of the financial cycle in Asian countries. Second, we combine and compare the two analytical approaches – turning-point analysis and frequency-based filter to draw more robust conclusions. Third, we explore several variables and quarterly data, rather than the annual data typically used in other studies that could extract the characteristics of financial cycles. Fourth, we consider full cycles and compare short-term and medium-term. Fifth, we employ extensive investigations on synchronization and dynamic correlation across multiple financial markets and countries.

The financial systems of our sample of Asian countries have undergone significant changes and developments over the past decades. In earlier years, from the view of Stiglitz (1996) banks dominated the financial markets and have been highly concentrated as a result of entry restrictions; more recently, Asian economies have become less-bank centered and have developed equity and bond markets. Most countries have established long-term credit banks and institutions that provide credit for agriculture, small firms and housing. For housing (see Terrones, 2004), East Asian governments created financial institutions for housing finance. Many government-sponsored development banks transformed themselves from government agencies financing development projects into more market-oriented financial enterprises.[24] For equity and bond markets, Malaysia established a rating agency for bond issues in 1991, and Hong Kong, Taiwan and Thailand strengthened their infrastructure for bonds and equity issues. In recent years, East Asian governments increased their efforts to promote stock markets (see Corsetti, Pesenti and Roubini, 1998). Moreover, liberalizations of financial systems in recent decades in a wide number of countries appear to have increased the frequency and scope of financial cycles (Edward 1991).

The following explains our selections of financial variables and countries to capture the financial cycle, our empirical representation of financial cycles of the synchronizations of different financial markets within a country and across countries.

[24] The largest development banks of Japan, Korea, Singapore, and Taiwan have undergone such a transformation.

Why do we choose credit, house and equity prices as the variables?

There are many representative variables to describe financial cycles. These include interest rates, volatility, risk premium, default rate, nonperforming loan, etc. Recently, a few theoretical and empirical papers suggest additional indicators, such as credit spreads (Cúrdia and Woodford (2010), Gilchrist et al (2009)), leverage and liquidity (Adrian and Shin (2008), Geanakoplos (2010)), bank lending standards (Lown and Morgan (2006)) and banks' non-core liabilities (Shin and Shin (2011)). Many financial commentators have shown that the financial intermediaries raise their leverage during asset price booms and lower it during downturns, resulting in pro-cyclical actions that tend to exaggerate the fluctuations of the financial cycles. In this chapter, we focus on credit, property prices and equity prices.

Credit is likely to be the most obvious candidate for the analysis of financial cycles because it links saving and investment. It plays an essential role in crises as the credit booms always result in subsequent credit crunches, as illustrated by past financial crashes (Rogoff and Reinhart (2009)). Fisher and Keynes emphasize the role of credit markets in the propagation of cyclical fluctuations. The nature of credit cycles has been examined in many studies, including Kiyotaki and Moore (1996), Gorton and He (2005), Myerson (2011) and Greenwood and Hanson (2011). There are other sources of credit in the economy, such as bond markets, nonbank financial intermediaries, trade credit, informal finance, and so on. Our measure of credit is aggregate claims on the private sector by deposit-taking banks.

Credit is important in the financing of construction and the purchase of property, thus credit and property prices tend to co-vary closely with each other. Drehmann (2012) and Claessens (2011) describe the financial cycle in terms of credit and property prices.

Our other two variables are house and equity prices. House prices series are taken to correspond to various measures of indices of house or land prices depending on the source country. Equity prices are share price indices weighted by the market value of outstanding shares. These two variables have been employed in earlier studies (Pagan and Sossounov (2003), Gomez and Perez de Gracia (2003), and Hall, McDermott and Tremewan (2006)). In addition, Lowe (2001) points out that movement in property prices appears to be more important for the development of financial cycles than equity prices.

Borio (1994) emphasizes that the mutually reinforcing relationship between credit and asset prices lies at the heart of financial cycles. For instance, an increase in the credit supply or an

increase of banks' willingness to lend will cause high credit growth to have a direct and indirect effect on asset prices. Economic agents could use credit to purchase real and financial assets directly. Credit expansions increase aggregate demand and tend to energize economic activity, enhancing higher expectations for future income on assets and increase their valuation indirectly. In turn, higher asset values strengthen the value of agents and at the same time their borrowing capacity increases through value of collateral.

Borio and Lowe (2002) suggest that risks for financial instability increase substantially if "rapid credit growth, rapid increases in asset prices and, in some cases, high levels of investment" occur simultaneously, which is also called "troublesome threesome" by Lower (2001). In contrast, equity prices do not co-vary closely with credit and property prices, and their variability occurs at higher frequencies compared with the other two series. Consequently, combing the three series seem a promising way to describe financial cycles concretely and empirically.

Why do we select Asian countries?

Financial crises occurred almost at the same time in most of our selected Asian countries. Baig (1999) tests the evidence of contagion between the financial markets of Thailand, Malaysia, Indonesia, Korea and Philippines. Following the collapse of the Thai baht on July 2, 1997, the financial markets of East and Southeast Asia experienced similar distress during late 1997 and early 1998. The evidence from this crisis demonstrates that shocks originating from one market can be transmitted easily to other markets, thus becoming a source of substantial instability across countries.

In contrast to the financial markets in developed countries, the financial markets in most Asian countries are in early stages of liberalization and developments, so that they tend to be more turbulent and fragile, as well as subject to greater intervention and control by governments. Further, in these economies, banking tends to be highly concentrated and dominates the financial markets; only recently have Asian economies become less-bank centered and developed equity and bond markets.

As early as 1987, the crash began in Hong Kong and spread west to Europe, hitting the United States after other markets had already declined by a significant margin; from 1986-1991, Japanese asset price bubble caused financial crisis; in 1910, Shanghai was trapped in rubber stock

market crisis; beginning from 1997, in the Asian financial crisis, devaluations and banking crises were across Asia; as part of a global financial downturn, the automotive industry crisis of 2008-2010, China, India, South Korea and Japan were affected; starting from 1990s, continuing to 2000s, Japan was in its recession with deflation being the main problem (Radelet and Sachs, 1998). The features of financial cycles in Asian countries are relatively vague, as well as the relationship in them between financial crises and real business cycles.

What are the questions that we could answer in this chapter?

Several recent studies have shed light on the question of financial cycles in advanced economies. In particular, Claessens (2011b) studies 21 industrial countries to identify the cycle features in credit, property and equity prices. It finds that financial cycles tend to be long and severe, especially in housing and equity markets and the synchronization within a country is high as well as across countries. Drehmann (2012) employs turning point and frequency-based filter to draw the financial cycle picture. He shows that financial cycle peaks are very closely associated with financial crises and the length and amplitude have increased since the mid-1980s. In addition, both these studies show that the financial cycle is much longer than the traditional business cycle.

The following questions are critical for understanding the characteristics of financial cycles in Asian countries. First, what are the main features of financial cycles? We relate them to the aspects of frequency, duration, amplitude and slop. Second, it is necessary to compare short-term cycles (between 1 to 8 years) with medium-term cycles (between 8 and 30 years), and different financial cycles with business cycles according to the basic features. Third, after the liberalization of financial markets, the frequency and the amplitude of the cycles may have changed. Since the financial markets are fragile and immature in most of Asian countries, are they similar or distinct from those of developed countries? Fourth, how synchronized are financial cycles within a country and across countries? These financial variables co-move with each other in different degrees. Claessens demonstrates that cycles in credit and house prices appear to be the most highly synchronized within countries. The degrees of synchronization across countries are the highest for credit and equity cycles, and have been increasing over time. Do these synchronizations also exist in Asian countries? Fifth, are the financial cycles associated with financial crises, especially at

their peak phases? Most of the financial crises occur at, or close to, the peak of the financial cycles and as a result, most peaks coincide with financial crises (see Drehmann, 2012).

Finally, the most common measure of co-movement between time series is the classical correlation, which is also commonly used in the literature on business cycle correlation. However, classical correlation is a static analysis that fails to capture any dynamics in the movements between different financial markets. Therefore, we employ dynamic correlation analysis to investigate the details of the synchronization within a country and across countries in the domain of frequency.

The remainder of this chapter is organized as follows: section 2 provides the literature on the financial market, financial cycles and the impact of the financial cycle on economic growth; section 3 specifies our analysis; second 4 describes the data and specifies the methodologies used to identify cycles and the creation of the index of synchronization within a country and across countries; section 5 presents graphs and our findings on the set of selected variables; and section 6 summarizes and concludes.

3.2 Theories and Empirical Literature

While there are very many studies on real business cycles, there are relatively few studies covered on the topic of financial cycles. Financial and real flows demonstrate frequent fluctuations of significant amplitude, which indicate definitive effects and interactions with one another. Fisher (1933) is among the earliest contributions to this topic and describes a debt-deflator cycle. Sinai (1992) provides a review of the earlier literature and constructs a large-scale structural macro econometric model to study financial crises and its relationship with the business cycle.

There are various ways to uncover the characteristics of the financial cycles. Detken and Smets (2004), Goodhart and Hoffman (2008), Schularick and Taylor (2009) have shed light on the empirical behavior of the relationship between credit, asset prices and real economic activity. Detken shows that, historically, asset price crashes have often been associated with sharp declines in economic activity and financial instability. Borio and Lowe (2002), Alessi and Detken (2009) and Gerdesmeier et al. (2010) develop leading indicators of financial distress. English et al. (2005), Borio and Lowe (2004), Ng (2011), and Hatzius et al (2010) investigate the estimating properties for economic activity of various financial indicators. Benetrix and Lane (2011) show that fiscal

variables also co-vary with the financial cycles.

In an environment of rapid change in financial markets due to financial innovation, deregulation and new forms of financial competition, the role of different financial factors changes over time, and in fact, the role of credit in the macro economy has changed substantially over time (Xavier Freixas and Jean-Charles Rochet 1997, chap. 6). In the case of the United States, the "credit crunch" and the "overleverage" of households and firms were among the major contributors to the U.S. economic slowdown after 2007. Some economists have emphasized credit's macroeconomic role and importance (Fisher (1993), Gurley and Shaw (1955), Minskey (1964) and Gertler (1988)). In recent years, adverse credit-market conditions have been cited as sources and propagation mechanisms of recessions in Japan, Latin America and U.S.A. (see Bernanke and Lown, 1991). Gilchrist and Zakrajsek (2008) show the linkage between corporate credit spreads and real sectors. Bernanke (1983 and 1989) concludes that the cyclicality in the supply of business credit can be caused by shocks to borrowers' collateral and bank capital. Using micro data, Ivashina and Scharfstein (2010) and Mian and Sufi (2010) explore the credit and housing cycles.

Malkiel (2007) discusses the cyclical behavior of the equity prices. Financial innovation or general shifts in the supply of credit can have a direct impact on asset prices, creating a potentially important feedback mechanism (see Allen and Gale, 2000). This is especially so in developing countries in which the financial sector is dominated by banks.

Speaking of financial crises, since the early 1970s, financial crisis can be observed in terms of volatility in the prices of commodities, currencies, real estate and stocks (Kindleberger and Aliber (2005) and Reinhart and Rogoff (2009)). The term "bubble" is a sign of crisis and generic term for the increases in asset prices in the mania phase of the cycle. Kindleberger (2005) findsthat real estate bubbles and stock price bubbles have occurred at more or less the same time in Japan and in some of the Asian countries. In addition to numerous papers on the dynamics of financial markets, recent books (James, 2009, and Ferguson, 2009) analyze the history of global financial crises. For more detailed quantitative analysis, some scholars have reached back to expand the dataset across both time and space and examine the nature of financial crises and other rare events with new panel datasets, as in recent work by Barro (2009), and Miguel Almunia et al. (2010). For the 1997 Asian financial crisis, the standard 'Washington view' attributes it to inappropriate macroeconomic policy during the 1990s (Greenspan 1998, Corsetti, Pesenti, and Roubini 1998). In contrast, Radelet and Sachs (1998) and Wade and Veneroso (1998) argue that the crisis began

with a mild panic, while Krugman (1998) argues that there was a "Pangloss equilibrium" that caused a bubble in asset prices.

Financial cycles in advanced economies have been extensively studied from an empirical perspective (Claessens, 2011, Drehmann, 2012, Borio 2012, Claessens, 2011) employs traditional cycle-dating methods (turning-point analysis) for 21 OECD countries. Aikman (2011) documents the relationship between the credit cycle and the business cycles. The more recent study by Drehmann (2012), combines two analytical approaches – turning-point analysis and frequency-based filters together to draw more robust conclusions about industrialized countries over 1960-2011. Borio (2012) emphasizes again the importance of financial cycle to call for rethink of modeling strategies and for significant adjustments to macroeconomic policies. From more empirical evidences, Hasen (2003) studies the relationship between macroeconomic imbalances and bankruptcies in the Nordic countries using Cointegration analysis and Granger-causality tests.

While the 2008 global financial crisis spurred many researchers to investigate the major characteristics of financial cycles in advanced economies, we did not find many studies on this topic for Asian countries. Among such studies, Poměnková (2014) employs a wavelet spectrum analysis to study globalization and business cycles in China and G7 countries. He (2012) develops a multi-level structural factor model to study Asian business cycle synchronization. Glick (2013) presents empirical evidence of linkage on asset market between China and other countries (Indonesia, Korea, Malaysia, Philippines, Singapore and Taiwan) in Asia.

In this chapter, we investigate the properties of financial cycles, and their synchronization within a country and across the countries, as well as the relationship between financial crisis and cycles.

3.3 Data

This section explores the behavior of the quarterly series of financial variables for 11 Asian countries and areas (China, Hong Kong, Taiwan, Japan, South Korea, India, Indonesia, Malaysia, Philippines, Thailand and Singapore)[25] during our sample periods.

We concentrate on cycles in three market segments, which together constitute the core of financial intermediation. These variables include credit, house price and equity price. Our measure of credit is a aggregate claims on the private sector by deposit money banks. Credit series are from Datastream covering from 1960 to 2013. House price correspond to various measures of indices of house or land prices depending on the source country and are partially available in some countries. House prices are from the Bank for International Settlements (BIS) and the statistics department in each country. Equity prices are represented as share price indices weighted with the market value of outstanding shares and are mainly from Datastream. All of these variables have been employed in earlier studies (see section 3.1 Introduction).

We employ two methodologies to identify financial cycles: 'turning-point analysis' -- which is used to identify the peaks and troughs in the series and summaries their behavior between those phases[26] -- and frequency-based filter analysis. For turning-point analysis, the nominal values of data have been deflated by the CPI to yield real values and are then converted to logs. Each time series data is normalized by setting its value in 2005 Q1 to be 100. The data used by the filter are transformed into quarterly growth rates and stationary series.

3.4 Methodologies

Turning-Point Analysis

We first apply the traditional cycle-dating turning-point analysis, originally proposed by Burns and Mitchell (1946) for dating business cycles, to identify the peaks and troughs in financial cycles. Among recent studies, Bry and Boschan (1971) and Harding and Pagan (2002) use this method for business cycle analysis. Claessens, et al, (2011) and Drehmann (2012) employ this

[25] We add Hong Kong, Singapore and Taiwan into our sample set based on the availability of data.
[26] For some other dating methods, see Stock and Watson (2010) and Sinai (2010).

approach to identify financial cycles in several developed countries, and Hall et al. (2006) also use it on cycles in equity and housing prices.

A complete financial cycle has two phases, the contraction phase, which is from peak to trough, and expansion phase, which is from trough to the next peak. Many earlier studies have been done on the recovery phase of the early part of expansion period, but the there are few works focusing on the whole cycle.

The turning-point algorithm searches for local maxima and minima over the series. It uses additional censoring rules to identify the cycles including (1) the minimum length of the cycle (the distance between two consecutive peaks or troughs); (2) the minimum length of each phase (contraction from peak to trough or expansion from trough to peak) of the cycle; (3) peaks and troughs to appear alternately; and (4) a trough (peak) to be lower (higher) than the preceding peak (trough).

Following Harding and Pagan (2002), we aim to identify, first, the short-term financial cycle. For the short-term cycle, we set the cycle length as 4 quarters and the length of each phase to be at least 2 quarters. To identify financial crises, which often result in major and long-lasting output losses, we also identify medium-term cycles, for which we set the minimum cycle length window to 8 quarters, so that the phase (contraction or expansion) length would be at least 4 quarters. These assumptions lead to the algorithm specified in Table 3.1. In this table, a point in a quarterly financial series Y_t occurs at t if it satisfies the condition in the second column and can be marked as a peak or trough.

Table 3.1 Turning-point algorithms

Short-term (ST) algorithm	Conditions
Peak	$\Delta Y_{t,t-i} > 0$ for $\forall\, i \in [-2,-1,1,2]$
Trough	$\Delta Y_{t,t-i} < 0$ for $\forall\, i \in [-2,-1,1,2]$
Medium-term (MT) algorithm	
Peak	$\Delta Y_{t,t-i} > 0$ for $\forall\, i \in [-4,-3,-2,-1,1,2,3,4]$
Trough	$\Delta Y_{t,t-i} < 0$ for $\forall\, i \in [-4,-3,-2,-1,1,2,3,4]$

Frequency-Based Filter Analysis

Any time series can contain some or all of the four components: trend, cyclical, seasonal and irregular components.[17] A trend exists when there is a long-term increase or decrease in the data; any pattern showing an up and down movement around a given trend is identified as a cyclical pattern; seasonality occurs when the time series exhibits regular fluctuations during the same month every year or during the same quarter every year; every time series has an unpredictable component that makes it a random variable. These components may be combined in different ways. It is usually assumed that they are multiplied or added as follows:

$$y_t = T \times C \times S \times I \tag{19}$$

$$y_t = T + C + S + I \tag{20}$$

Where T is trend, C is cyclical, S is seasonal and I is the irregular component. The irregular component is the residual time series after the trend-cycle and the seasonal components (including calendar effects) have been removed. It corresponds to the high frequency fluctuations of the series.

There are several time-series filters commonly used in macroeconomic and financial research to separate the behavior of a time series into trend, cyclical and irregular components. A band-pass filter, for example, is a device that passes frequencies within a certain range and rejects frequencies outside that range. In this chapter, the filter is used to isolate different cycle terms and choose the most important one to compare with the business cycles, which usually has duration between 5 to 32 quarters (Christiano and Fitzgerald, 2003 and Comin and Gertler, 2006).

Christiano and Fitzgerald (2003) express a time series x_t in terms of frequency ω_i, as in equation (8):

$$x_t = a_0 + \sum_{i=0}^{n}\{\alpha_i \cos(\omega_i t) + \beta_i \sin(\omega_i t)\} + e_t \tag{21}$$

A specific time series has different frequency components. Let y_t denotes the data generated by applying the band pass filter $\hat{y}_t$ to the raw data x_t, and approximate y_t by $\hat{y}_t$ to minimize the mean square error:

$$E[(y_t - \hat{y}_t)^2 | x] \tag{22}$$

To isolate the component of $x_t$with period of oscillation between p_l and p_u, is computed as follows:

[17] Time Series Analysis: The Basics – Australian Bureau of Statistics: http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Time+Series+Analysis:+The+Basics

$$\hat{y}_t = B_0 x_t + B_1 x_{t+1} + \cdots + B_{T-1-t} x_{T-1} + \tilde{B}_{T-1} x_T + B_1 x_{t-1} + \cdots + B_{T-2} x_2 + \tilde{B}_{t-1} x_1 \quad (23)$$

For t = 3, 4, …, T-2, $j \geq 1$

$$B_j = \frac{\sin(jb) - \sin(ja)}{\pi_j}$$

$$B_0 = \frac{b-a}{\pi}, a = \frac{2\pi}{p_u}, b = \frac{2\pi}{p_l}, \quad (24)$$

After applying the filter $\hat{y}_t$, the component of x_t, whose frequency is within the specific lower and upper bound, will be drawn out and the other components whose frequencies that are out of the range will be filtered. For example, if we set the lower and upper bound as $p_l = 6$ and $p_u = 32$, y_t is the component of x_t with periodicities between 1.5 and 8 years.

Synchronization Analysis

In order to examine synchronization within a country and across countries, we rely on an index initially developed by Harding and Pagan (2002b). Define a concordance index for variable x and y, over period t = 1, … T, as follows:

$$CI_{xy} = \frac{1}{T}\sum_{i=1}^{T}[C_t^x \cdot C_t^y + (1 - C_t^x) \cdot (1 - C_t^y)] \quad (25)$$

Where C_t^x = {0, if x is in downturn phase at time t; 1, if x is in expansion phase at time t}

C_t^x = {0, if y is in downturn phase at time t; 1, if y is in expansion phase at time t}

The index measures concordance of the two series by calculating the fraction of time that they are in the same phase of their respective cycles. If the index is equal to 1, the series are perfectly pro-cyclical; otherwise they are countercyclical if it equals zero. Therefore, at the level of variables, this index measures the extent to which the financial variables within a country coincide with each other; at the country level, this index measures the extent to which financial cycles in different countries coincide over time.

Dynamic correlation

Besides the concordance index, there are many other methods to measure the synchronization of business cycles, such as the unconditional correlation between the two countries in different time periods, the identification of delays various phases of business cycles, volatility of cyclical fluctuations in economic activity, stability and similarity of unexpected fluctuations in economic activity or shock (see Darvas, Z., and G. Szapary, 2008).

However, the concordance index cannot capture the whole picture of the cycle co-movement, so we introduce another measurement, dynamic correlation (see Croux, Forni and Reichlin (2001)) to show the correlation of any two series in different frequencies. Unlike classical correlation, which measures only the linear relationship between times series, the dynamic correlation is an alternative approach based on spectral analysis where time series are represented by sine and cosine waves and the results are represented in frequency domain.

For two stochastic processes x_t and y_t , we transform them into spectral density $S_x(\omega)$ and$S_y(\omega)$, which is interpreted as the decomposition of the variance in the frequency domain. We define the spectral density of $(x_t, y_t)'$ as:

$$S(\omega) = \begin{pmatrix} S_x(\omega) & S_{xy}(\omega) \\ S_{yx}(\omega) & S_y(\omega) \end{pmatrix}, \omega \in [-\pi, \pi] \tag{26}$$

Where the cross-spectrum $S_{xy}(\omega)$ is a complex number. The relation defines the dynamic correlation as follows:

$$\rho_{xy}(\omega) = \frac{C_{xy}(\omega)}{\sqrt{S_x(\omega)S_y(\omega)}}, \omega \in [0, \pi] \tag{27}$$

Where $C_{xy}(\omega)$ is the real part of $S_{xy}(\omega)$ or is a co-spectrum of the two time series. The value of the dynamic correlation is from -1 to 1. To integrate the frequency band from ω_1 to ω_2, (2.5.2) can be transformed as:

$$\rho_{xy}(\omega_1, \omega_2) = \frac{\int_{\omega_1}^{\omega_2} C_{xy}(\omega)d\omega}{\sqrt{\int_{\omega_1}^{\omega_2} S_x(\omega)d\omega \int_{\omega_1}^{\omega_2} S_y(\omega)d\omega}} \tag{28}$$

For a specific frequency range from $\omega_1 = 0$ to $\omega_2 = \pi$, the value of the integration on that range is the same as the classical correlation coefficient.

3.5 Empirical Results

3.5.1 Turning-Point Analysis

In this session we analyze the characteristics of financial cycles for individual series in each country by applying turning-point methodology. We compare the short-term and medium-term cycles in each country and then summarize the comparison across countries.

Short-Term Cycles and Medium-Term Cycles in each Country

After searching the local maximum and minimum points in individual series by the turning-point dating algorithm, we obtain a set of peaks and troughs for each variable. Table 3.2 - 3.12 capture the features of financial cycles in our set of 11 countries (China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, India, Indonesia, Singapore and Philippines). The results describe the cycle in the terms of frequency, amplitude, duration and slope.

China has been experiencing fast economic growth and rapid expansion of financial intermediation in the last thirty years. Since 1978, when China began its reforms, it kept an annual growth rate of 9.8%[27] and the total loans relative to GDP has increased from 51% to 107%.[28] However, its financial system was still quite underdeveloped until 1984 when the People's Bank of China functioned as the central bank and the Big Four state-owned commercial banks appeared. A series of financial reforms from 1994 to 2000 aimed to less administrative and more independent banking. After the WTO entry, China welcomed an impressive financial liberalization process, including interest rate liberalization, less restriction on ownership takeovers and greater freedom to foreign banks (see Chang 2006).

Table 3.2 shows the results for China that for the medium-term cycle, the frequency of equity prices (5 years from 1978 to 2013) is slightly higher than that of house prices and credit (9-10 years and 7.5 years respectively). The duration of expansion is 4 times longer than that of contraction in credit (house prices), yet in the case of equity prices, they have the same length of duration. Looking at the amplitudes in the expansion and contraction phases, credit increases 14.33% in the expansion phase, contrasting to the decrease in the contraction phase that is just 1.72%;

[27] Yearbook 2007 from China Statistics

[28] China Compendium of Statistics, 1949-2004 and Yearbook 2007

house prices raised up 5.06% in the expansion phase, while decreased 3.63% in contraction phase. In equity prices, its changes in the expansion and contraction phases are 16.74% and -10.53% respectively, which are significantly highest among the three variables. Although the short-term cycle is similar to the medium-term cycle, the cycle duration and amplitude in house prices is obviously larger in medium-term cycle than those in short-term cycle. On average, the financial cycle is about 5-10 years, and the contraction phase in the medium-term cycle is significantly shorter than the expansion phase except equity prices. Additionally, equity prices have the highest frequency, the strongest upswing and downturn phases.

Table 3.2 Characteristics of medium-term and short-term cycles: individual series in China (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	1.5	30.5	14.33	-1.72	24.5	6
House prices[5]	7.5	15.2	2.48	-1.96	10.5	4.7
Equity prices[6]	4.5	17.45	14.47	-10.49	8.25	9.2
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	30.5	14.33	-1.72	24.5	6
House prices	2.5	37.3	5.06	-3.63	26.3	11
Equity prices	3.5	19.2	16.74	-10.53	9.7	9.5

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2

The financial system in Japan is much longer in history and mature than other Asian countries. Table 3.3 illustrates the characteristics of financial cycles in Japan. The medium-term cycle shows that the cycle duration of equity prices is 7 years, which have the highest frequency, followed by credit and house prices. The duration and amplitude in the expansion phase in all three financial variables are much longer and stronger than those in the contraction phase. Comparing to the short-term cycle, the medium-term cycle has lower frequency, stronger amplitude and longer duration than the short-term cycle.

Table 3.3 Characteristics of medium-term and short-term cycles: individual series in Japan (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	6	25.5	1.52	-0.52	17	8.5
House prices[5]	3	58	18.93	-10.41	32	26
Equity prices[6]	13	17.77	7.01	-5.08	10.08	7.69
Medium-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit	4.5	34.65	2.23	-0.61	23.25	11.4
House prices	3	58	18.93	-10.41	32	26
Equity prices	7	27.85	10.06	-7.21	16.14	11.71

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1957Q1-2009Q2; 5. Data is from 1955Q1 to 2012Q2. 6. Data is from 1951Q1 to 2013Q2

Hong Kong, as a part of China, is very different from the mainland. As one of the "Four Tigers", Hong Kong plays a role of the financial center in Asia, and bears more expectation on the financial liberalization as well as reformation. Like China and Japan, the equity price only has a 4-year duration in the medium-term cycle, which is the highest among the three markets (the duration of house prices is 9 years, and credit is 11 years). In credit and house prices, both the duration and amplitude in the expansion phase are much longer and stronger than those in the contraction phase, yet equity price has the symmetric wave in the two sides of peaks and troughs. As a result, the medium-term cycle is less frequent and more intensive than the short-term cycle. For Taiwan, house prices and equity prices have the close frequency of 5 years of cycle duration on average. For India, another fast-growing country, the features of cycle are similar to those in China, except the frequency in India is higher than that in China.

Table 3.4 Characteristics of medium-term and short-term cycles: individual series in Hong Kong (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	4.5	26.25	8.13	-0.9	20	6.25
House prices[5]	6.5	20.17	9.19	-6.31	11	9.17

Equity prices[6]	11	13.63	22.77	-21.84	6.27	7.36
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	2.5	43.67	10.89	-1.1	37.67	6
House prices	3.5	36	15.61	-11.12	21.67	14.33
Equity prices	8	17.01	24.09	-24.21	8.13	8.88

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q4-2013Q1; 5. Data is from 1980Q1 to 2012Q4. 6. Data is from 1974Q1 to 2013Q2

Table 3.5 Characteristics of medium-term and short-term cycles: individual series in Taiwan (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	9	13.78	19.99	-13.88	7.56	6.22
House prices[5]	7	18	4.02	-3.29	10.71	7.29
Equity prices[6]	9.5	16.17	11.81	-7.30	9.67	6.5
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	3	39	50.03	-24.73	16.33	22.67
House prices	6	20.17	4.54	-3.63	11.67	8.5
Equity prices	7	21.14	14.17	-8.78	12.28	8.86

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1980Q1-2009Q2; 5. Data is from 1980Q1 to 2012Q4. 6. Data is from 1971Q2 to 2013Q2

Table 3.6 Characteristics of medium-term and short-term cycles: individual series in India (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	11	21.72	6.36	-1.01	17.27	4.45
House prices[5]						
Equity prices[6]	6	15.83	13.93	-7.75	8.83	7
Medium-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit	6	30.84	8.06	-1.31	24.17	6.67
House prices						
Equity prices	5	19	16.93	-9.26	11.4	7.6

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1951Q2-2013Q1; 5. Data is not long enough for statistic significant. 6. Data is from 1987Q2 to 2013Q2

The financial system in South Korea was directly under government control from the 1960s to the 1980s. In the early 1980s, South Korea began reforming its financial system in an attempt to introduce a market-based financial system. The reforms were heavily influenced by interest politics and led indirectly to the financial crisis of 1997. Table 3.7 indicates that in medium-term cycle, the average cycle duration of equity prices is 6.5 years, making it as the shortest one among these three variables. The expansion has the longer duration and greater amplitude than contraction in credit and equity prices, but not in house prices.

Table 3.7 Characteristics of medium-term and short-term cycles: individual series in Korea (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	4	49.25	15.41	-1.08	43.5	5.75
House prices[5]	6	20.5	2.73	-3.12	8.17	12.33
Equity prices[6]	7.5	18.18	12.01	-9.69	10.75	7.43
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	85	32.52	-1.20	72	13
House prices	4	28.75	3.77	-4.34	10	18.75
Equity prices	5	26.2	18.13	-13.11	13.6	12.6

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1962Q4-2013Q1; 5. Data is from 1980Q1 to 2013Q2. 6. Data is from 1975Q1 to 2013Q2

Following the industrial transformation took place in the 1970s and the 1980s Malaysia has evolved in recent years to be a leading country in the developing world with rapid economic growth, and had one of the highest levels of financial development in the world in 2000. In order to achieve a better financial system, various financial restructuring programs have been launched since the 1970s. Today, Malaysia has one of the most dynamic equity markets in the world, along with a large and deep banking sector that has grown rapidly since the 1960s. From Table 3.8, it reveals that credit and equity prices have the same high frequency, 5.5 years of duration (see Chang,

2006). As the other countries, the amplitude and duration are greater in expansion phase than those in contraction phase. However, house prices from 1980 to 2012 are very stable, which is only about 1% change from peak to trough or trough to peak. The medium-term cycle is better to describe the cycle because it has larger amplitude in each phase of the cycle, making the cycle pattern more visible and reliable.

Table 3.8 Characteristics of medium-term and short-term cycles: individual series in Malaysia (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	3	51.33	85.09	-1.65	46.33	5
House prices[5]	9	14	1.38	-0.65	8.67	5.33
Equity prices[6]	9	13.33	8.7	-7.36	7.44	5.89
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1	52	32.17	-1.53	43	9
House prices	4.5	22.4	1.16	-0.65	14.4	8
Equity prices	5.5	22.27	11.80	-8.10	12.6	9.67

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1964Q2-2013Q1; 5. Data is from 1980Q1 to 2012Q4. 6. Data is from 1980Q2 to 2013Q2

The average growth rate of Thailand from 1970 to 1990 was as high as 6.7 percent per year after its considerable expansion in the 1950s. However, in 1997, Thailand experienced a severe economic crisis, which combined the effects of a currency crisis. The Bank of Thailand was depleted of most of its international reserves in defending the baht currency, and had to give up the fixed exchange rate regime and float the currency (see Chang 2006, Drehmann 2012). Table 3.9 shows the financial cycle in Thailand. House prices have the highest frequency with only 4.5-year duration, followed by equity prices and credit. Other characteristics are similar to those in the earlier countries. The amplitudes of house prices in expansion and contraction phases show no significant difference from this in credit and equity prices.

Table 3.9 Characteristics of medium-term and short-term cycles: individual series in Thailand (Turning-point analysis)

	Cycles[1]	**Amplitude[2]**	**Duration**

			(In percent)		(Number of quarters)	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	3	49.67	20.80	-2.37	41.67	8
House prices[5]	9.5	12.73	2.78	-2.88	6.4	6.33
Equity prices[6]	7.5	18.54	14.70	-11.79	10.25	8.29
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	80.5	40.13	-3.52	70	10.5
House prices	6.5	17.86	2.46	-2.84	10	7.86
Equity prices	3	43.67	26.52	-19.47	26	17.67

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1965Q1-2013Q1; 5. Data is from 1980Q1 to 2011Q4. 6. Data is from 1975Q3 to 2013Q2

While Tokyo has been regarded as old financial center in East Asia, Singapore and Hong Kong are competing to become the next largest international financial center.[29] After Singapore broke away from the Federation of Malaysia and gained independence in 1965, it developed very fast into an industrial center with extensive trading activities. Due to robust financial systems with prudent fiscal and monetary policies, Singapore and Hong Kong were not impacted severely other than Indonesia, Philippines and Thailand during the financial crises. Table 3.10 provides information on financial cycles in Singapore. Equity prices have a relatively higher frequency than credit and house prices. The amplitude and duration have the same features as in other countries; the only exception is the equity price, which has a shorter expansion than contraction.

Table 3.10 Characteristics of medium-term and short-term cycles: individual series in Singapore (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	3.5	36.08	7.53	-0.40	31.75	4.33
House prices[5]	6.5	22.53	16.84	-5.97	14.67	7.86
Equity prices[6]	6.5	15	7.53	-6.59	7	8

[29] Ranks in terms of financial development: Hong Kong topped the WEF's 2012 survey of 62 countries, followed by the US, the UK and Singapore. Japan was further down the list at 6th, with Korea at 15th, Malaysia 18th, China 23rd, Thailand 34th, India 40th, Philippines 49th, Indonesia 50th, Vietnam 52nd, and Bangladesh 57th—From "Asian Century Institute", http://www.asiancenturyinstitute.com/economy/254-financial-development-in-asia

Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	3.5	31.25	7.10	-0.51	26.25	5
House prices	5	27.8	19.57	-7.58	18.2	9.6
Equity prices	4	20.75	10.91	-8.71	8.75	12

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1966Q1-2013Q2; 5. Data is from 1975Q1 to 2013Q1. 6. Data is from 1988Q1 to 2013Q3

Indonesia and the Philippines remain relatively underdeveloped in their banking systems and equity markets compared to their neighbors. For the medium-term cycle in Indonesia, equity prices have the highest frequency (duration of 6 years), followed by house prices (8 years) and credit (14 years). The duration of expansion is about 7 times longer than that of contraction in credit series, and 2 times in equity price, while house prices, however, the duration of expansion is only half the one of contraction. The amplitude of expansion is much more intensive than of contraction: credit goes up 14.87% from trough to peak, while it falls 9.24% downward from peak to trough. The amplitude of expansion in equity is 2 times more intensive than that of contraction; by contrast, the amplitude of expansion in house prices is just 0.4% and that of contraction is -2.06%. On average, there are obvious differences between short-term cycles and medium-term cycles: the later one has higher frequency, larger amplitude and longer duration than the former.

For the Philippines, Table 3.12 relies on only two financial variables because of the unavailability of data in house prices. Equity prices have a higher frequency than credit (the cycle durations are 25 and 32 quarters respectively). Credit increases 16.35% in the expansion phase, yet equity prices rise by 12.76%, and the changes of the expansion phase in the two variables are both stronger than that in the contraction phase. Credit has a longer duration in the expansion than that in the contraction but equity price shows no significant difference between the two phases.

Table 3.11 Characteristics of medium-term and short-term cycles: individual series in Indonesia (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	4.5[1]	23.1	6.55	-2.83	18.6	4.5
House prices[5]	5.5	22	0.32	-1.52	10	12
Equity prices[6]	5.5	18.2	17.1	-12.39	11	7.2

Medium-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit	1.5	54.5	14.87	-9.24	47.5	7
House prices	3.5	32	0.4	-2.06	10	22
Equity prices	4	25	18.66	-9.91	17	8

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1968Q1-2009Q2; 5. Data is from 1980Q1 to 2013Q2. 6. Data is from 1983Q3 to 2013Q2

Table 3.12 Characteristics of medium-term and short-term cycles: individual series in Philippines (Turning-point analysis)

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	7	27.57	11.59	-3.26	20.86	6.71
House prices[5]						
Equity prices[6]	6	16	10.39	-9.33	8.83	7.17
Medium-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit	5	38.6	16.35	-4.38	30.6	8
House prices						
Equity prices	3.5	24.5	12.76	-10.70	12	12.5

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1957Q1-2007Q4; 5. Data is not available. 6. Data is from 1986Q2 to 2013Q2

The overall Characteristics of Short-Term and Medium-Term Cycles in Asia

After searching the local maximum and minimum in the individual series, Table 3.13 summarizes the results across our set of 11 countries (China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, India, Indonesia, Singapore and Philippines).

The turning-point dating method identifies 203 complete short-term financial cycles and 125 full medium-term cycles during the sample periods. Among our variables, credit has the longest dataset -- from the 1950s to 2013 -- followed by equity prices (from the 1970s to 2013) and house prices (from the 1980s to 2013).

As shown in Table 3.13, the medium-term cycle has a longer duration, stronger amplitude and more violent slope in each financial series. Therefore, we select the medium-term cycle rather

than the short-term one for comparison with the business cycle. The following analysis concentrates on the medium-term cycle.

Frequency can be represented by the reciprocal of the cycle duration, which is the average number of quarters from peak to peak, or from trough to trough. In the third column of Table 3.13, the medium-term cycle of equity prices lasts about 24 quarters (6 years), while housing prices lasts for 32 quarters (8 years) and credit lasts for 48 quarters (12 years), i.e., credit has the lowest frequency, yet equity prices display the highest frequency, attesting to its greater volatility among the three selected indicators of the financial market.

Amplitude implies the intensity of the variables in each own cycle. Looking at the columns 4 and 5 of Table 3.13, the amplitude of the expansions is 17.94, 12.77 and 6.52 percent for credit, equity price and house prices respectively, while it is 2.69, 9.96 and 4 percent for declines in credit, equity price and house prices respectively. The skewed shape of the cycle is most outstanding in credit, which has the highest amplitude in expansions but the lowest one in contractions, while house prices have relatively modest changes both in upturns and downturn. Overall, the amplitude of recoveries is much severe than that of contractions.

Columns 6 and 7 of Table 3.13 show the downturns from peak to trough last, on average, about 10-14 quarters, while the upturn tend to be much longer (13-37 quarters). To illustrate the differences, credit expansions last, on average, about 37 quarters while house prices are over 17 quarters and equity prices are over 13 quarters. These findings suggest that financial expansions in the financial cycle last longer than contractions, so that the financial cycle exhibits a skewed distribution.

The slope of a financial expansion (contraction) is the ratio of its amplitude in expansion (contraction) phase to its duration. So the slope indicates the 'speed' of the movement. The last two columns of Table 3.13 show that the speed of upturns in credit and house prices is quite similar, at about 0.5 percent per quarter, while equity prices tend to move much faster -- by about three times more than those in credit and house prices. Additionally, the slope of expansions is much greater than that of contractions.

To summarize, the financial cycle is skewed; contractions tend to have sharper declines in short periods, while expansions are often much longer and slower. The cycle in credit displays the most skewed shape with extraordinarily longer and stronger expansions than contractions; in contrast, the cycle in equity prices is volatile and has the shortest cycle duration and the greatest

amplitude. The medium-term cycle, which lasts 24 to 48 quarters (6 - 12 years), provides a better description of the characteristics of financial cycles than the short-term cycle. Finally, comparing our results with developed countries (Drehmann (2012)), the estimated cycle duration is about 8 - 18 years, which is 1.5 times longer than that in the selected Asian countries; the cycle amplitude is 7 times stronger in the expansion phase and 4 times stronger in the contraction phase than those in the sample countries.

Table 3.13 Characteristics of short-term and medium-term cycles: individual series in all Asian Countries[1] (Turning-point Analysis)

	Cycles[2]		**Amplitude[3] (In percent)**		**Duration (Number of quarters)**		**Slope[4] (Speed of cycle)**	
Short-term cycle	Number	Duration[5]	Expansion	Contraction	Expansion	Contraction	Expansion	Contraction
Credit	57	32.25	17.94	-2.69	26.28	5.97	0.68	-0.45
House prices	60.5	22.57	6.52	-4.01	12.46	10.11	0.52	-0.40
Equity prices	86	16.37	12.77	-9.96	8.94	7.43	1.43	-1.34
Medium-term cycle	Number	Duration	Expansion	Contraction	Expansion	Contraction	Expansion	Contraction
Credit	31.5	47.32	20.79	-4.53	37.75	9.57	0.55	-0.47
House prices	38.5	31.14	7.94	-5.14	17.14	14.00	0.46	-0.37
Equity prices	55.5	24.24	16.43	-11.82	13.42	10.82	1.22	-1.09

1. Results based on the mean of the distribution in all these Asian countries; 2. Cycle number is the total number of cycles in the three variables, and 0.5 means half a cycle (from peak to trough or trough to peak); 3. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 4. The slope of expansion is the amplitude from trough to peak divided by the duration; the slope of contraction is the amplitude from peak to trough divided by the duration; 5. The duration of the full cycle is the summary duration of expansion and contraction.

3.5.2 Frequency-Based Filter Analysis

In this section, we employ another way to identify the cycles in financial series: frequency-based filter. This is one of band-pass filters first suggested by Christiano and Fitzgerald (2003), which isolates the component of each series that corresponds to the selected frequency interval. Afterwards Comin and Gertler (2006) study the behavior of medium-term macroeconomic cycles for the US economy. Based on their studies, we employ the approach to isolate the short-term and medium-term cycles in each financial series.

There are other filtering approaches in the literature, including the band-pass filtering recommended by Baxter and King (1999) and Hodrick and Prescott (1997) filter (HP). HP filter is

a high-pass filter that removes the trend and returns high-frequency components in series. The Baster-King filter is a band-pass filter that allows both the low and high frequency components. Christiano and Fitzgerald (2003) discuss optimal finite-sample approximations to the ideal band-pass filter and shows the previous two methods are much noisier and less optimal than the later one. Since the filter implies a zero trend and stationary series, we first convert the data into quarterly growth rates and then apply on the filter.

In order to decide the component that can well identify the cyclical behavior, we create an index for each component that is the ratio of standard deviations (volatility) to the frequency range. The higher the value of the index, the better the component describes the cycle behavior.

We first take China as an example to demonstrate the analysis process and then we summarize our findings from all these countries.

China

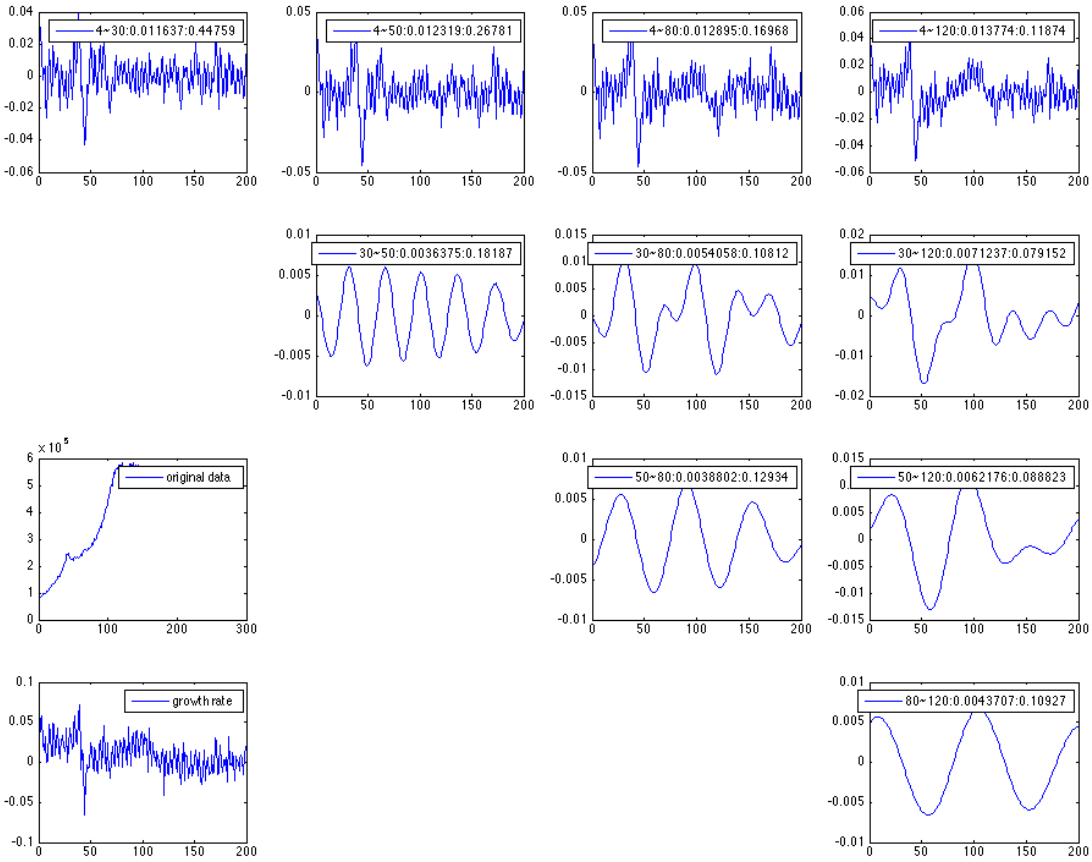
Frequency-based filter analysis allows separation of the components on the basis of frequencies and shows the results visually and quantitatively. For example, Figure 3.1 shows the cyclical shape of Chinese house prices on the basis of different frequency band. We calculate the standard deviation and the index (ratio of the standard deviation to the range length). A higher index means that the component is more volatile or has greater amplitude per quarter unit than the other components in the series, so that this index can be interpreted as indicating their importance in shaping the dynamics of the variable.

Different components are independent of each other. The two graphs at the bottom left corner represent the original data and the growth rate respectively. The frequency is split into several ranges. The graphs in the first row are very noisy since they pertain to the lower frequency components and the index decreases dramatically from 0.52 to 0.1. Another strong component is in the range from 24 to 48 quarters (6-12 years), which is the most volatile, with greater amplitude than other components (except the extremely high frequent one). In other words, the cyclical component (with the periodicity between 6 to 12 years) is more important in shaping the cyclical behavior for Chinese house prices than those with other periodicities. This result is confirmed by the results using the turning-point method.

In order to narrow down the range and find out the cyclical components more precisely, Table 3.14 calculates the different frequency ranges from 4 to 112 quarters where each component

possess 12 quarters. In this table, the components with the durations from 16 to 28 quarters and from 28 to 40 quarters have the highest and most significant cyclical index. To make the interval smaller and search the range in greater details, Figure 3.2 illustrates the cyclical components with duration of only 4 quarters (1 year) in a 3 dimensional graph. This graph supports the earlier findings.

Fig. 3.1 Cyclical Components of Chinese house prices



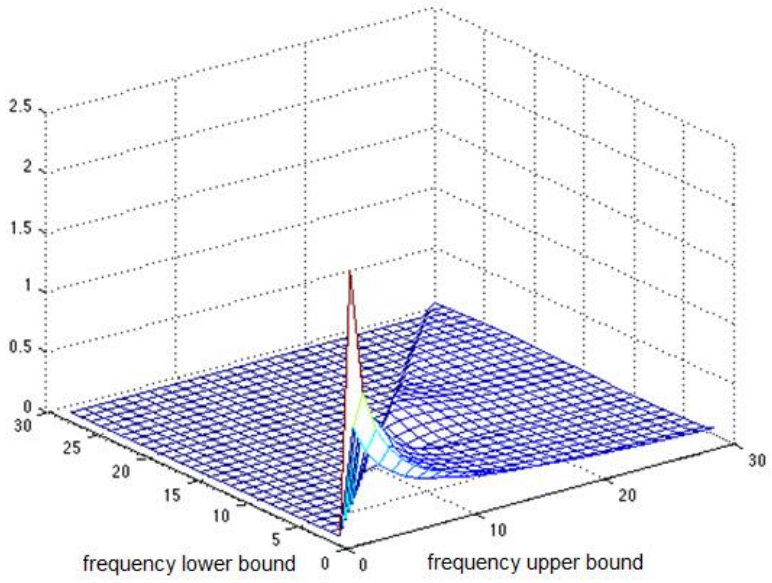
Note: Figure 3.1 shows the cyclical shape of Chinese housing prices on the basis of different frequency band. The two sub-graphs at the bottom left corner represent the original data and the growth rate respectively. On the top of each sub-graph, the figures indicate the frequency range and the corresponding strength (index: ratio of the standard deviation to the range length).

Table 3.14 The Cyclical Index of Different Bands of Components of Chinese house prices

Rang	16 Q	28	40	52	64	76	88	100	112
4 Q	0.86700	0.47939	0.34131	0.25672	0.20793	0.17803	0.15493	0.13806	0.12569
16	NA	0.39292	0.26028	0.17572	0.13891	0.12201	0.10630	0.09542	0.08841
28	NA	NA	0.31777	0.16426	0.12472	0.11260	0.09749	0.08774	0.08217
40	NA	NA	NA	0.04175	0.09308	0.10263	0.09052	0.08388	0.08056
52	NA	NA	NA	NA	0.16945	0.14836	0.11741	0.10295	0.09564
64	NA	NA	NA	NA	NA	0.16205	0.12224	0.10922	0.10264
76	NA	NA	NA	NA	NA	NA	0.11652	0.11759	0.11245
88	NA	NA	NA	NA	NA	NA	NA	0.13022	0.12128
100	NA	NA	NA	NA	NA	NA	NA	NA	0.11713

Note: The first column is the beginning of range with the unit of quarters, and the first row is the end of range. For instance, the second column and second row is 0.867 that is cyclical index (the ratio of standard deviation to the range) of the component with the frequency from 4 to 16 quarters.

Figure 3.2: Strength of cyclical components in Chinese house market



Note: Figure 3.2 illustrates the strength of cyclical component in different frequency ranges from 0 to 30 quarters in a 3 dimensional graph. X-axis and Y-axis indicate the frequency lower bound and upper bound respectively, and Z-axis indicates the strength of the cycle component.

Frequency-Based Filter Analysis: the Cycle Term

Table 3.15 summarizes the frequency ranges. It applies the frequency-based filter to the data on each country and shows strong and completed cyclical patterns. The results show that the cyclical components of credit are between 6 and 12 years for China, Japan, Hong Kong, Taiwan, India and Singapore; those for Korea, Thailand, Indonesia and Philippines are considerably longer (18 and 24 years). On average, the cycle in equity prices is the shortest one, followed by house prices, and the cyclical pattern is the least significant for credit. Comparing with financial cycles in advanced financial markets between 8 and 30 years, estimated by Drehmann (2012), the cyclical duration in the Asian countries is much shorter.

Table 3.15 The Cycle Term in Each Country

Country	Range of Credit (Year)	Range of House (Year)	Range of Equity (Year)
China	6-12 (0.324)	6-12 (0.239)	4-9 (5.184)
Japan	7.5-12.5 (0.182)	8-16 (0.530)	6-12 （1.215）
Hong Kong	6-12 (0.608)	6-12 (0.462)	3-12 (2.440)
Taiwan	6-12 (1.835)	3-9 (0.431)	4-9 (2.544)
India	7.5-10 (0.48)	NA	5-7.5 (2.441)
Korea	20-25 (0.135)	6-8 (0.761)	6-8 (2.760)
Malaysia	10-20 (0.174)	5-10 (0.082)	5-10 (1.243)
Thailand	20-25 (0.213)	4-8 (0.421)	8-16 (1.196)
Singapore	8-16 (0.285)	5-10 (1.191)	5-10 (1.589)
Indonesia	18-24 (0.505)	8-16 (0.090)	5-10 (2.593)
Philippines	16-18 (0.870)	NA	5-10 (2.006)

Note: The figures refer to the range of the strong cyclical component in each variable series. The number in brackets indicates the ratio index (standard deviation per quarter).

Compare the two methodologies

To compare the two approaches, the turning-point dating algorithm and the frequency-based filter, we draw the cycles identified by the two methods in one graph. We apply the turning-point dating analysis on the log-level data, yet for stationary reason, we transform original data into growth rate in order to implement frequency-based filter. The two methods are fundamentally distinct, and they have their own advantages and shortcomings for special series to illustrate the features of cycles. Figures 3.3 and 3.4 demonstrate the cyclical patterns resulting from the two algorithms of Chinese house prices and equity prices, respectively.[30] In the figures, the dates of

[30] Here we only show the two cycle patterns identified by two methods in Chinese house and equity market to demonstrate the advantage and disadvantage of each method.

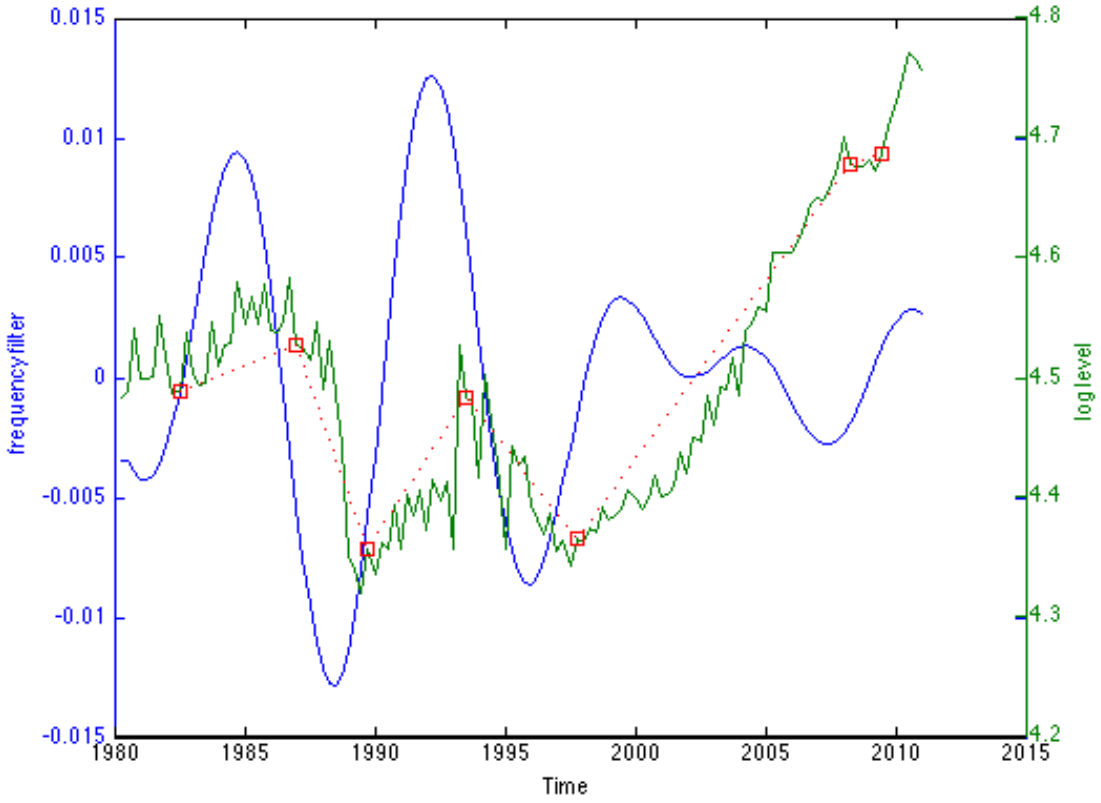
peaks (the onset of contractions) and troughs (the beginning of the expansions) are not identical using the two approaches, and there are several months and even 1 to 2 years of discrepancy.

We compare advantages and weaknesses of the two methodologies in the following respects: first, the turning-point method perform better than frequency-based filter in the case of short-term stable series with small and frequent fluctuation. For instance, during the year of 1980 to 1987 in Figure 3.3, China's house market experienced a relatively prosperous period with local small ups-and-downs, turning-point analysis can detect this wave as a global peak in financial cycles, while frequency-based-filter draws an earlier decline before the actual peak. Second, both of them perform well and produce well-shaped financial cycles when the series are smooth and cycles are obvious. For the period from 1990 to 1995 in Figure 3.3, date of the peaks identified by the two ways are fairly close. Third, when the series experience a long-term continuously unstable increase or decrease, frequency-based-filter may perform better than turning-point, because turning-point can detect the local maximum (peak) or minimum (trough) but it always ignores the global ones. To illustrate, from 1993 to 1995 in Figure 3.4, the frequency-based filter captures the cycle's behavior well but not turning-point method. Fourth, excessive components with different frequencies included in the series makes it difficult for frequency-based filter to separate the typical cycle accurately. As shown in Figure 3.3 during the period of 2000 to 2008, frequency-based filter cannot extract the cycle well for the series with many noisy signals.

Since these Asian countries have not yet developed mature financial markets, for some periods, one methodology is superior to another. Although both of the methodologies have their own constrains to draw financial cycles well, they can be improved to avoid some inaccuracies. For example, we may use some smooth technology to deal with the short-term stable series with small and frequent fluctuation. We also can enlarge the checking window for turning-point analysis in order to capture the global maximum and minimum.

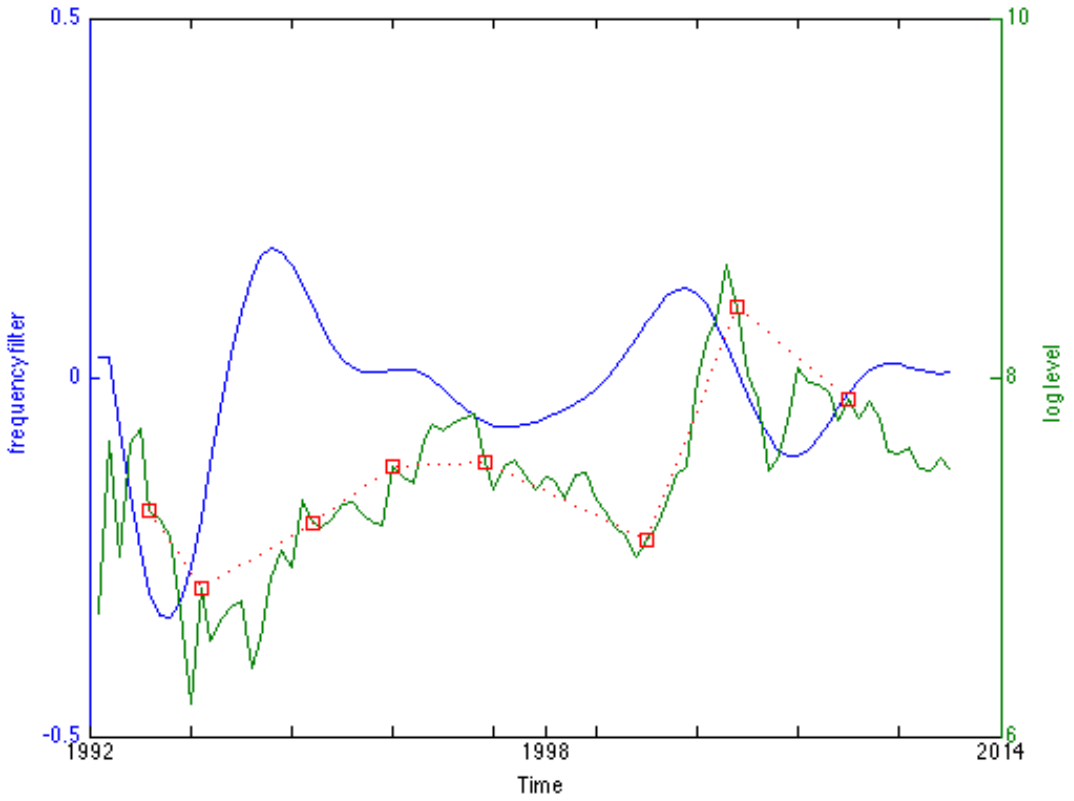
Both methods perform well and produce well-shaped financial cycles after eliminating small fluctuations and noisy signals. Since these Asian countries have not yet developed mature financial markets, from a technique point of view, excessive components with different frequencies are included in the original data, making it difficult to separate the typical cycle accurately. So the turning-point method illustrates the shape of the cycle in a more visual way than the frequency-based filter.

Figure 3.3 Combination of turning-point and frequency-based filter of Chinese house prices



Note: Figure 3.3 illustrates financial cycles identified by turning-point analysis and frequency-based filter respectively from 1980 to 2013. The blue line (growth rate of original series) is drawn by frequency-based filter and green line (log level of original series) is captured by turning-point analysis. The red squares are the dates of peaks and troughs identified by turning-point analysis.

Figure 3.4 Combination of turning-point and frequency-based filter of Chinese equity price



Note: Figure 3.3 illustrates financial cycles identified by turning-point analysis and frequency-based filter respectively from 1980 to 2013. The blue line (growth rate of original series) is drawn by frequency-based filter and green line (log level of original series) is captured by turning-point analysis. The red squares are the dates of peaks and troughs identified by turning-point analysis.

3.5.3 Synchronization of Financial Cycles

This section investigates the synchronization between the financial cycles within a country and across countries. The synchronization represents how concordant the two series are during some specific period. It measures the fraction of time the two series are in the same phase. Based on the index created in Section 3.4.2, if the index is equal to 1, the two series are perfectly pro-cyclical; otherwise, if it is zero, the two series are counter-cyclical.

Synchronization within countries

Table 3.15 shows the concordance between financial cycles in each country. The last two rows of this table show the mean and median statistics. On average, the synchronization between any two financial markets is about 0.55; that is, the two are in the same phase for about 55 percent of the time. However, Claessens (2011A) reports, that in developed countries, the credit and house prices are highly synchronized (0.68) but the linkage of equity prices with the other variables is relatively weak (with credit is 0.57 and with house price is 0.55). For our set of developing countries, this finding does not apply, especially for equity prices, implying that the linkages between these financial markets are relatively weak. Financial markets in these economies are usually not well developed and the fluctuations in credit, house prices and equity prices are quite similar, and governments play essential roles in these markets by rigorous regulations.

Our finding also suggests that the more mature the financial market, the higher degree of synchronization between our financial variables. In Table 3.15, Japan and Hong Kong, both are financial centers, have the greatest synchronization: the indices for Japan are 0.74, 0.69 and 0.68 and the indices for Hong King are 0.64, 0.57 and 0.65.

Table 3.15 Synchronization of Financial Cycle within a Country

Country	Credit & House Prices	Credit & Equity Prices	House Prices & Equity Prices
China	0.476	0.518	0.44
Hong Kong	**0.644**	**0.572**	**0.652**
Taiwan	0.424	0.321	**0.629**
Japan	**0.744**	**0.692**	**0.684**
Korea	**0.571**	0.471	0.5
Malaysia	0.47	**0.629**	0.52
Thailand	**0.57**	**0.596**	0.492
Indonesia	0.474	**0.588**	**0.517**
India	-	**0.635**	-
Singapore	**0.588**	0.431	**0.673**
Philippines	-	0.517	-
Median	0.57	0.57	0.52
Mean	0.55	0.54	0.57

Note: House price for India and Philippines are not available. Bold means the number is above the mean of 0.55.

Synchronization across countries

Table 3.16 provides the synchronization statistics between cycles across countries. The highest degree of cross-country synchronization is between cycles in credit (the average is about 0.61), while the least concordance between cycles is in house prices (the average is about 0.512). This finding is broadly consistent with the notion that credit and equity markets are more closely integrated across countries than the house market: both credit (financial capital) and equities are tradable assets in the international financial markets. Even house and land are non-tradable in the international market and are controlled firmly by governments in some countries, the synchronization is not low (0.5). The extent of synchronization implies that the global factors, including the world interest rate, exchange rate and commodity prices might contribute to the co-movement of these financial markets globally. Our overall finding that the synchronizations of credit and equity prices is greater than that of house prices across our set of developing countries, is consistent with the result for advanced economies by Claessens (2011A) and Terrones (2004).

Table 3.16 Synchronization of Financial Cycles across Countries

	Credit	House Price	Equity Price
Mean	0.61	0.512	0.6
Median	0.619	0.5	0.599
Max	0.899	0.726	0.862
Min	0.279	0.274	0.353

The concordances of credit, house prices and equity prices across countries are shown in Tables 3.17, 3.18 and 3.19, respectively. For credit, Korea has the highest synchronization with other countries, following by Hong Kong, Japan, Thailand, Indonesia and Philippines. Korea and Hong Kong are in first and second place in the table for house prices; Japan, Taiwan and China are also quite high. For the cycles in equity price, Japan ranks top, followed by Taiwan, Korea and India. As a result, the more developed the countries, the more their financial cycles synchronize with the other countries'.

Table 3.17 Synchronization of Financial Cycles across Countries in Credit

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	0.518	0.606	**0.657**	**0.707**	0.279	0.486	**0.671**	0.386	**0.614**	0.467
6	Hong Kong	0.518	-	0.489	**0.623**	**0.652**	**0.696**	**0.899**	**0.739**	**0.768**	0.587	**0.726**
4	Taiwan	0.606	0.489	-	0.526	**0.722**	0.564	0.504	**0.639**	0.466	**0.657**	**0.661**
6	Japan	**0.657**	**0.623**	0.526	-	**0.741**	0.347	**0.762**	0.537	**0.652**	0.54	**0.672**
9	Korea	**0.707**	**0.652**	**0.722**	**0.741**	-	0.321	**0.762**	**0.792**	**0.619**	**0.688**	**0.729**
1	Malaysia	0.279	**0.696**	0.564	0.347	0.321	-	0.528	0.597	0.515	0.545	0.48
6	Thailand	0.486	**0.899**	0.504	**0.762**	**0.762**	0.528	-	**0.644**	**0.782**	0.497	**0.762**
6	Indonesia	**0.671**	**0.739**	**0.639**	0.537	**0.792**	0.597	**0.644**	-	0.55	**0.785**	0.594
5	India	0.386	**0.768**	0.466	**0.652**	**0.619**	0.515	**0.782**	0.55	-	0.529	**0.618**
5	Singapore	**0.614**	0.587	**0.657**	0.54	**0.688**	0.545	0.497	**0.785**	0.529	-	**0.661**
6	Philippines	0.467	**0.726**	**0.661**	**0.672**	**0.729**	0.48	**0.762**	0.594	**0.618**	**0.661**	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH are represented China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold means the number is above the average of 0.6. # refers the number of countries with which the synchronization is above the average.

Table 3.18 Synchronization of Financial Cycles across Countries in House Prices

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	0.452	**0.637**	0.452	0.46	**0.726**	**0.637**	0.274	-	0.452	-
6	Hong Kong	0.452	-	**0.598**	**0.679**	**0.538**	**0.515**	**0.555**	0.439	-	**0.652**	-
4	Taiwan	**0.637**	**0.598**	-	**0.55**	**0.545**	0.492	0.484	0.432	-	0.508	-
4	Japan	0.452	**0.679**	**0.55**	-	**0.687**	0.481	0.508	0.427	-	**0.602**	-
5	Korea	0.46	**0.538**	**0.545**	**0.687**	-	0.432	0.453	**0.575**	-	**0.571**	-
2	Malaysia	**0.726**	**0.515**	0.492	0.481	0.432	-	0.461	0.288	-	0.424	-
3	Thailand	**0.637**	**0.555**	0.484	0.508	0.453	0.461	-	0.477	-	**0.57**	-
1	Indonesia	0.274	0.439	0.432	0.427	**0.575**	0.288	0.477	-	-	0.391	-
	India	-	-	-	-	-	-	-	-	-	-	-
4	Singapore	0.452	**0.652**	0.508	**0.602**	**0.571**	0.424	**0.57**	0.391	-	-	-
	Philippines	-	-	-	-	-	-	-	-	-	-	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH are represented China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold means the number is above the average of 0.5. # refers the number of countries with which the synchronization is above the average.

Table 3.19 Synchronization of Financial Cycles across Countries in Equity Price

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	**0.635**	0.388	**0.6**	0.353	**0.612**	0.529	**0.635**	0.388	0.388	0.588
5	Hong Kong	**0.635**	-	0.538	**0.652**	**0.617**	**0.639**	0.546	0.508	0.562	0.578	**0.862**
6	Taiwan	0.388	0.538	-	**0.686**	**0.838**	0.526	**0.632**	**0.608**	**0.714**	**0.775**	0.532
7	Japan	**0.6**	**0.652**	**0.686**	-	**0.662**	0.556	0.599	0.567	**0.648**	**0.765**	**0.706**
6	Korea	0.353	**0.617**	**0.838**	**0.662**	-	0.511	0.599	0.55	**0.724**	**0.824**	**0.615**
5	Malaysia	**0.612**	**0.639**	0.526	0.556	0.511	-	**0.602**	**0.808**	**0.657**	0.52	0.56
3	Thailand	0.529	0.546	**0.632**	0.599	0.599	**0.602**	-	0.533	**0.61**	0.51	0.541
3	Indonesia	**0.635**	0.508	**0.608**	0.567	0.55	**0.808**	0.533	-	0.59	0.588	0.514
6	India	0.388	0.562	**0.714**	**0.648**	**0.724**	**0.657**	**0.61**	0.59	-	**0.667**	0.59
5	Singapore	0.388	0.578	**0.775**	**0.765**	**0.824**	0.52	0.51	0.588	**0.667**	-	**0.637**
4	Philippines	0.588	**0.862**	0.532	**0.706**	**0.615**	0.56	0.541	0.514	0.59	**0.637**	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH are represented China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold means the number is above the average of 0.6. # refers the number of countries with which the synchronization is above the average.

3.5.4 Financial Cycles with Financial Crises

Although the 2008 crisis resulted in a global recession and a sharp decline in global trade, both Europe and the US experienced severe economic downturns and collapse in their financial system; Asian economies, on the other hand, were affected largely through the trade channel, but their financial systems remained well and recover from the crisis much more rapidly than the West. Although the surface cause may be blamed by the weakness of the financial system in the West, its deeper causes can be traced to the systemic risks in the global economy, such as the size and volatility of capital flows, the flexibility of exchange rates, the inadequacy of the regulatory regimes and governance of the international financial system (see Chang 2006). So it is believed that Asia's success in managing the crisis is due to a more cautious approach to financial liberalization.

Since a financial crisis is a sign of financial distress in the financial sector, it is useful to check the relationship between the cyclical phases in the financial cycles and the timing and incidence of crises. The financial crisis is defined as systemic banking crises and we follow the dating of crises in Laeven and Valencia (2008) and Reinhart and Rogoff (2008), and additionally we determine these dates by judgements of corresponding central banks.

Financial crises are associated with the onset of the contraction phase of the financial cycles. Table 3.20 indicates the closeness of financial crises in Asia with the peaks (the beginning of the contractions), derived by the two statistical methodologies. The closeness is calculated by the time distance between the time marking the onset of a financial crisis and the nearest peak in each variable.

The second column of Table 3.20 shows the dates of financial crises around 1997 and 2008. Most of the peaks identified by both the methodologies are less than one year away from these dates. From the table, the closeness measured by the frequency-based filter tends to be 2 quarters larger than that derived by the turning-point method. The negative numbers imply that the peaks are prior to the onset of crises, which is consistent with the common assumption that crises start with excess liquidity, followed by speculative manias, culminating in a bubble and subsequent crash.

Table 3.20 Financial crises and peaks in medium-term cycles: individual series

Country	**Event Date**	**Turning-point method**			**Frequency-based filters**		
		Credit	House	Equity	Credit	House	Equity
China	1998 Q3	-19	-8*	-5	0	3	-7
	2007 Q4	-	0	0	8	-12	-6
Japan	1991 Q4	4	-5	-6	-12	-12	-
	1997 Q4	-4	-	-5	-2	0	-8
	2008 Q3	-5	-2	-4	-8	-11	-12
Hong Kong	1987 Q4	12*	6*	9	2	-5	-9
	1997 Q4	-1	-1	-3	-9	-3	-6
	2008 Q4	-1*	-3	-4	-12	-16	4
Taiwan	2008	-2*	12	-1	0	4	8
Korea	1997 Q4	0	7*	9	-	-9	10
	2008 Q4	-4*	-7	-4	9	0	-9
Malaysia	1997 Q3	1	-7*	-2	-12	-12	-12
	2009 Q1	-	-4	-4	3	7	9
Thailand	1997 Q2	2	-4	-10	-	-3	-16
	2008 Q4	0*	1	-12	16*	-12	-
Singapore	1997 Q3	5	-5	10	-6	-12	7
	2008 Q2	1*	-1	-3	-7	-9	-12
Indonesia	1997 Q3	3	3	0	-	16	-11
Philippines	1997 Q3	1	1	-4	-12	-	7
Average (MT)		-1.18	-1.07	-2.05	-3.87	-4.78	-3.71
Average (MT & ST)		-0.41	-0.94	-2.05	-2.63	-4.78	-3.71

Note: The figures refer to the distance (in quarters) between a financial crisis date and the nearest peak in the medium-term cyclical component of the corresponding variable. Negative (positive) numbers indicate that the nearest peak precedes (follows) the crisis date. * indicates that the distance is in short-term cycles. The above average is the medium-term cycles, while the average with ST means the average of both medium-term and short-term cycles.

Table 3.21 provides further information on the relationship between cyclical peaks and crises. For both short-term cycles and medium-term cycles, the peaks are classified into two categories – peaks close to crisis and peaks not close to crisis. First, about 30-35% of the peaks are close to crises. The links between the peaks and crises are tighter in medium-term cycles than those in the short-term cycles because there are more crises occurring close to peaks in medium-term cycles than in short-term cycles. Second, cycles that are close to crises tend to be longer for the three variables and have greater amplitude only in credit and house prices in the medium-term cycles. For example, for cycles in credit, the amplitude of the cycles that peaks close to crises is 44% higher than the others with peaks not close to crises. And their duration (55.9 quarters) is also much greater than the duration of the cycles of peaks not close to crises.

But the situations of amplitude are complicated in the short-term cycle, especially for cycles in credit and equity prices. It is cautious to rely on the higher-frequency (short-term) cycles to characterize the financial cycle, because the financial markets in our Asian countries are not stable and these series of variables consist of many high frequency components that play as white noise. As a result, we focus more on the medium-term cycle, which can display and reveal the financial cycles more visually.

Table 3.21 Financial crisis and peaks in all cycles: Individual series

	Peaks close to crisis[1]		**Amplitude[3] (Percentage change)**		**Duration (In quarters)**	
Variables	Number[2]	Percentage	Close to crisis	Not close to crisis	Close to crisis	Not close to crisis
Short-term cycle						
Credit	18/51	35%	17.3	20.9	40.6	13.7
House price	17/66	25.7%	7.3	5.8	17.1	7.8
Equity price	19/87	21.8%	9.3	16.0	10.6	7.3

Medium-term cycle						
Credit	12/33	36.4%	26	18.1	55.9	22.3
House price	13/45	28.9%	8.6	7.3	21.6	12.7
Equity price	19/53	35.8%	13	19.8	14.9	12.3

Note: 1. The peaks that close to crisis are all within 3 years around the crisis date. 2. The number refers to the ratio of number of peaks close to crisis to all financial peaks. 3. Amplitude is the percentage change of the last trough to the current peak.

3.5.5 Dynamic correlation

For dynamic correlation analysis, we first convert the original series into the stationary processes by computing their growth rate, then we transform them into spectral density and calculate the dynamic correlation between any two series, applying the theory proposed by Croux, Forni and Reichlin (2001).

We separate three segments of the aggregate correlation. First, the low long-run movements (over 8 years) correspond to the frequency band below $\pi/16$ (shown as the vertical lines in each graphs) that belongs to the financial frequency. Second, the traditional business cycles, which are usually between 1.5 and 8 years, belong to the part of $\pi/16$ and $\pi/3$. Finally, the short-run components of cycles are defined to have frequencies over $\pi/3$.

We analyze the dynamic correlations of these three financial variables in each country and then across countries in full range of frequency (from 0 to π). Since we focus on the financial cycles corresponding to the low frequency band (from 0 to $\pi/16$) and the financial cycles synchronization in full range of spectrum is biased, we filter the data and analyze the correlation of long-run movement in the frequency of financial cycle. All the correlations among different variables and countries vary significantly over the frequencies. For example, Fig. 3.5 to 3.8 show the dynamic correlation between any two variables in China and Japan in full range and financial frequencies, respectively.

From Figure 3.5, the positive correlations among the three variables raise up when the frequency increases, and then drop down to 0 as the frequency increases further. We draw a vertical line in Figure 3.5, because slow-moving low frequency component of correlations that is most likely associated with long-term dynamics. Then we filter the data and Figure 3.6 shows the

dynamic correlations between different financial cycles, which zooms in on such low frequency range (from 0 to $\pi/16$). It provides a new framework to assess long run co-movements.

We found below the vertical line, which marks the financial cycle upper bound, the correlations are positive and the one between credit and house prices is highest. After filtering the data, Figure 3.6 shows the dynamic correlation in the low frequencies (financial frequencies) in China and the numbers in the upper-right corner implies the static correlation coefficients especially in that frequencies. The coefficient is 0.795 between credit and house prices in long-run movements, and the one between credit and equity prices is 0.412 and the one between house and equity prices is 0.292 respectively. In Japan, the three correlations are all positive in the low frequency range but decrease dramatically as the frequency increases and the coefficient between house and equity prices is slightly higher than the one between credit and equity prices. After applying this process to each country, we find that only in China and Japan, there are high positive correlations among the three financial cycles. In Taiwan, Hong Kong, Korea, Malaysia and Singapore the correlations between credit and equity prices are negative. And we also detect negative correlations between credit and house prices in those countries except China, Hong Kong, Japan and Singapore. These countries include Thailand, Indian and Indonesia also have negative correlations between house and equity prices. However, in the high-frequency range, the dynamic correlation is more volatile around 0.

As a result, most of the financial markets in each country are positively related with some of them are negatively synchronized. The relative degrees of synchronizations among the three markets vary in different countries. Finally, in the range of financial frequencies, the dynamic correlations decrease when the frequencies increase. In general, below the financial frequency boundary, positive correlations dominate.

Table 3.22 calculates the static correlation coefficients in the range of financial frequencies between any two countries in credit cycle. On average, except for China and India, many countries are positively related with each other. Malaysia, Thailand, Indonesia, Singapore and Philippines are comparably higher synchronized (the coefficient is 0.448), followed Korea, Hong Kong and Japan. In the case of China, there are 8 countries negatively related to it.

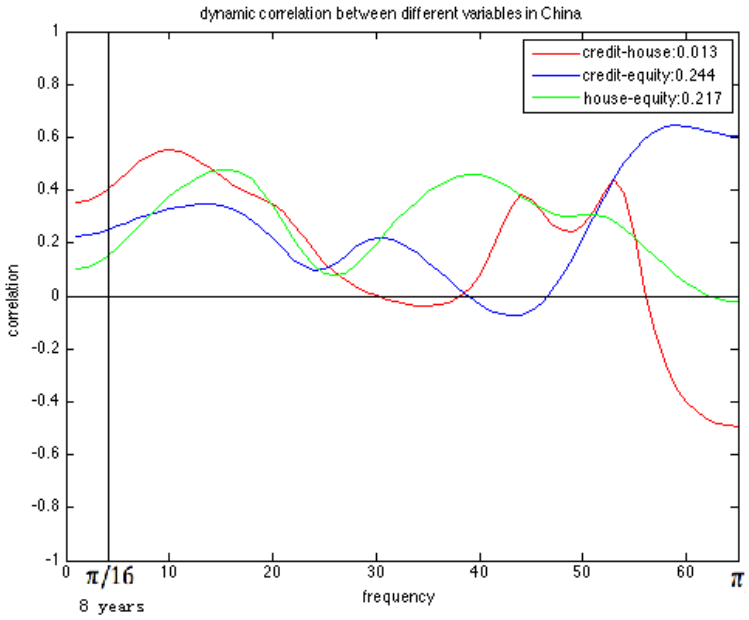
The dynamic correlations of house prices across countries are summarized in Table 3.23. The results are opposite to the conclusions in credit market: the average level of synchronization

is lower than credit and most of the correlations are negative. There is no significant difference of the degree of synchronization among these countries.

Table 3.24 point out the dynamic synchronization of equity prices across countries. There is no surprising to see the degree of synchronization is the highest in equity prices among the three financial markets. Korea, Malaysia, Singapore and Philippines are relatively higher synchronized, while Thailand, Indonesia, Japan and Taiwan are less related to other countries.

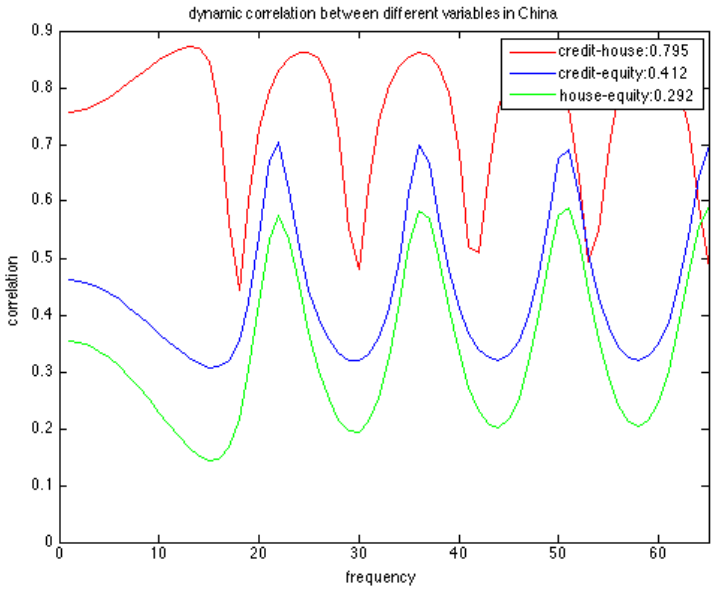
Consequently, the degree of synchronization in equity prices is the highest, followed by credit and house prices, which are consistent with the results in the previous investigations.

Fig. 3.5 Dynamic correlation in China
(Full range)



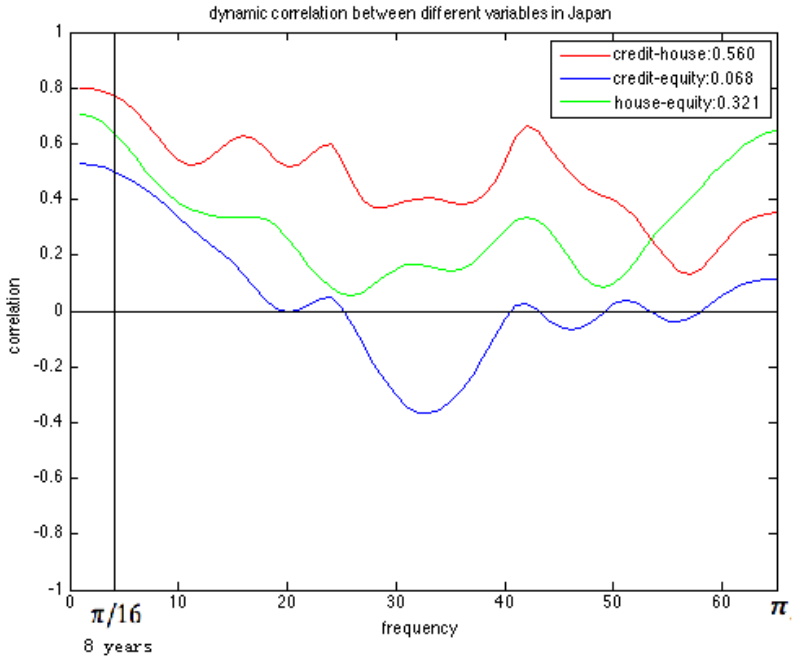
Note: Figure 3.5 shows the dynamic correlations between different financial cycles in different frequency, ranging from 0 to pi. The upper-right legend implies the integrated correlation especially in that frequency range. x-axis is the frequency ranging from 0 to pi. At the point of pi/16, which corresponds to 8 years, can be assumed as the threshold of high and low frequency. Y-axis indicates the strength of correlation.

Fig. 3.6 Dynamic correlation in China
(Financial frequencies)



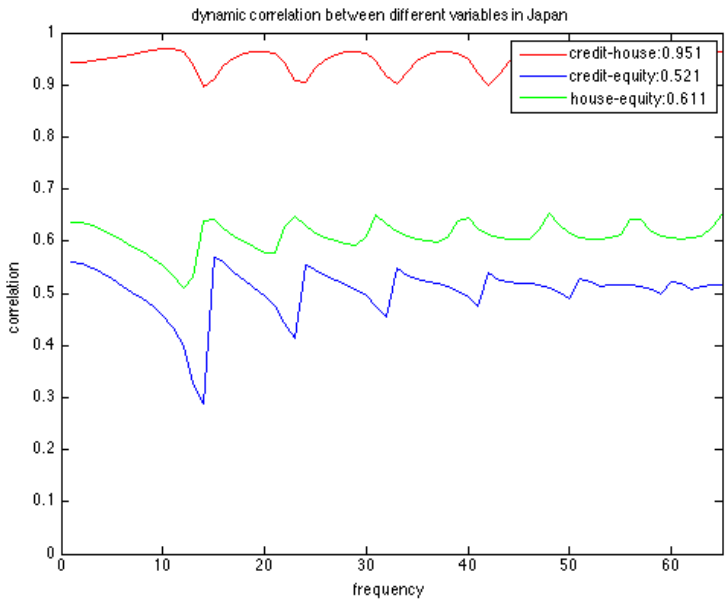
Note: Figure 3.6 shows the dynamic correlations between different financial cycles, which zooms in on very low frequency range (from 0 to pi/16). The upper-right legend implies the integrated correlation especially in that frequency range. Y-axis indicates the strength of correlation. The reason that the three correlations are periodic is that both equity price and credit have spikes in the time series data. The spikes in the time domain will end up with fast oscillating and small cycles in the frequency domain, and the small cycles exist throughout the whole frequency domain, that means, zooming in anywhere in Figure 3.5 will show regular cycles. The cycle duration in this figure is determined by the position of spikes in the time domain (see Oppenheim, Schafer and Buck, 1989).

Fig. 3.7 Dynamic correlation in Japan
(Full range)



Note: Figure 3.7 shows the dynamic correlations between different financial cycles in different frequency, ranging from 0 to pi. The upper-right legend implies the integrated correlation especially in that frequency range. x-axis is the frequency ranging from 0 to pi. At the point of pi/16, which corresponds to 8 years, can be assumed as the threshold of high and low frequency. Y-axis indicates the strength of correlation.

Fig. 3.8 Dynamic correlation in Japan
(Financial frequencies)



Note: Figure 3.8 shows the dynamic correlations between different financial cycles, which zooms in on very low frequency range (from 0 to pi/16). The upper-right legend implies the integrated correlation especially in that frequency range. Y-axis indicates the strength of correlation. The reason that the three correlations are periodic is that both equity price and credit have spikes in the time series data. The spikes in the time domain will end up with fast oscillating and small cycles in the frequency domain, and the small cycles exist throughout the whole frequency domain, that means, zooming in anywhere in Figure 3.7 will show regular cycles. The cycle duration in this figure is determined by the position of spikes in the time domain (see Oppenheim, Schafer and Buck, 1989).

Table 3.22 Integration of Dynamic Correlation of Financial Cycles across Countries in financial frequencies in Credit

Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
China	1	**-0.681**	0.0117	**-0.543**	0.0483	-0.181	-0.351	-0.362	-0.412	-0.565	-0.842
Hong Kong	**-0.681**	1	0.2879	0.3711	0.0117	0.1172	-0.294	0.1084	0.2452	**0.6875**	**0.6128**
Taiwan	0.0117	0.2879	1	0.1475	0.2265	0.2608	0.2583	-0.099	0.3682	0.5338	0.3423
Japan	**-0.543**	0.3711	0.1475	1	0.1329	-0.184	-0.104	0.3194	-0.142	0.4561	-0.254
Korea	0.0483	0.0117	0.2265	0.1329	1	**0.5056**	**0.9251**	0.0890	**0.8570**	0.3526	-0.027
Malaysia	-0.181	0.1172	0.2608	-0.184	**0.5056**	1	0.4167	-0.338	0.1347	**0.8105**	**0.7181**
Thailand	-0.351	-0.294	0.2583	-0.104	**0.9251**	0.4167	1	-0.056	**0.9265**	0.1568	0.4607
India	-0.362	0.1084	-0.099	0.3194	0.089	-0.338	-0.056	1	0.2517	-0.209	-0.289
Indonesia	-0.412	0.2452	0.3682	-0.142	**0.857**	0.1347	**0.9265**	0.2517	1	-0.141	0.1356
Singapore	**-0.565**	**0.6875**	**0.5338**	0.4561	0.3526	**0.8105**	0.1568	-0.209	-0.141	1	0.4847
Philippines	**-0.842**	**0.6128**	0.3423	-0.254	-0.027	**0.7181**	0.4607	-0.289	0.1356	0.4847	1

Average (p)	0.030	0.305	0.271	0.285	0.350	0.423	0.444	0.192	0.417	0.497	0.459
Average (n)	-0.492	-0.294	-0.099	-0.245	-0.027	-0.234	0.024	-0.226	-0.232	-0.305	-0.386

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Average (p) represents the averages of the positive relationships and Average (n) implies the ones of the negative relationships. Bold numbers mean the value is larger than 0.5 or smaller than -0.5.

Table 3.23 Integration of Dynamic Correlation of Financial Cycles across Countries in financial frequencies in House prices

Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
China	1	-0.234	0.2941	**-0.910**	**-0.620**	0.1976	0.2381	-0.083	-0.123	**-0.502**	-
Hong Kong	-0.234	1	0.0995	0.2221	-0.371	0.0826	0.4722	**0.5972**	0.2471	-0.074	-
Taiwan	0.2941	0.0995	1	-0.348	0.0491	0.1496	-0.312	-0.212	0.2019	-0.102	-
Japan	**-0.91**	0.2221	-0.348	1	0.4615	-0.077	-0.089	**-0.907**	0.0390	0.0463	-
Korea	**-0.62**	-0.371	0.0491	0.4615	1	-0.140	**-0.340**	**-0.793**	0.3934	0.0859	-
Malaysia	0.1976	0.0826	0.1496	-0.077	-0.14	1	-0.040	**0.8182**	0.3706	0.0721	-
Thailand	0.2381	0.4722	-0.312	-0.089	-0.34	-0.04	1	**-0.991**	0.1517	-0.037	-
India	-0.083	**0.5972**	**-0.212**	**-0.907**	**-0.793**	**0.8182**	**-0.991**	1	**0.5991**	**-0.746**	-
Indonesia	-0.123	0.2471	0.2019	0.039	0.3934	0.3706	0.1517	**0.5991**	1	-0.129	-
Singapore	**-0.502**	-0.074	-0.102	0.0463	0.0859	0.0721	-0.037	**-0.746**	-0.129	1	-
Philippines	-	-	-	-	-	-	-	-	-	-	1
Average (p)	0.243	0.287	0.159	0.192	0.247	0.282	0.287	0.672	0.286	0.068	-
Average (n)	-0.412	-0.226	-0.244	-0.466	-0.453	-0.086	-0.302	-0.622	-0.126	-0.265	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Average (p) represents the averages of the positive relationships and Average (n) implies the ones of the negative relationships. Bold numbers mean the value is larger than 0.5 or smaller than -0.5.

Table 3.24 Integration of Dynamic Correlation of Financial Cycles across Countries in financial frequencies in Equity prices

Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
China	1	**0.6373**	-0.198	-0.412	**-0.596**	**-0.616**	**-0.722**	**-0.821**	-0.019	**-0.554**	**0.5132**
Hong Kong	**0.6373**	1	0.0684	0.2278	-0.019	0.2981	-0.010	0.3182	-0.098	**0.5463**	**0.5116**
Taiwan	-0.198	0.0684	1	**0.6043**	0.4425	0.4358	0.4358	0.2359	**0.6615**	**0.5271**	0.3856
Japan	-0.412	0.2278	**0.6043**	1	**0.6380**	0.3005	0.3723	0.2089	**0.6096**	**0.7064**	**0.6854**
Korea	**-0.596**	-0.019	0.4425	**0.638**	1	**0.8243**	0.4285	0.4639	**0.6810**	**0.9315**	**0.8421**
Malaysia	**-0.616**	0.2981	0.4358	0.3005	**0.8243**	1	**0.7057**	-0.188	**0.7273**	**0.7121**	**0.6134**
Thailand	**-0.722**	-0.01	0.4358	0.3723	0.4285	**0.7057**	1	0.0054	**0.6636**	**0.6718**	0.4557
India	**-0.821**	0.3182	0.2359	0.2089	0.4639	-0.188	0.0054	1	0.1976	0.4394	-0.132
Indonesia	-0.019	**-0.098**	**0.6615**	**0.6096**	**0.681**	**0.7273**	**0.6636**	0.1976	1	0.3718	0.0759
Singapore	**-0.554**	**0.5463**	**0.5271**	**0.7064**	**0.9315**	**0.7121**	**0.6718**	**0.4394**	0.3718	1	**0.9453**
Philippines	**0.5132**	**0.5116**	0.3856	**0.6854**	**0.8421**	**0.6134**	0.4557	-0.132	0.0759	**0.9453**	1

Average (p)	0.384	0.373	0.422	0.484	0.656	0.577	0.467	0.267	0.499	0.650	0.559
Average (n)	-0.492	-0.042	-0.198	-0.412	-0.308	-0.402	-0.366	-0.380	-0.059	-0.554	-0.132

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Average (p) represents the averages of the positive relationships and Average (n) implies the ones of the negative relationships. Bold numbers mean the value is larger than 0.5 or smaller than -0.5.

3.6 Conclusions

As early as the 1940s, Burns and Mitchell (1946) began to establish the empirical characteristics of business cycles. Numerous studies have repeated this exercise for the business cycles in developed economies. Although there have been many studies covering various aspects of fluctuations in financial markets, there is very limited empirical work to provide comprehensive analysis of these cycles, especially for developing economies. The object of our study in this chapter is to fill this gap.

Financial markets in Asian countries are not necessarily similar to those in developed countries. For example, although the recent crisis resulted in a global recession and a sharp decline in global trade, its biggest impact was felt in Europe and the USA, both of which experienced severe economic downturns and near collapse in their financial systems. Asian economies were able to recover from this crisis much more rapidly than the West did.[18]

While many proposals for financial reforms that have been put forward for helping the development of Asian financial system, in the view of Khor and Tan (2010), Asian governments are very cautious of how dangerous the risk of financial crises can be and Asia's ability to avoid the recent crisis is not guaranteed in the future. Asia is heterogeneous with different levels of development, and it is challenging for them to choose an appropriate regulatory regime which would enable them to avoid the contagion of crises from the advanced western countries. This chapter employs two statistical methodologies, turning-point analysis and frequency-based filter, to study the financial cycles in Asian countries using data covering quite a long time period (since the 1960s). We describe the basic characteristics, such as frequency, duration and amplitude, of individual financial series in each country and across countries and examine the relationship between the financial cycles and financial crisis. We also investigate the synchronization of

[18] http://www.eastasiaforum.org/2010/11/10/an-asian-response-to-international-financial-reforms/

financial cycles within a country and across countries. At the end, we analyze the dynamic correlations between different financial cycles.

Our findings are as follows. First, although the turning-point and frequency-based filter are not perfect to extract cycles from the unstable and immature financial markets, to some extent, there exist financial cycles in Asian countries: both of the methods show that the characteristics of financial cycles in the selected Asian countries are very different from those in the advanced countries (Drehmann, 2012): (1) the estimated cycle duration in the advanced countries (ranging from 8 to 18 years) is 1.5 times longer than that in the selected Asian countries (ranging from 6 to 12 years); (2) the cycle amplitude in the advanced countries is 7 times stronger in the expansion phase and 4 times stronger in the contraction phase than those in the sample countries. Second, the financial cycle displays a skewed shape with longer and stronger expansion than contraction. Third, cycles in house and equity prices are relatively stronger than that in credit. Fourth, the peaks of the financial cycles tend to coincide very closely with financial crises, and the cycles with the peaks close to crises are preceded by longer expansion periods and greater amplitude. Fifth, the degree of synchronization across countries is higher for the cycles in credit and equity prices than for those in house prices. Among our set of countries, the financial cycles in Japan, Korea, Hong Kong and Taiwan have a higher degree of the synchronization with the rest of the countries in this group than with those of other countries. However, the overall synchronizations are weaker than advanced countries (see Claessens, 2011A). Finally, the dynamic correlations among the three financial cycles within a country and across countries vary along the frequencies range and decrease when the frequencies increase.

These findings provide some meaningful implications. We argue that they are consistent with the view that financial markets in these Asian countries are still in the earlier stage of development and these cycles are not prominent as those of advanced countries. This may reflect a stable and mature financial system is always accompanied by financial liberalization and prospective monetary policy. Our results shed some light on the term and amplitude of financial cycles in these countries, so policy responses should take into account for the expected recessions. Based on our work, additional empirical analyses may be carried out regarding the determinants of the duration and amplitude of financial cycles, the role of financial institutions, as well as the relations with global fluctuations.

Chapter 4

Financial Cycles and Business Cycles in Asian Countries

4.1 Introduction

There is a close interaction between the financial markets and the business world. Financial cycles influence and are influenced by the business cycles. For example, the drop in U.S. house prices after 2006 brought a reduction in consumption spending through its impact on household wealth, borrowing and mortgage equity withdrawals.[19] In the view of microeconomics (see Sinai, 2010), the changes in financial conditions on household impact business spending decisions through the financial accelerator mechanism. On the household side, the permanent income model of consumption has implications for the responsiveness of consumption to both income and asset values. Further, changes in the supply of external financing can affect corporations and households, and thereby generate business cycles.

Increasing the credit supply has a direct and an indirect effect on asset prices (see Detken and Smets, 2004). Agents use credit to purchase real and financial assets: credit expansions strength aggregate demand and tend to generate an upswing in economic activity indirectly. Many studies have investigated the impact of credit and asset price booms and of financial distress on business cycles. Fisher's (1933) theory of debt-deflation provides an early analysis of how the financial sector can amplify business cycle fluctuations. Minsky (1977) and Kindleberger (1978) add to this discussion. Gertler (1988), Sinai (1992, 2010), and Bernanke (1993) provide reviews of the early literature. Ebeling (1996) argues that trade cycles result from excessive growth of circulating credit, which expands the real economy, eventually leading to unsustainable investment projects.

In addition, other observers believe that stock prices are likely to have an impact on the prices of goods and services and thereby affect economic activity and inflation (see Bernanke and Gertler (2001), Bullard and Schalling (2002), Filardo (2000)). If stock prices become inconsistent with developments in economic fundamentals, such as during a speculative bubble, the bursting of the bubble causes a general decline in investment and output and increases unemployment,

[19] http://www.globalpropertyguide.com/North-America/United-States/Price-History

thereby bring about a contraction in economic activities. Therefore, there are some debates on whether asset prices should be taken into account in the conduct of monetary policy.

The 1997-1998 Asian financial crisis heavily influenced business downturns in most Asian countries. In the 1997 financial crisis (see Radelet, 1998), triggered by the collapse of Thai baht, Indonesia, South Korea and Thailand were mostly affected, and Hong Kong, Malaysia and Philippines were hurt by the slump, while China, Taiwan and Singapore were less affected. During that period, the panic among lenders led to large withdrawals of credit from the crisis countries, causing a credit crunch and further bankruptcies. After that, economies in the region were impacted severely.

The aim of this chapter is to examine the relationship between financial cycles and business cycles. In an earlier chapter (chapter 3, Financial cycles in Asian countries), we analyze the basic characteristics and synchronizations of the financial cycles for a sample of Asian countries over the period of 1960-2013. As the severe financial disruption cast on the real output of economy, it becomes more urgent to explore the links between financial cycles with the real economy, therefore, in this chapter, we broaden our understanding of the interactions of these cycles by investigating the behavior of major macroeconomic and financial variables during business and financial cycles.

The rest of the chapter is organized as follows: the next section reviews the recent literature of the relationship between the financial cycle and the business cycle; section 3 outlines the methodologies and theoretical predictions; section 4 presents the empirical results and section 5 concludes.

4.2 Empirical Literature

Credit is the most obvious candidate to describe the financial cycles and credit spreads have long been used to gauge the degree of strains in the financial system. Because asset prices are based on forwarding-looking expectations, movements in credit spreads have been shown to be useful for forecasting economic activity. Helbling *et at*. (2011) study the interactions between credit and output. Several studies analyze the relationship between credit spreads and economic activity (Stock and Watson (1989); Friedman and Kuttner (1998); Gertler and Lown (1999); Mueller (2007) and King, Levin and Perli (2007)). Although macroeconomic evidence offers

mixed guidance on the importance of interest rates for investment spending, recent work by Gilchrist and Zakrajsek (2007) using firm-level data shows that investment is highly responsive to changes in corporate credit spreads.

Recently, a number of studies focus on the interactions between the financial and business cycles. Harding and Pagan (2002a, b) propose a simple method for analyzing the concordance between macroeconomic and financial variables. Artis *et al* (2003) analyze the cycles in Euro area data. Both microeconomic and macroeconomic studies suggest an important link between house prices and household consumption (see Case, Wuigley and Shiller (2005); Carroll, Otsuka and Slacalek (2006); and Campbell and Cocco (2008)). As for financial linkages, some studies point out a positive relationship between financial integration and business cycle movements both in output and consumption in the case of advanced economies (Imbs 2004, 2006). Stock and Watson (2003) and Engel and West (2005) reveal the links between various asset prices and real aggregate. The behaviors of real and financial variables surrounding financial crises are examined by Reinhart and Rogoff (2009). Cochrane (2006) suggests that in a world without financial frictions, macroeconomic developments and financial conditions interact closely through wealth and substitution effects.

The financial mechanism connecting the balance sheet conditions of borrowers to real activity is often described as the "broad credit channel". Kashyap and Stein (2000) show that small U.S. commercial banks are sensitive to the changes in monetary policy. In contrast, Cetorelli and Goldberg (2008) point out that commercial banks can offset declines in domestic deposits by shifting deposits from their global subsidiaries.

4.3 Data

This chapter explores the cycles of the quarterly series of real GDP, unemployment, credit, house prices and equity prices for 11 Asian countries (China, Hong Kong, Taiwan, Japan, South Korea, India, Indonesia, Malaysia, Philippines, Thailand and Singapore) over our sample periods. Given the unavailability of data on the equity prices in some of these countries, we analyze the synchronization starting from 1980.

We include quarterly real GDP growth rate and unemployment rate as the measures of real activity and as the representative variables for the business cycle. The data of credit, house prices and equity prices are the same as in chapter 3.

A cycle can be viewed as an expansion, followed by a contraction. An expansion is defined as the phase from a trough to peak; and the contraction is the period from the peak to the trough. We employ two methodologies to identify financial and business cycles using selected 5 variables (real GDP, unemployment rate, credit, house prices and equity prices). The first methodology is 'turning-point analysis'. It identifies the peaks and troughs in the series and summaries their behavior between those phases. The second method is the frequency-based filter analysis.

We first compare the differences between the financial cycles and the business cycles according to our methodologies. Then we study the synchronization within a country and across countries using a concordance index and dynamic correlations. To assess the causality relationship between financial and business variables, we test the marginal predictive power of these variables by carrying out the Granger-causality test and reporting the corresponding p-values.

4.4 Methods

Turning-Point Analysis

A number of methodologies have been developed over the years to characterize business cycles. Burns and Mitchell (1946) first introduce the definition of a business cycle and the methodology for the analysis of business cycles in the United States. Their method uses changes in the levels of economic activity, while some other researchers examine the fluctuations in economic activity around trends (for example, Backus and Kehoe, 1992; Stock and Watson, 1999).

Financial and business cycles can be established using de-trended series or the first differences of the variables. The former method yields the cycle as a deviation from the trend value. It suffers from the problem that the addition of new data can affect the estimated trend as well as the estimated cycles. To avoid this problem, this chapter uses the logs of the variables. This method, which yields turning points, is robust to the inclusion of newly available data.

The algorithm in this chapter,[32] which is called BB, is adopted from Bry and Boschan (1971), and is extended by Harding and Pagan (2002). Claessens *et al* (2011) and Drehmann (2012) use it to identify financial cycles in several advanced countries.

Many earlier studies have been done on the recovery phase of the early part of the expansion period for business cycles (see Eckstein and Sinai (1986); Balke and Wynne (1995); and Mussa (2009)). However, few studies focus on the completed cycles.

We first examine the short-term cycles, and then the medium-term cycle. Specifically, a peak in a quarterly series y_t occurs at time t if:

$$\{[(y_t - y_{t-2}) > 0, (y_t - y_{t-1}) > 0] \; and \; [(y_{t+1} - y_t) < 0, (y_{t+2} - y_t) < 0]\} \quad (29)$$

A cyclical trough occurs at time t if:

$$[(y_t - y_{t-2}) < 0, (y_t - y_{t-1}) < 0] \; and \; [(y_{t+1} - y_t) > 0, (y_{t+2} - y_t) > 0]\} \quad (30)$$

Similarly, for medium-term cycle, if it is a peak (trough), it should be larger (less) than the four points before it and after it.

Frequency-Based Filter Analysis

The methodology of frequency-based filter, synchronization analysis and dynamic correlation is provided in Chapter 3.

Granger causality

The Granger-causality tests are preformed within a vector error-correction framework to examine if the financial variables help to predict the growth of economy or if the economic growth causes the development of financial market.

The discussion and methodologies are provided in Chapter 3.

4.5 Empirical Results

4.5.1 Business Cycles from Turning-Point Analysis

Chapter 3 characterizes the main features of financial cycles. It reports, first, that financial (cycles in the Asian countries are longer and severer than the business cycle in output in developed

[32] The details of this methodology can be found in the second chapter of this thesis.

countries, while not as long as their financial cycle. Second, the credit cycle displays a quite skewed shape with exceptionally longer and stronger expansions than contractions, and equity prices have the greatest volatility, as well as the shortest cycle duration and greatest amplitude. Third, financial cycle peaks are very closely followed by financial crises. Fourth, the cycle in financial variables tend to be highly synchronized within a country and across countries. Finally, the dynamic correlations show the co-movement of these financial variables in different frequencies and describe the details of the synchronization relationship.

This section investigates the core features of both financial cycles and business cycles by applying the turning-point and frequency-based filter methodologies, and discusses the relationship between them across different cyclical phases.

Basic features of business and financial cycles in each country

The empirical literature on developed economies indicates that the medium-term financial cycle is different from the business cycle, which normally has the length of 6 to 24 quarters, which is very much longer than of financial cycles. After applying the turning-point methodology, we compare the financial and business cycles in the Tables 4.1 to 4.11 for our sample of Asian countries.

Since opening up to foreign trade and implementing free market reforms in 1979, China has been among the world's fastest-growing economies, with the average real annual GDP growth of 10% from 1979 to 2013However, its economy has shown signs of slowing in recent years: real GDP grew by 7.7% in both 2012 and 2013.

Table 4.1 shows the financial and business cycles in credit, house prices, equity prices, real GDP and employment rate for China. From 1980-2013, the employment rate had 3.5 cycles with the average frequency of 9 years. On average, the duration of the business cycle is 10 years in China, which is much longer than the financial cycle. However, the duration of the cycle in employment rate is close to that of credit. In contrast, there is no difference between the short-term and medium-term cycles in real GDP. By comparison, the duration and amplitude of the contractions in employment rate is two times longer and stronger than of expansions, which is contrary to that of financial cycles.

Table 4.1 Characteristics of medium-term and short-term cycles: individual series in China by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	1.5	30.5	14.33	-1.72	24.5	6
House prices[5]	7.5	15.2	2.48	-1.96	10.5	4.7
Equity prices[6]	4.5	17.45	14.47	-10.49	8.25	9.2
Real GDP[7]	0.5	43	304.3	-	43	-
Employment[9]	3.5	36.5	21.61	-46.3	11.5	25
Unemployment[8]	3.5	36.5	46.3	-21.61	25	11.5
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	30.5	14.33	-1.72	24.5	6
House prices	2.5	37.3	5.06	-3.63	26.3	11
Equity prices	3.5	19.2	16.74	-10.53	9.7	9.5
Real GDP	-	-	-	-	-	-
Employment	3	37	22.36	-46.3	12	25
Unemployment	3	37	46.3	-22.36	25	12

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1973Q1-2013Q2; 8. Data is from 1980Q1-2013Q4. 9. Data converted from "unemployment".

As one of the world's leading international financial centers, Hong Kong's service-oriented economy is characterized by low taxation, near-free port trading and a well-established international financial market. Table 4.2 provides the summary statistics of business and financial cycles in Hong Kong. The business cycles in Hong Kong do not show noticeable differences between short and medium term cycles. Table 4.2 implies that the business cycle lasts for 5 years, while the financial cycle lasts between 5 and 9 years. We also find that the swings in the employment cycle are more outstanding than those in the real GDP cycle. On average, the changes of real GDP in expansion and contraction phases are only 2.79% and -0.89%, respectively, which is significantly less than those in financial cycles. However, for the employment rate, the changes of amplitude in expansion and contraction phases are 43% and -102% respectively.

Table 4.2 Characteristics of medium-term and short-term cycles: individual series in Hong Kong by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction

Credit[4]	4.5	26.25	8.13	-0.9	20	6.25
House prices[5]	6.5	20.17	9.19	-6.31	11	9.17
Equity prices[6]	11	13.63	22.77	-21.84	6.27	7.36
Real GDP (Oxford)[7]	5.5	21.13	2.79	-0.89	16.33	4.8
Employment (Oxford)	7	18.14	43.63	-102.75	11.14	7
Unemployment (Ox)[8]	7	18.14	102.75	-43.63	7	11.14
Medium-term cycle	Number	Duration	Expansion	Contraction	Expansion	Contraction
Credit	2.5	43.67	10.89	-1.1	37.67	6
House price	3.5	36	15.61	-11.12	21.67	14.33
Equity price	8	17.01	24.09	-24.21	8.13	8.88
Real GDP (Oxford)	3	31.66	3.99	-1.03	26.33	5.33
Employment (Oxford)	6	19.84	49.0	-118.31	12.67	7.17
Unemployment (Ox)	6	19.84	118.31	-49.0	7.17	12.67

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1980Q1-2013Q4.

Taiwan developed from cheap, labor-intensive manufactures into that of heavy industry and infrastructure in the 1970s, and then to advanced electronics. After the 1980s, the Taiwanese economy began to stabilize and became one of the "Four Asian Tigers". The 1997 Asian financial crisis did not affect Taiwan much. From 1981-1995, the Taiwanese economy grew at an annual rate of 7.52%. By 1995, the service sector became the largest one at 51.67% of GDP. Taiwan has recovered quickly from the global financial crisis of 2007-2010 and its economy has been growing steadily.

Table 4.3 shows the comparison between business and financial cycles[33] in Taiwan. The average cycle length of real GDP in Taiwan is 10 years, much longer than that of financial cycles. However, the cycle duration in employment rate is only 4 years, which is very close to that of financial cycles. The change of amplitude of real GDP in the expansion phase is only 4.36 percent and in the contraction phase is -0.91 percent. The change of amplitude of the employment rate in the expansion phase is 30.85 percent, which is 7 times larger than that of real GDP. The intensities of the change of real GDP cycles in the expansion and contraction phases are similar to those in

[33] Since we have emphasized the importance of the medium-term cycle in financial variable and the short-term cycle in business cycle, the financial and business cycle we mention in this section are the medium-term cycle and the short-term cycle, respectively.

house prices. As a result, the business cycle in employment rate displays the greatest variety in amplitude.

Table 4.3 Characteristics of medium-term and short-term cycles: individual series in Taiwan by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	9	13.78	19.99	-13.88	7.56	6.22
House price[5]	7	18	4.02	-3.29	10.71	7.29
Equity price[6]	9.5	16.17	11.81	-7.30	9.67	6.5
Real GDP (Oxford)[7]	2.5	38.67	4.36	-0.91	33.67	5
Employment (Ox)	7.5	16.84	30.85	-87.42	9.13	7.71
Unemployment (Ox)[8]	7.5	16.84	87.42	-30.85	7.71	9.13
Medium-term cycle	Number	Duration	Expansion	Contraction	Expansion	Contraction
Credit	3	39	50.03	-24.73	16.33	22.67
House price	6	20.17	4.54	-3.63	11.67	8.5
Equity price	7	21.14	14.17	-8.78	12.28	8.86
Real GDP (Oxford)	1.5	25.5	2.45	-0.77	18	7.5
Employment (Ox)	4.5	25.55	35.89	-114.28	14.75	10.8
Unemployment (Ox)	4.5	25.55	114.28	-35.89	10.8	14.75

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1980Q1-2013Q4.

Japan was into the world's second largest economy from 1978 to 2010, when it was supplanted by China. In the second half of the 1980s, rising stock and real estate prices caused the Japanese asset price bubble. With the collapse of that bubble, growth in Japan throughout the 1990s was only 1.5%, leading to 'Japan's Lost Decade'. Currently, the economy of Japan is the third largest, after USA and China, in the world.

Table 4.4 provides the information on business and financial cycles in Japan for the different time periods specified in in the footnotes. The business cycle in real GDP after 1980 becomes more frequent, and has smaller amplitudes than the employment rate: it has only 0.51% changes in expansion phase and -0.32% changes in contraction phase; while for the employment rate, the cycle length is 25 quarters, the amplitude in expansion phase is 18%, and in the contraction

phase is 40%. Compared with the financial cycle, the duration of the cycle in real GDP is the shortest.

Table 4.4 Characteristics of medium-term and short-term cycles: individual series in Japan by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	6	25.5	1.52	-0.52	17	8.5
House price[5]	3	58	18.93	-10.41	32	26
Equity price[6]	13	17.77	7.01	-5.08	10.08	7.69
Real GDP (Oxford)[7]	5	13.36	0.51	-0.32	9.16	4.2
Real GDP (IFS)[8]	5.5	37.43	18.86	-1.78	32.83	4.6
Real GDP (OECD)[9]	5.5	26.13	0.94	-0.05	21.33	4.8
Employment (Ox)	5	24	17.87	-43.43	9.8	14.2
Employment (IFS)	3.5	18.75	18.4	-40.26	10.75	8
Employment (OECD)	12.5	18	19.0	-35.87	8	10
Unemployment (Ox)[10]	5	24	43.43	-17.87	14.2	9.8
Unemployment (IFS)[11]	3.5	18.75	40.26	-18.4	8	10.75
Unemployment (OECD)[12]	12.5	18	35.87	-19.0	10	8
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	4.5	34.65	2.23	-0.61	23.25	11.4
House price	3	58	18.93	-10.41	32	26
Equity price	7	27.85	10.06	-7.21	16.14	11.71
Real GDP (Oxford)	2	35.5	0.97	-0.36	25	10.5
Real GDP (IFS)	2	74.5	13.98	-0.97	64	10.5
Real GDP (OECD)	2	74.5	2.49	-0.22	64	10.5
Employment (Ox)	2.5	37.83	31.15	-74.95	16.5	21.33
Employment (IFS)	1.5	36	32.93	-58.85	21	15
Employment (OECD)	7	30.57	29.34	-65.35	12	18.57
Unemployment (Ox)	2.5	37.83	74.95	-31.15	21.33	16.5
Unemployment (IFS)	1.5	36	58.85	-32.93	15	21
Unemployment (OECD)	7	30.57	65.35	-29.34	18.57	12

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1955Q1-2013Q2; 9. Data is from 1960Q1-2013Q4; 10. Data is from 1980Q1-2013Q4; 11. Data is from 1955Q1-2013Q4. 12. Data is from 1955Q1-2013Q4.

South Korea is now one of the world's wealthier nations, and is a member of the Organization for Economic Co-operation and Development (OECD) and the G-20 major economies. It has been among the fastest growing developed countries in the 2000s. In the 1997 Asian financial crisis, the Korean economy suffered a severe liquidity crisis and needed a bailout by the IMF. It was also one of the few more developed countries that was able to avoid a recession during the 2008 global financial crisis, though it growth rate fell considerably. Its growth rate was only 2.3% in 2008 and 0.2% in 2009, but reached 6.1% in 2010.

From Table 4.5, we find that the average cycle length of real GDP in South Korea is 7 years, which is similar to the ones of house and equity prices. However, the oscillation in real GDP with the 2.45% changes in expansion phase and -0.69% changes in contraction phase is very small comparing with the credit and equity prices, but not different from house prices. For employment, the cycle length is 6 years and the amplitude in expansion phase is 17 percent and contraction is -43 percent.

Table 4.5 Characteristics of medium-term and short-term cycles: individual series in Korea by Turning-point analysis

	Cycles[1]		Amplitude (In percent)		Duration (Number of quarters)	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	4	49.25	15.41	-1.08	43.5	5.75
House price[5]	6	20.5	2.73	-3.12	8.17	12.33
Equity price[6]	7.5	18.18	12.01	-9.69	10.75	7.43
Real GDP (bank)[9]	5.5	28.67	5.5	-0.91	23.67	5
Employment (OECD)	5	24	17.86	-43.43	9.8	14.2
Unemployment (OECD)[12]	5	24	43.43	-17.86	14.2	9.8
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	85	32.52	-1.20	72	13
House price	4	28.75	3.77	-4.34	10	18.75
Equity price	5	26.2	18.13	-13.11	13.6	12.6
Real GDP (bank)	1.5	85	32.52	-1.20	72	13
Employment (OECD)	4	28.75	3.77	-4.34	10	18.75
Unemployment (OECD)	5	26.2	18.13	-13.11	13.6	12.6

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1970Q1-2013Q2; 9. Data is from 1970Q1-2013Q2; 10. Data is from 1982Q2-2013Q4; 11. Data is from 1993Q1-2013Q2; 12. Data is from 1980Q1-2013Q4.

Malaysia, Indonesia and Thailand are newly industrialized economies. During our sample period, Indonesia has been viewed as one of Southeast Asia's best performing economies after the Asian tigers (Hong Kong, Singapore, South Korea, and Taiwan), followed by Thailand and Malaysia in Southeast Asia. Since the 1980s, the industrial sector has boosted Malaysia's economic growth. Malaysia consistently achieved more than 7% GDP growth and low inflation in the 1980s and 1990s. Malaysia was affected by the financial crisis in 1997, with its GDP suffering a sharp 7.5% contraction in 1998 and 5.6% in 1999. Although Indonesia's economy grew with impressive speed during the 1980s and 1990s, it suffered considerably from the financial crisis of 1997; after 1999, the economy recovered with growth over 4% - 6% in recent years. From 1980 to 1984, the Indonesian economy grew an average of 5.4 percent per year, with the average growth rate per year rising to 8.8 percent from 1985 to 1996 and slumping by -5.9 percent from 1997 to 1998. The Thai economy collapsed as a result of the 1997 Asian financial crisis. It took Thailand as long as 10 years to regain its 1996 GDP. From 2007 to 2012, its average GDP growth rate was 3.25 percent per year.

Tables 4.6 to 4.8 provide the data on business and financial cycles in Malaysia, Indonesia and Thailand. The cycle duration of real GDP in Malaysia is 7 years, which is close to that of house and equity prices. The amplitude of real GDP is 4.07 percent in the expansion phase and -0.45 percent in the contraction phase. While the length of the employment cycle is 4 years, the amplitude in expansions, on average, is 31 percent, and in contractions is -35 percent. From Table 4.7, the cycle length of real GDP in Indonesia is 10 years, while that of the employment rate is 4 years. The frequency of the cycle in real GDP is similar to that of credit, yet the frequency of the cycle in the employment rate is close to that of equity prices. For the cycle amplitude, the change of real GDP in the expansion phase is 5.5% and that in the contraction phase is -1.07%. The amplitude of the cycle in the employment rate is close to that of the financial cycles in the expansion phase, while in the contraction phase, the amplitude is -10.22 percent. For Thailand, Table 4.8 shows that the duration of the real GDP cycle is about 8 years, with the amplitude of expansion being 9.03% and that of contraction being -2%. For the employment rate, the cycle length is 4 years, close to that of house prices. The amplitudes of the employment rate in expansion and contraction phases are quite high with 62.62 percent and -31 percent respectively.

Table 4.6 Characteristics of medium-term and short-term cycles: individual series in Malaysia by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	3	51.33	85.09	-1.65	46.33	5
House price[5]	9	14	1.38	-0.65	8.67	5.33
Equity price[6]	9	13.33	8.7	-7.36	7.44	5.89
Real GDP (Oxford)[7]	4	28.25	4.07	-0.45	23.25	5
Employment (Ox)	6.5	15.69	31.4	-34.92	9.86	5.83
Unemployment (Ox)[9]	6.5	15.69	34.92	-31.4	5.83	9.86
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1	52	32.17	-1.53	43	9
House price	4.5	22.4	1.16	-0.65	14.4	8
Equity price	5.5	22.27	11.80	-8.10	12.6	9.67
Real GDP (Oxford)	1.5	49	7.22	-1.14	44	5
Employment (Ox)	2.5	37.33	44.19	-64.65	29.33	8
Unemployment (Ox)	2.5	37.33	64.65	-44.19	8	29.33

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1988Q1-2013Q2; 9. Data is from 1985Q1-2013Q4; 10. Data is from 1998Q1-2013Q2.

Table 4.7 Characteristics of medium-term and short-term cycles: individual series in Indonesia by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	4.5	23.1	6.55	-2.83	18.6	4.5
House price[5]	5.5	22	0.32	-1.52	10	12
Equity price[6]	5.5	18.2	17.1	-12.39	11	7.2
Real GDP (Oxford)[7]	2.5	44.17	5.5	-1.07	38.67	5.5
Employment (Ox)	6	21.67	13.93	-10.22	9.17	12.5
Unemployment (Ox)[9]	6	21.67	102.22	-13.93	12.5	9.17
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	54.5	14.87	-9.24	47.5	7
House price	3.5	32	0.4	-2.06	10	22
Equity price	4	25	18.66	-9.91	17	8
Real GDP (Oxford)	0.5	-	-	-1.73	-	5
Employment (Ox)	3	31.34	31.79	-14.14	11.67	19.67
Unemployment (Ox)	3	31.34	141.14	-31.79	19.67	11.67

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of

the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1997Q1-2013Q1; 9. Data is from 1985Q1-2013Q4.

Table 4.8 Characteristics of medium-term and short-term cycles: individual series in Thailand by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	3	49.67	20.80	-2.37	41.67	8
House price[5]	9.5	12.73	2.78	-2.88	6.4	6.33
Equity price[6]	7.5	18.54	14.70	-11.79	10.25	8.29
Real GDP (Oxford)[7]	3.5	33.75	9.03	-2	27.75	5
Employment (Ox)	7.5	15.88	62.62	-31.03	11	5.88
Unemployment (Ox)[9]	7.5	15.88	313.03	-62.62	5.88	11
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	1.5	80.5	40.13	-3.52	70	10.5
House price	6.5	17.86	2.46	-2.84	10	7.86
Equity price	3	43.67	26.52	-19.47	26	17.67
Real GDP (Oxford)	1.5	44	8.35	-2.18	38	6
Employment (Ox)	6	21	70.36	-41.99	13.33	7.67
Unemployment (Ox)	6	21	411.99	-70.36	7.67	13.33

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1993Q1-2013Q1; 9. Data is from 1980Q1-2013Q4; 10. Data is from 2001Q1-2013Q2.

The economic development of India depended heavily on its socialist-inspired policies for most of the period since its independence in 1947. Since the mid-1980s, India has slowly opened up its markets through economic liberalization. After more fundamental reforms starting in 1991, India has progressed towards a freer market economy. In the late 2000s, India's growth reached 7.5%, and 10% in 2011. India is now the tenth-largest economy in the world and the third largest in terms of purchasing power parity (PPP). Its economic growth has been driven by the expansion of services, which have been growing faster than other sectors.

For India, Table 4.9 identifies 1.5 cycles in real GDP and 6 cycles in the employment rate from 1980 Q1 to 2013 Q4 and concludes that the frequency of the real GDP cycle is 16.5 years and that of the employment cycle is 5 years. The cycle length of the real GDP is extremely long,

probably due to the fast growth of economy during the recent decades. Compared with financial cycles, the cycle in real GDP is 3 times longer than that in credit and 4 times longer than that in equity prices. Looking at amplitude, the expansion of real GDP is 13.88 percent, which is close to that of equity prices, while the contraction is as small as -0.4 percent.

Table 4.9 Characteristics of medium-term and short-term cycles: individual series in India by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	11	21.72	6.36	-1.01	17.27	4.45
House price[5]						
Equity price[6]	6	15.83	13.93	-7.75	8.83	7
Real GDP (Oxford)[7]	1.5	66.5	13.88	-0.4	63.5	3
Employment (Ox)	6	19.33	10.01	-12.25	14.33	5
Unemployment (Ox)[9]	6	19.33	12.25	-10.01	5	14.33
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	6	30.84	8.06	-1.31	24.17	6.67
House price						
Equity price	5	19	16.93	-9.26	11.4	7.6
Real GDP (Oxford)	-	-	-	-	-	-
Employment (Ox)	3	24	12.89	-20.51	13.67	10.33
Unemployment (Ox)	3	24	20.51	-12.89	10.33	13.67

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1996Q4-2013Q1; 9. Data is from 1980Q1-2013Q4.

Singapore is a highly developed, trade-oriented market economy and has the third highest per capita GDP in the world. Singapore's economy had the real growth averaging 8.0% from 1960 to 1999. During the 2007 crisis, it decreased to 5.4% and recovered to 9.9% in 2000. Affected by the worldwide electronics slump, its growth rate fell to -2.0% in 2001. In the second quarter of 2013, Singapore's unemployment rate was around 1.9% and the country's economy had a growth rate of only 1.8%.

For Singapore, Table 4.10 points out that the real GDP cycle had a length of 9.5 years, which is slightly longer than that of credit. The swings in real GDP are somewhat similar to those

of credit, with the expansion being 6.5% and contraction being -0.68%. However, the frequency of the cycle in the employment rate is longer than that in real GDP (3 years). And the oscillation of employment over the cycle is greater than that of real GDP and other financial variables.

The economy of the Philippines is the 40th largest in the world, according to 2013 International Monetary Fund statistics. It is considered to be a newly industrialized country, which has been transitioning from an agriculture-based economy to services and manufacturing. In the years 2012 and 2013, Philippines showed high real GDP growth rates: 6.8% and 7.2% respectively.

For the Philippines, Table 4.11 shows, first, that the frequency of real GDP is 6 years, which is the same as that of equity prices, and the frequency of the employment rate is 3 years. On average, the business cycle is more frequent than the financial cycle. Second, the oscillation of real GDP is very small, with an increase in the expansion phase of 6.5% and a decrease in the contraction phase of -0.68%. However, the swing in employment (35% increase in expansion and 57% decrease in contraction) is the highest among the variables.

Table 4.10 Characteristics of medium-term and short-term cycles: individual series in Singapore by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	3.5	36.08	7.53	-0.40	31.75	4.33
House price[5]	6.5	22.53	16.84	-5.97	14.67	7.86
Equity price[6]	6.5	15	7.53	-6.59	7	8
Real GDP (Oxford)[7]	3	38	6.5	-0.68	34	4
Employment (Ox)	10	12.6	34.85	-57.04	6.5	6.1
Unemployment (Ox)[9]	10	12.6	57.04	-34.85	6.1	6.5
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	3.5	31.25	7.10	-0.51	26.25	5
House price	5	27.8	19.57	-7.58	18.2	9.6
Equity price	4	20.75	10.91	-8.71	8.75	12
Real GDP (Oxford)	2	46.5	8.07	-0.36	39	7.5
Employment (Ox)	5	24.4	54.68	-96.01	15.4	9
Unemployment (Ox)	5	24.4	96.01	-54.68	9	9

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1984Q3-2012Q4; 9. Data is from 1980Q1-2013Q4; 10. Data is from 1992Q1-2013Q1; 11. Data is from 1986Q1-2013Q4.

Table 4.11 Characteristics of medium-term and short-term cycles: individual series in Philippines by Turning-point analysis

	Cycles[1]		**Amplitude[2] (In percent)**		**Duration (Number of quarters)**	
Short-term cycle	Number	Duration[3]	Expansion	Contraction	Expansion	Contraction
Credit[4]	7	27.57	11.59	-3.26	20.86	6.71
House price[5]						
Equity price[6]	6	16	10.39	-9.33	8.83	7.17
Real GDP (Oxford)[7]	4.5	24.5	2.64	-1.38	19	5.5
Employment (Ox)	10	12.9	28.63	-42.52	6.7	6.2
Unemployment (Ox)[9]	10	12.9	42.52	-28.63	6.2	6.7
Medium-term cycle	Number	Duration3	Expansion	Contraction	Expansion	Contraction
Credit	5	38.6	16.35	-4.38	30.6	8
House price						
Equity price	3.5	24.5	12.76	-10.70	12	12.5
Real GDP (Oxford)	1.5	38	3.1	-2.29	27	11
Employment (Ox)	5	22.4	38.51	-59.88	10.6	11.8
Unemployment (Ox)	5	22.4	59.88	-38.51	11.8	10.6

1. Cycle number here, 0.5 means half a cycle (from peak to trough or trough to peak); 2. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 3. The duration of the full cycle is the summary duration of expansion and contraction. 4. Data is from 1978Q1-2013Q4; 5. Data is from 1980Q1 to 2010Q4. 6. Data is from 1992Q2 to 2013Q2; 7. Data is from 1980Q1-2013Q4; 8. Data is from 1981Q1-2012Q4; 9. Data is from 1980Q1-2013Q4; 10. Data is from 1992Q1-2013Q2; 11. Data is from 1986Q1-2013Q4.

The overall characteristics of business and financial cycles in Asia

Frequency of business cycles

Using the turning-point methodology, from 1980 Q1 to 2013 Q4, we identify 38 cycles in real GDP, 74 cycles in employment rate, 31 cycles in credit, 38 cycles in house prices and 55 cycles in equity prices. The employment rate has the highest frequency, followed by equity prices. Real GDP and house prices have almost the same frequency, and credit has the lowest frequency.

Duration of business cycles

We next analyze the main features of business cycles in terms of duration and amplitude. In advanced countries, the financial cycles tend to be longer and with larger amplitude than the business cycle. However, this finding differs from the results in our sample of Asian countries. First, the cycles in real GDP and employment are quite different: the duration of the cycles in real GDP is 8 years, which is larger than that in equity prices but smaller than that in credit, while the

duration of the employment rate is only 5 years, which is the shortest among all the variables. Second, it is noticeable that, in the real GDP cycle, recessions are much shorter than contractions in the financial cycle. For real GDP, a recession lasts on average about 4.7 quarters while the recovery lasts about 28 quarters. We notice that both credit and real GDP have uneven lengths of expansions and contractions. Therefore, both credit and real GDP display skewed shapes.

Amplitude of business cycles

Across our sample of countries, financial cycles are more significant than business cycles, especially the real GDP cycle. On average, the amplitude in both expansion and contraction phases in financial cycles is about 3 to 4 times larger than that of the cycle in output. The typical decline in output from peak to trough (the recession's amplitude) is about 0.9%, and the typical cumulative output over 1960-2013 is about 5.48%. The slope of a recession -- that is, the ratio of its amplitude to duration -- is about -0.19, and the slope of a recovery is typically about 0.19, so they have the same variance, but with opposite directions. In contrast, for all the variables except for employment rate, the average amplitude of expansion is larger than that of contraction: for the employment rate, the average amplitude of contractions is about 4 times stronger than that of expansions.

Table 4.12 Characteristics of short-term and medium-term cycles: individual series in all Asian Countries[1] by Turning-point Analysis

	Cycles[2]		**Amplitude[3] (In percent)**		**Duration[4] (Number of quarters)**		**Slope[5] (Speed of cycle)**	
Variables	Number	Duration[5]	Expansion	Contraction	Expansion	Contraction	Expansion	Contraction
Credit[6]	31.5	47.32	20.79	-4.53	37.75	9.57	0.55	-0.47
House prices	38.5	31.14	7.94	-5.14	17.14	14.00	0.46	-0.37
Equity prices	55.5	24.24	16.43	-11.82	13.42	10.82	1.22	-1.09
Real GDP[7]	38	33.70	5.48	-0.90	28.90	4.70	0.19	-0.19
Employment	74	19.78	28.48	-80.48	9.90	9.97	2.88	-8.08
Unemployment	74	19.78	80.48	-28.48	9.97	9.90	8.08	-2.88

1. Results are based on the mean of the distribution in all these Asian countries; 2. Cycle number is the total number of cycles in the three variables, and 0.5 means half a cycle (from peak to trough or trough to peak); 3. Percentage change of expansion is from trough to peak, while percentage of contraction is from peak to trough; 4. The duration of the full cycle is the summary duration of expansion and contraction; 5. The slope of expansion is the amplitude from trough to peak divided by the duration;

the slope of contraction is the amplitude from peak to trough divided by the duration; 6. The features of credit, house and equity prices are all from medium-term cycles, while GDP and employment are from short-term cycles; 7. Excepting China.

4.5.2 Business Cycles identified by Frequency-Based Filter

Historically, the study of the business cycles has focused on the behavior of macroeconomic data with cycles lasting between one and eight years. In our study, we want to estimate the different types of cyclical patterns with different periodicities. This approach is inspired by the work of Comin and Gertler (2006), who study the behavior of medium-term macroeconomic cycles for the US economy. Similarly, we employ a band-bass filter to isolate the different frequencies of cycles. Since the filter is to isolate the cycles with the specific frequency range, the results show the components with different frequencies. In order to determine the components that identify the cyclical behaviors, we create an index as the ratio of standard deviations (volatility) to the frequency ranges (standard deviation per quarter).[34]

We have shown the results on financial cycles in Chapter 3: on average for our set of countries, the cyclical components of financial variables are between 6 to 12 years and credit has the longest duration, followed by house prices and equity prices. Compared with the advanced financial markets, whose cycles of periodicities were estimated by Drehmann (2012) as being between 8 and 30 years, the cyclical duration in our sample of Asian countries is much shorter.

This section applies the same methodology to real GDP and employment, and compares the results on business cycles with those on financial cycles.

Hong Kong

In this section, we take Hong Kong as an illustration to demonstrate how the frequency-based filter analyzes the business cycles in each country. We then summarize the results across our sample of countries. Frequency-based filter analysis allows separation of the components on the basis of frequencies and shows the results visually and quantitatively. Figures 4.1 and 4.2 show the cyclical shape of real GDP and unemployment rate for Hong Kong on the basis of frequency-band filters. We calculate the standard deviation and the index (ratio of the standard deviation to

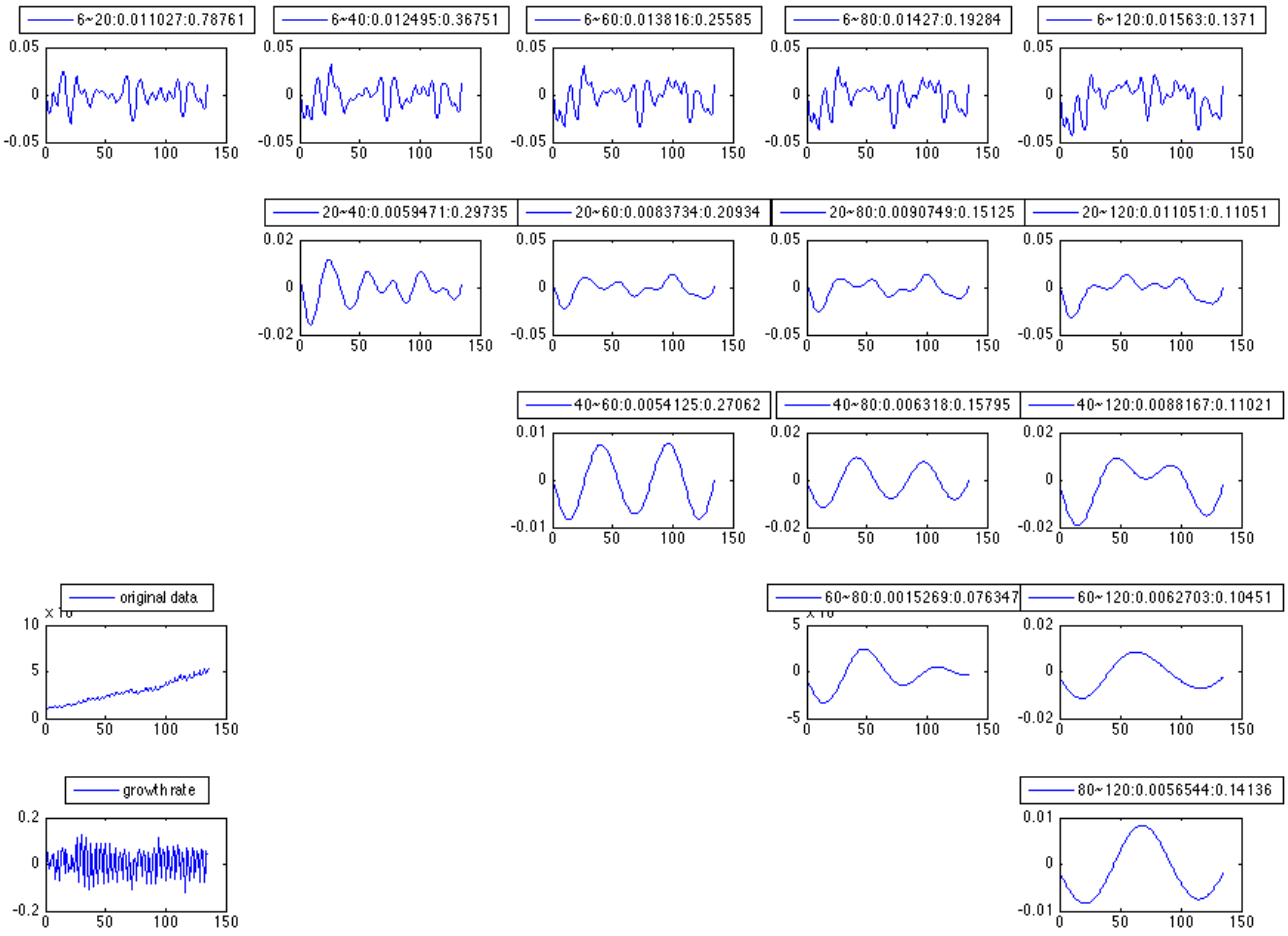
[34] See the details in Chapter 3.

the range length). A higher ratio means that the component is more volatile, i.e., with greater amplitude per quarter than the other components in the series.

The relatively higher indices in each subfigure in Figure 4.1 and 4.2 indicate the relatively important cyclical components in the real GDP and unemployment series. In Figure 4.1, as shown in the first row, although the indices of the subfigures are very high, they represent irregular components. So we focus on another subfigure (with an index of 0.297), which is the highest among all the components except for the irregular ones. As a result, this strong component with the range from 20 to 40 quarters is the most volatile and its amplitude is greater than others; in other words, it is more important than other components in shaping the cyclical behaviors of the business cycles in Hong Kong. Similarly, Figure 4.2 plots the cyclical components of unemployment rate. Comparing the indices when excluding the high frequency and irregular components, we conclude that the one ranging from 20 to 40 best represents the cyclical shape of unemployment rate in Hong Kong. All the results are confirmed by the turning-point methodology.

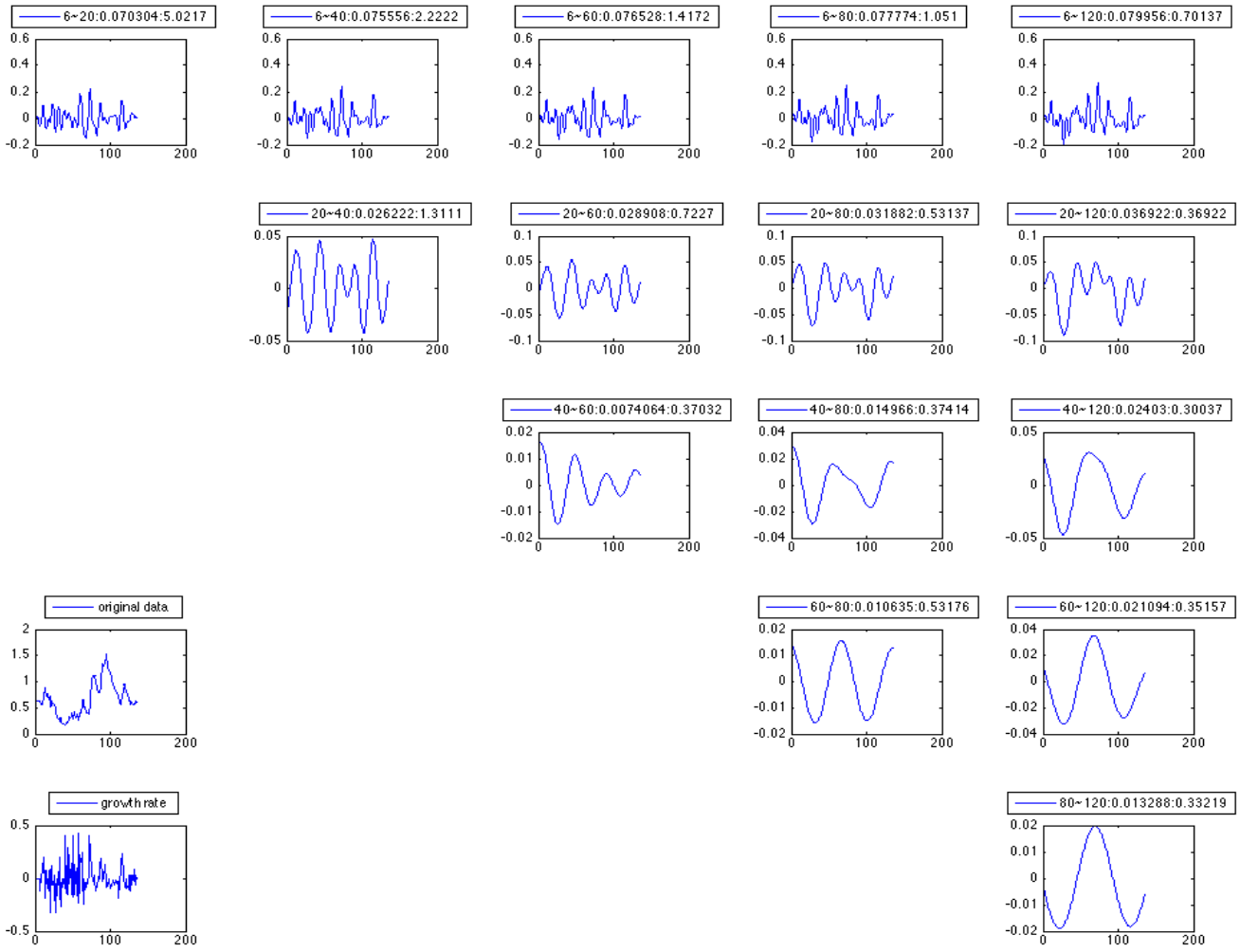
In order to narrow down the frequency range, Tables 4.13 and 4.14 show the different components ranging from 4 to 112 with the interval of 12 quarters for real GDP and unemployment in Hong Kong. After calculating the indices, in both of Tables 4.13 and 4.14, the component with the range from 16 to 28 quarters has the highest index value and is the most significant cyclical component. Continuing scaling down the range (the interval is only 4 quarters), Figures 4.3 and 4.4 illustrate the indices of the different components in three dimensions.

Fig. 4.1 Cyclical Components of real GDP of Hong Kong



Note: The two sub-graphs in the lower left quarter are original trend and growth rate. The header on the top of the each sub-graph indicates the frequency range and the cycle index (the ratio of standard deviations (volatility) to the frequency range).

Fig. 4.2 Cyclical Components of unemployment of Hong Kong



Note: The two sub-graphs in the lower left quarter are original trend and growth rate. The header on the top of the each sub-graph indicates the frequency range and the cycle index (the ratio of standard deviations (volatility) to the frequency range).

Table 4.13 The Cyclical Index of Different Bands of Components of real GDP of Hong Kong

Rang	16 Q	28	40	52	64	76	88	100	112
4 Q	3.1731	1.6084	1.0825	0.8134	0.6602	0.5506	0.4711	0.4141	0.3704
16	NA	0.4276	0.2994	0.2089	0.2084	0.1685	0.1362	0.1249	0.1185
28	NA	NA	0.4006	0.2243	0.2335	0.1777	0.1375	0.1257	0.1193
40	NA	NA	NA	0.1606	0.2651	0.1812	0.1315	0.1216	0.1164
52	NA	NA	NA	NA	0.3800	0.1981	0.1273	0.1204	0.1167
64	NA	NA	NA	NA	NA	0.0710	0.1084	0.1278	0.1243
76	NA	NA	NA	NA	NA	NA	0.1810	0.1782	0.1579
88	NA	NA	NA	NA	NA	NA	NA	0.1842	0.1551
100	NA	NA	NA	NA	NA	NA	NA	NA	0.1293

Note: The first column is the beginning of range with the unit of quarters, and the first row is the end of range. For instance, the second column and second row is 3.173 that is cyclical index (the ratio of standard deviation to the range) of the component with the frequency from 4 to 16 quarters.

Table 4.14 The Cyclical Index of Different Bands of Components of unemployment of HK

Rang	16 Q	28	40	52	64	76	88	100	112
4 Q	6.0536	3.2912	2.2561	1.7081	1.3707	1.1522	0.9973	0.8797	0.7870
16	NA	2.3599	1.4176	0.9978	0.7619	0.6368	0.5550	0.4926	0.4424
28	NA	NA	1.4623	0.8780	0.6160	0.5186	0.4595	0.4109	0.3699
40	NA	NA	NA	0.5823	0.3492	0.3711	0.3687	0.3459	0.3185
52	NA	NA	NA	NA	0.4236	0.4640	0.4357	0.3934	0.3534
64	NA	NA	NA	NA	NA	0.5620	0.4972	0.4357	0.3840
76	NA	NA	NA	NA	NA	NA	0.4718	0.4179	0.3698
88	NA	NA	NA	NA	NA	NA	NA	0.3828	0.3385
100	NA	NA	NA	NA	NA	NA	NA	NA	0.2998

Note: The first column is the beginning of range with the unit of quarters, and the first row is the end of range. For instance, the second column and second row is 6.0536 that is cyclical index (the ratio of standard deviation to the range) of the component with the frequency from 4 to 16 quarters.

Figure 4.3: The Strength of Cyclical Component of real GDP

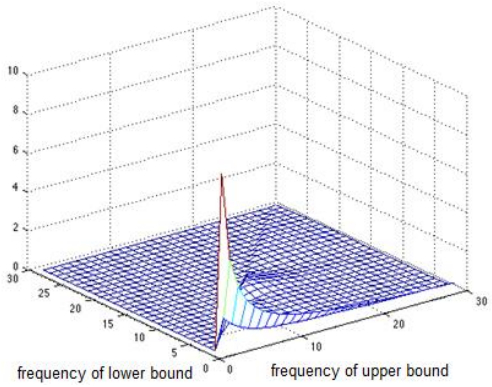
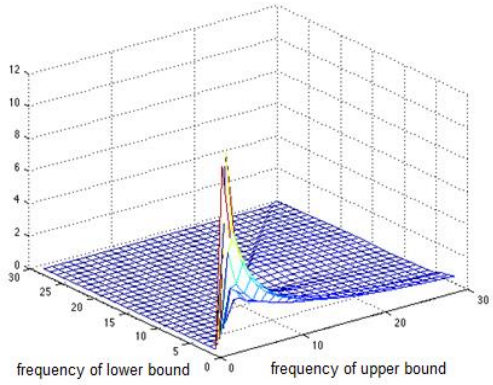


Figure 4.4: The Strength of Cyclical Component of Unemployment



Note: Figure 4.3 and 4.4 illustrates the different frequency ranges from 0 to 30 quarters in a 3 dimensional graph. X-axis and Y-axis indicate the frequency lower bound and upper bound respectively, and Z-axis indicates the strength of the cycle component.

Frequency-based filter across countries

After applying the frequency-based filter to each country, we summarize the cyclical components of real GDP and unemployment rates in Table 4.15. This table shows the outstanding and completed cyclical patterns (in the form of cycle duration) and the extent of volatility. From the second column, the real GDP cycle is between 5 to 10 years for most of the Asian countries: Japan has the shortest cycle length of 3 to 7.5 years and China and India have the longest duration of 10-15 years. The developed economies tends to show a business cycle of 1.5 to 8 years, by comparison, in the emerging economies, with the average cycles in output is 5 to 10 years, except for China and India, the cycle duration is as long as 10 to 15 years. The long duration of the business cycles in our developing countries may be caused by high economic growth with promotion and intervention from government.

The second column of Table 4.15 shows the cycle lengths of unemployment rates. The average cyclical duration of unemployment is much shorter than that of real GDP. The cyclical duration of unemployment for China and Hong Kong is the same as that for real GDP (5 to 10 years), followed by Japan (5 to 7.5 year). However, other countries have shorter cycle durations. For example, the durations of Thailand and Malaysia are only 3 to 7 years.

Chapter 3 shows that by average the credit cycle has duration of 6 to 12 years, while house and equity prices have shorter cyclical durations than credit. The duration of business cycles in our sample of countries is only slightly shorter than that of financial cycles.

Table 4.15 The Business Cycle Term in Each Country

Country	Range of real GDP (Year)	Range of unemployment (Year)
China	10-15 (0.799)	5-10 (0.556)
Japan	3-7.5 (0.125)	5-7.5 (0.781)
Hong Kong	5-10 (0.297)	5-10 (1.311)
Taiwan	5-10 (0.133)	3-5 (3.042)
India	10-15 (0.382)	4-7 (0.263)
Korea	5-10 (0.180)	5-7.5 (0.781)
Malaysia	5-10 (0.176)	3.5-7.5 (0.909)
Thailand	5-10 (0.308)	3-6 (8.381)
Singapore	7.5-10 (0.202)	2.5-6 (4.163)
Indonesia	5-10 (0.505)	4-7 (3.852)
Philippines	5-10 (0.395)	2.5-4 (2.316)

Note: The figures refer to the range of the strong cyclical component in each variable series. The number in brackets indicates the ratio index (standard deviation per quarter).

4.5.3 Synchronization

Globalization has tied the economies of countries more closely together in various ways, and the presumption would be that financial linkages contribute to the synchronization of business cycles. However, theoretical models do not have a clear prediction regarding the relationship between the financial cycles and business cycles.

Assessing output synchronization among countries is important for a number of reasons. First, more synchronized business cycles would imply a faster transmission of shocks across countries and imply the need for greater international policy coordination. Second, if the business cycles in a country are mostly influenced by external factors, the impact of domestic policies will be lessened. Tables 4.16-4.18 investigate the synchronization of business cycle across countries.

Synchronization within a country

Table 4.16 demonstrates the degree of synchronization between business and financial cycles using the concordance index. We first compute the concordance between business and financial cycles for each country, and then calculate summary statistics – mean and medium, in the last two rows. On average, cycles in real GDP and credit appear to be the most synchronized, with a median synchronization of 0.728 and mean of 0.625. That is, cycles in output and credit are typically in the same phase in about 70 percent of the time. The concordance statistics of real GDP and house prices is 0.563, and is slightly lower than that of real GDP and equity prices (0.567). This may imply that the substantial impact of external financial markets, such as capital flows on equity prices, in turn influence the real sectors. In contrast, the synchronization between employment and financial cycles is not as high as that for output and financial variables: the synchronization between output and employment is about 0.5.

We also find that the more developed economies of Japan, Korea, Indonesia and Singapore, display higher degrees of synchronization between business and financial cycles than the other emerging economies do. This may reflect that the greater maturity of the financial markets causes the fluctuations in credit and house prices more than the real sectors of the economy. By comparison, less developed countries usually do not possess house finance markets.

Table 4.16 Synchronization of Business and Financial Cycles within a Country

Country	G & EM	G & C	G & H	G & EQ	EM & C	EM & H	EM & EQ
China	-	-	-	-	0.504	**0.593**	**0.686**
Hong Kong	0.333	**0.735**	0.420	0.481	0.402	**0.687**	**0.647**
Taiwan	**0.565**	0.541	0.481	0.474	0.339	0.477	0.416
Japan	**0.556**	**0.765**	**0.754**	**0.571**	0.417	0.523	0.481
Korea	**0.52**	**0.818**	0.541	**0.594**	**0.557**	**0.634**	0.398
Malaysia	0.452	**0.636**	0.511	**0.617**	0.446	0.532	**0.558**
Thailand	0.363	0.189	0.465	**0.602**	**0.674**	0.496	**0.556**
Indonesia	**0.556**	**0.720**	**0.672**	**0.636**	**0.636**	0.545	0.496
India	**0.630**	**0.78**	-	0.491	**0.591**	-	0.377
Singapore	0.481	0.331	**0.659**	**0.822**	**0.556**	0.477	**0.667**
Philippines	**0.541**	**0.739**	-	0.382	0.468	-	0.482
Median	0.531	0.728	0.526	0.583	0.504	0.532	0.496
Mean	0.500	0.625	0.563	0.567	0.508	0.552	0.524

Note: The data on house prices for India and Philippines are not available. Since there is not a complete GDP cycle in China, the synchronizations with GDP are not available. G, EM, C, H, EQ represent GDP, employment, credit, house prices and equity prices, respectively. Data on GDP and employment are from Oxford Economics.[35] A number in bold indicates an above-average value.

Synchronization across countries

Table 4.17 provides the synchronization of business and financial cycles across countries. Overall, the highest degree of cross-country synchronization is between cycles in credit (the concordance is 0.61), followed by equity prices (0.6), real GDP (0.54) and house prices (0.51). Synchronization of cycles in employment across countries is least among all the variables. This finding is broadly consistent with the notion that credit and equities are internationally traded across countries and their markets are more closely integrated than labor markets, which suffers from very limited international flows of labor. As a consequence, globalization contributes to the synchronization of real GDP, credit and equities across countries, but not to employment.

[35] http://www.oxfordeconomics.com/

Table 4.17 Synchronization of Business and Financial Cycles across Countries

	Real GDP	Employment	Credit	House Prices	Equity Prices
Mean	0.544	0.495	0.61	0.512	0.6
Median	0.719	0.504	0.619	0.5	0.599
Max	0.956	0.659	0.899	0.726	0.862
Min	0.133	0.274	0.279	0.274	0.353

Turning to the synchronization across countries for individual variables, the concordances of real GDP and employment are shown in Tables 4.18 and 4.19. We observe that the real GDP of China, Hong Kong, Taiwan, Korea, Thailand, India, Indonesia and the Philippines all have extremely high level of synchronization with other countries; however, the real GDP of Japan, Malaysia and Singapore is less synchronized. Unlike real GDP, employment rate in Thailand coincides highly with the other 8 countries, followed by Japan, India and Indonesia. China, Hong Kong, Taiwan and the Philippines are the least synchronized with other countries.

Table 4.18 Synchronization of Business Cycles across Countries of Real GDP

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
7	China	-	**0.785**	**0.807**	0.207	**0.844**	0.178	**0.881**	**0.956**	**0.904**	0.133	**0.763**
7	Hong Kong	**0.785**	-	**0.844**	0.215	**0.704**	0.170	**0.8**	**0.741**	**0.778**	0.215	**0.696**
7	Taiwan	**0.807**	**0.844**	-	0.281	**0.681**	0.237	**0.763**	**0.763**	**0.8**	0.207	**0.733**
2	Japan	0.207	0.215	0.281	-	0.185	**0.837**	0.163	0.222	0.2	**0.807**	0.267
7	Korea	**0.844**	**0.704**	**0.681**	0.185	-	0.2	**0.859**	**0.815**	**0.822**	0.244	**0.756**
2	Malaysia	0.178	0.17	0.237	**0.837**	0.2	-	0.207	0.193	0.185	**0.852**	0.296
7	Thailand	**0.881**	**0.8**	**0.763**	0.163	**0.859**	0.207	-	**0.837**	**0.844**	0.193	**0.748**
7	India	**0.956**	**0.741**	**0.763**	0.222	**0.815**	0.193	**0.837**	-	**0.874**	0.133	**0.719**
7	Indonesia	**0.904**	**0.778**	**0.8**	0.2	**0.822**	0.185	**0.844**	**0.874**	-	0.215	**0.830**
2	Singapore	0.133	0.215	0.207	**0.807**	0.244	**0.852**	0.193	0.133	0.215	-	0.326
7	Philippines	**0.763**	**0.696**	**0.733**	0.267	**0.756**	0.296	**0.748**	**0.719**	**0.83**	0.326	-

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH are represented China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold means that the number is above the average of 0.6. # refers the number of countries with which the synchronization is above the average.

Table 4.19 Synchronization of Business Cycles across Countries of Employment

#	Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
4	China	-	0.481	0.470	0.274	0.464	**0.522**	**0.519**	0.341	0.378	**0.630**	**0.593**
4	Hong Kong	0.481	-	0.452	**0.659**	0.432	0.487	**0.622**	0.474	**0.556**	**0.570**	0.415
3	Taiwan	0.47	0.452	-	0.487	**0.504**	0.374	**0.539**	**0.513**	0.478	0.452	0.357
7	Japan	0.274	**0.659**	0.487	-	**0.496**	**0.530**	**0.607**	**0.519**	**0.556**	**0.496**	0.385
5	Korea	0.464	0.432	**0.504**	**0.496**	-	0.452	**0.544**	**0.568**	**0.544**	0.408	0.464
6	Malaysia	**0.522**	0.487	0.374	**0.53**	0.452	-	0.452	**0.548**	**0.530**	**0.522**	**0.6**
8	Thailand	**0.519**	**0.622**	**0.539**	**0.607**	**0.544**	0.452	-	**0.511**	**0.519**	**0.519**	0.378
7	India	0.341	0.474	**0.513**	**0.519**	**0.568**	**0.548**	**0.511**	-	**0.652**	0.4	**0.526**
7	Indonesia	0.378	**0.556**	0.478	**0.556**	**0.544**	**0.53**	**0.519**	**0.652**	-	**0.570**	0.430
6	Singapore	**0.63**	**0.57**	0.452	**0.496**	0.408	**0.522**	**0.519**	0.4	**0.57**	-	0.430
3	Philippines	**0.593**	0.415	0.357	0.385	0.464	**0.6**	0.378	**0.526**	0.43	0.43	-

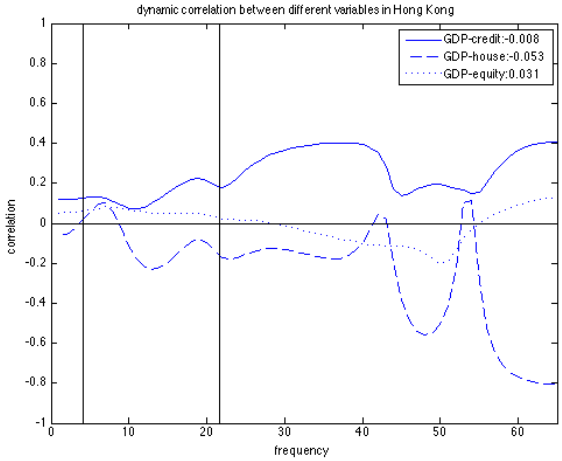
Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH are represented China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Bold means that the number is above the average of 0.5. # refers the number of countries with which the synchronization is above the average.

4.5.4 Dynamic correlation

In order to determine the cyclical components in business cycles, we do not adopt the traditional definition of the cycle presented earlier (6 to 24 quarters). Instead, for all the variables studied, the business cycles are identified with all movements whose recurrence period is between 16 to 48 quarters. First, we calculate the dynamic correlation over the full frequency range between different variables, and then apply the CF filter to strip out the cyclical movements with a recurrence period between 16 to 48 quarters. Finally, we compute the dynamic movements between these variables.

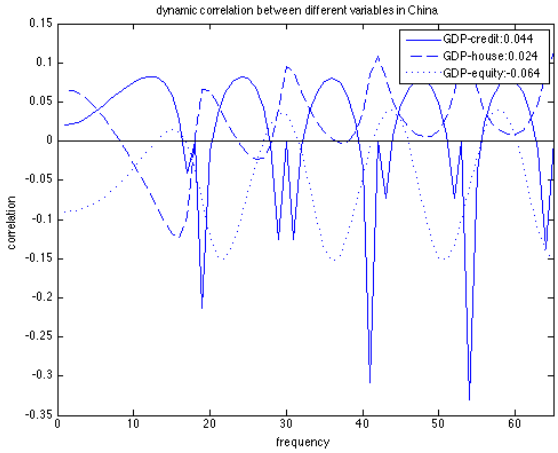
As indicated in Chapter 3, we distinguish three components of the aggregate correlation: the long-run movements (over 8 years), the traditional business cycles (1.5 and 8 years) and the short-run components (less than 1.5 years).

Fig. 4.5 Dynamic correlation of real GDP in China (Full range)



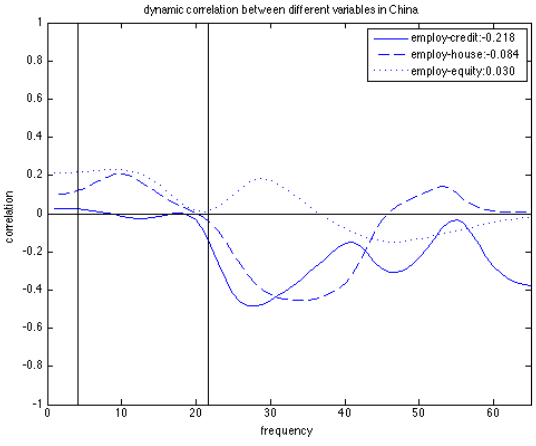
Note: Figure 4.5 shows the correlations between different financial cycles from frequency 0 to pi.

Fig. 4.6 Dynamic correlation of real GDP in China (Business frequencies)



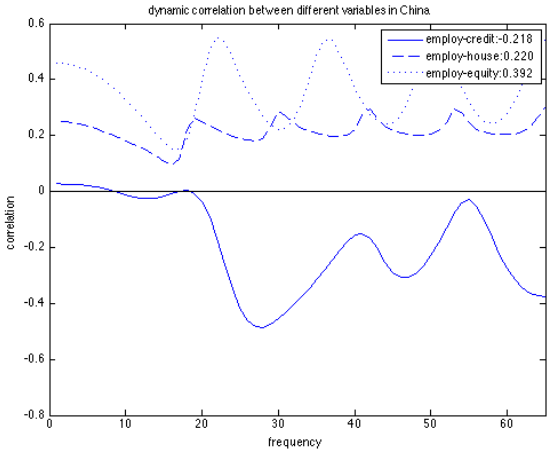
Note: Figure 4.6 shows the correlations between different financial cycles from frequency 0 to pi/16.

Fig. 4.7 Dynamic correlation of employment (Full range)



Note: Figure 4.7 shows the correlations between different financial cycles from frequency 0 to pi.

Fig. 4.8 Dynamic correlation of employment (Business frequencies)



Note: Figure 4.8 shows the correlations between different financial cycles from frequency 0 to pi/16.

As an illustration, Figures 4.5 - 4.8 demonstrate the dynamic correlation between business and financial cycles in China. In figure 4.5, at very low frequency, the positive correlations between real GDP and the three financial variables increase as the frequency increases. For the business cycle frequency range (1.5 to 8 years), as shown between the two vertical lines, we find

that the correlations between real GDP, credit and equity prices are positive, but between real GDP and house prices is negative. The results for the business and financial cycle ranges (16-48 quarters) are shown in Figure 4.6. The coefficient between real GDP and credit in long-run movements is 0.044, while the one between real GDP and equity prices is 0.024 and the one between real GDP and house prices is -0.064. This is quite different for employment. Figures 4.8 and 4.9 show that the dynamic correlations increase in the low frequency range but decrease dramatically as the frequency increases. The coefficients are positive between employment, equity and house prices, but is negative between employment and credit.

We examine the dynamic correlations between business and financial cycles in each country, and find that the dynamic correlations between business cycles and credit are positive, except for Hong Kong and Taiwan. The trend and sign of the correlations between real GDP, employment and other financial cycles is upward and positive except for China, Korea, Thailand, and Philippines. The dynamic correction between credit and real GDP implies that temporary increases in credit are followed by temporary increases in the level of real activity.

We also explore the dynamic correlations of real GDP across our sample of countries. In most countries, the correlation is significantly positive at low frequencies, including the frequency of the business cycle but not always different from 0 at higher frequencies. This confirms our theory that real economic activities are strongly linked at low frequencies because of common structural determinants; and that, at shorter horizons, the determinants of the these variables are more likely to differ.

Tables 4.20 and 4.21 examine the integration of the dynamic correlation of business cycles across countries over the selected frequencies rather than over the full frequency range. In the case of real GDP, only China and Thailand are synchronized with other countries, with a positive integration above 0.5. Korea, India and Philippines are less positively related, followed by the group of Hong Kong, Taiwan, Japan, Malaysia and Singapore. Indonesia is the least positively synchronized with other countries. Interestingly India and the Philippines are highly negatively related with other countries, with values of -0.482 and -0.402, respectively.

The synchronization of employment is not as high as that of real GDP across countries. The highest synchronization with other countries occurs in Hong Kong, Malaysia, Taiwan and Japan, with concordance of 0.34, 0.32, 0.31 and 0.30, respectively. Other countries are not highly synchronized: Thailand and China have concordance of only 0.268 and 0.247 with other countries,

followed by the Philippines, Korea, Singapore and Indonesia. The level of synchronization for India (0.083) is quite low. Singapore, Hong Kong, Korea and India have a correlation of -0.363, -0.306, -0.274 and -0.269, respectively, with other countries.

Table 4.20 Integration of Dynamic Correlation of Business Cycle across Countries in Selected Frequencies for real GDP

Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
China	1	0.379	0.491	-0.141	-0.039	-0.173	0.424	**0.634**	-0.293	-0.028	**0.587**
Hong Kong	0.379	1	**0.678**	-0.128	-0.012	0.024	-0.052	-0.199	**0.518**	0.324	0.221
Taiwan	0.491	**0.678**	1	0.105	-0.148	-0.218	-0.034	0.126	0.123	0.342	**0.663**
Japan	-0.141	-0.128	0.105	1	0.416	**0.572**	0.459	0.327	-0.045	0.47	0.272
Korea	-0.039	-0.012	-0.148	0.416	1	**0.68**	**0.735**	0.381	-0.114	0.286	0.316
Malaysia	-0.173	0.024	-0.218	**0.572**	**0.68**	1	**0.618**	0.208	0.178	**0.583**	0.252
Thailand	0.424	-0.052	-0.034	0.459	**0.735**	**0.618**	1	**0.765**	-0.344	0.342	**0.663**
India	**0.634**	-0.199	0.126	0.327	0.381	0.208	**0.765**	1	**-0.765**	0.237	**0.748**
Indonesia	-0.293	**0.518**	0.123	-0.045	-0.114	0.178	-0.344	**-0.765**	1	0.073	-0.402
Singapore	-0.028	0.324	0.342	0.47	0.286	**0.583**	0.342	0.237	0.073	1	0.391
Philippines	**0.587**	0.221	**0.663**	0.272	0.316	0.252	**0.663**	**0.748**	-0.402	0.391	1
Average (p)	0.503	0.357	0.361	0.374	0.469	0.389	**0.572**	0.428	0.223	0.339	0.457
Average (n)	-0.095	-0.098	-0.133	-0.105	-0.078	-0.196	-0.143	-0.482	-0.327	-0.028	-0.402

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Average (p) represents the averages of the positive relationships and Average (n) implies the ones of the negative relationships. Bold numbers mean the value is larger than 0.5 or smaller than -0.5.

Table 4.21 Integration of Dynamic Correlation of Business Cycle across Countries in Selected Frequencies for Employment

Countries	CH	HK	TW	JP	KO	MA	TH	ID	IN	SP	PH
China	1	-0.019	0.463	0.332	0.191	-0.264	-0.266	-0.033	0.003	**-0.531**	-0.158
Hong Kong	-0.019	1	0.347	**0.519**	-0.337	0.201	0.274	**-0.562**	0.009	**0.52**	**0.527**
Taiwan	0.463	0.347	1	0.452	0.241	-0.015	-0.127	-0.06	-0.039	0.152	0.218
Japan	0.332	**0.519**	0.452	1	-0.28	0.378	0.199	-0.423	-0.035	0.005	0.24
Korea	0.191	-0.337	0.241	-0.28	1	-0.395	-0.388	-0.101	0.221	-0.191	-0.224
Malaysia	-0.264	0.201	-0.015	0.378	-0.395	1	**0.626**	-0.127	-0.057	-0.266	0.069
Thailand	-0.266	0.274	-0.127	0.199	-0.388	**0.626**	1	0.083	0.177	-0.196	0.247
India	-0.033	**-0.562**	-0.06	-0.423	-0.101	-0.127	0.083	1	-0.315	**-0.633**	-0.164
Indonesia	0.003	0.009	-0.039	-0.035	0.221	-0.057	0.177	-0.315	1	0.1	0.161
Singapore	**-0.531**	**0.52**	0.152	0.005	-0.191	-0.266	-0.196	**-0.633**	0.1	1	0.238
Philippines	**-0.158**	**0.527**	0.218	0.24	-0.224	0.069	0.247	-0.164	0.161	0.238	1
Average (p)	0.247	0.342	0.312	0.304	0.218	0.319	0.268	0.083	0.112	0.203	0.243
Average (n)	-0.212	-0.306	-0.060	-0.246	-0.274	-0.187	-0.244	-0.269	-0.112	-0.363	-0.182

Note: CH, HK, TW, JP, MA, KO, TH, ID, IN, SP and PH represent China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Thailand, Indonesia, India, Singapore and Philippines. Average (p) represents the averages of the positive relationships and Average (n) implies the ones of the negative relationships. Bold numbers mean the value is larger than 0.5 or smaller than -0.5.

4.5.5 Granger Causality Test and Measures of the Causality Strength

This study examines the relationship between financial cycles and economic growth in a sample of 11 Asian countries, (China, Japan, Hong Kong, Taiwan, India, Korea, Malaysia, Thailand, Singapore, Indonesia and Philippines) for the 1980-2013 period. Does financial development promote economic growth, or does economic growth propel financial development?

We explore the direction of causality between credit, house prices, equity prices and real GDP per capita using vector autoregression, and perform Granger-causality tests within a vector error correction framework. We first convert the non-stationary variables into stationary ones by calculating the growth rates. Then we employ Non-Granger causality test to identify the direction of causation, if any, among the four variables in our model.

Patrick (1966) identifies two possible directions of causality relationship between financial development and growth, one is supply-leading hypothesis, which means that the financial liberalization increases the financial institutions and their services and thus leads to real economic growth. On the other hand, demand-following hypothesis postulates that the demand for financial services depends upon the growth of real output. Neusser and Kugler (1998) and Levin, Loayza and Beck (2000) support the former hypothesis, however, Al-Yousif (2002) supports the later one.

The results are reported in Table 4.22. The findings confirm the strong and positive relationship between economic growth and credit market. The bidirectional causality is only detected in the cases of China, Hong Kong and India. This implies that financial market in credit stimulates growth and, simultaneously, growth propels credit development. However, this relationship runs from economic growth to credit markets in Thailand, Singapore, Indonesia and Philippines; while the reverse relationship is significant in Korea and Malaysia. Of the 11 countries, unidirectional causalities running from house market to output growth are found for China and Malaysia, while this links running from economic growth to house market are shown for Taiwan, Korea and Indonesia. The bidirectional causality is found in Hong Kong and Thailand. However, there is little evidence of causal effects between stock market and economic growth. There is no

indication of causality in either direction in any of the 11 countries, with the exception of Japan, Hong Kong and Singapore.

Existing studies usually use Granger tests on time series data for a single countries. In contrast, this section also analyzes pooled data for 11 Asian countries to exploit both the cross-section and time-series dimensions of the data. Besides the country-level investigation, we we apply a newly developed GMM technique for panel data to conduct the causality test (see Abrigo and Love, 2015) to uncover the lead-lag relationships between the different cycles.

Results of the causality test between financial development (measured using the credit, house prices and equity prices) and economic growth (real GDP per capita) are presented in Table 4.23. To infer causality between financial cycles and economic growth, the Wald test is used to test the null hypothesis that the estimated coefficients in equation (see Chapter 2, equation (5)) are all zero. Five interesting results are obtained from this study. First, Table 4.23 shows significant evidence that bidirectional causality is apparent between credit development and economic growth. Second, house prices and equity prices matter for economic growth and causalities only runs from financial sectors, but the reverse effects are considered to be poor.

However, as the analysis in Chapter 2, the non-causality test could not capture the dynamic causality between different financial cycles and business cycle, therefore, we introduce the causality measures across countries, cycles, and time horizons. Figure 4.9 – Figure 4.19 show the results on the measurement of the strength of causality between financial markets and economic growth in the selected sample countries. We found that all of causalities are bidirectional and significant from the value of zero up to 4 quarters, even some of the linkages are not significant in our previous non-causality tests. Moreover, the figures indicate that causal relationship is strongest and last the longest time between credit development and output growth than house prices and equity prices.

The results supports the belief that there is a strong link between the financial sector and economic growth. Our study is in agreement with other causality studies by Neusser and Kugler (1998) and Levin, Loayza and Beck (2000). It implies that the policy of liberalization and financial reforms adapted by these Asian countries has shown to improve economic growth.

Table 4.22 Non-Granger Causality Wald Tests between Financial development and output growth

	Causality direction	χ^2 (P-values)	Causality direction	χ^2 (P-values)
China	Credit→GDP	14.898** (0.001)	Credit←GDP	6.815* (0.033)
	House→GDP	15.355** (0.000)	House←GDP	0.0255 (0.880)
	Equity→GDP	0.376 (0.828)	Equity←GDP	1.210 (0.546)
Japan	Credit→GDP	3.121 (0.210)	Credit←GDP	1.463 (0.481)
	House→GDP	4.662 (0.097)	House←GDP	4.936 (0.085)
	Equity→GDP	1.580 (0.454)	Equity←GDP	7.167* (0.028)
Hong Kong	Credit→GDP	7.069* (0.029)	Credit←GDP	12.584** (0.002)
	House→GDP	6.558* (0.038)	House←GDP	8.235* (0.016)
	Equity→GDP	3.226 (0.199)	Equity←GDP	9.779** (0.008)
Taiwan	Credit→GDP	2.328 (0.312)	Credit←GDP	0.821 (0.663)
	House→GDP	2.365 (0.306)	House←GDP	6.628* (0.036)
	Equity→GDP	3.955 (0.138)	Equity←GDP	3.769 (0.152)
India	Credit→GDP	39.434** (0.000)	Credit←GDP	64.129** (0.000)
	Equity→GDP	0.464 (0.793)	Equity←GDP	2.465 (0.179)
Korea	Credit→GDP	6.860* (0.032)	Credit←GDP	2.288 (0.318)
	House→GDP	5.418 (0.067)	House←GDP	8.225** (0.016)
	Equity→GDP	2.395 (0.032)	Equity←GDP	10.233** (0.006)
Malaysia	Credit→GDP	7.717* (0.021)	Credit←GDP	0.913 (0.633)
	House→GDP	8.933** (0.011)	House←GDP	4.571 (0.102)
	Equity→GDP	11.374** (0.003)	Equity←GDP	0.351 (0.839)
Thailand	Credit→GDP	4.871 (0.088)	Credit←GDP	6.453* (0.040)
	House→GDP	8.478** (0.014)	House←GDP	7.144* (0.028)
	Equity→GDP	2.291 (0.318)	Equity←GDP	1.501 (0.472)
Singapore	Credit→GDP	3.332 (0.189)	Credit←GDP	21.26** (0.000)
	House→GDP	1.323 (0.516)	House←GDP	0.476 (0.788)
	Equity→GDP	8.921* (0.025)	Equity←GDP	1.992 (0.369)
Indonesia	Credit→GDP	1.049 (0.592)	Credit←GDP	23.437** (0.000)
	House→GDP	3.743 (0.154)	House←GDP	15.352** (0.000)
	Equity→GDP	2.521 (0.283)	Equity←GDP	0.740 (0.691)
Philippines	Credit→GDP	0.906 (0.636)	Credit←GDP	7.045* (0.030)
	Equity→GDP	0.863 (0.649)	Equity←GDP	1.113 (0.573)

Note: Sample period: 1980 Q1-2013 Q4. Arrows indicate the direction of the causalities between financial cycles and business cycles based on the test of null hypothesis of Granger non-causality. A chi-squared test χ^2 provides

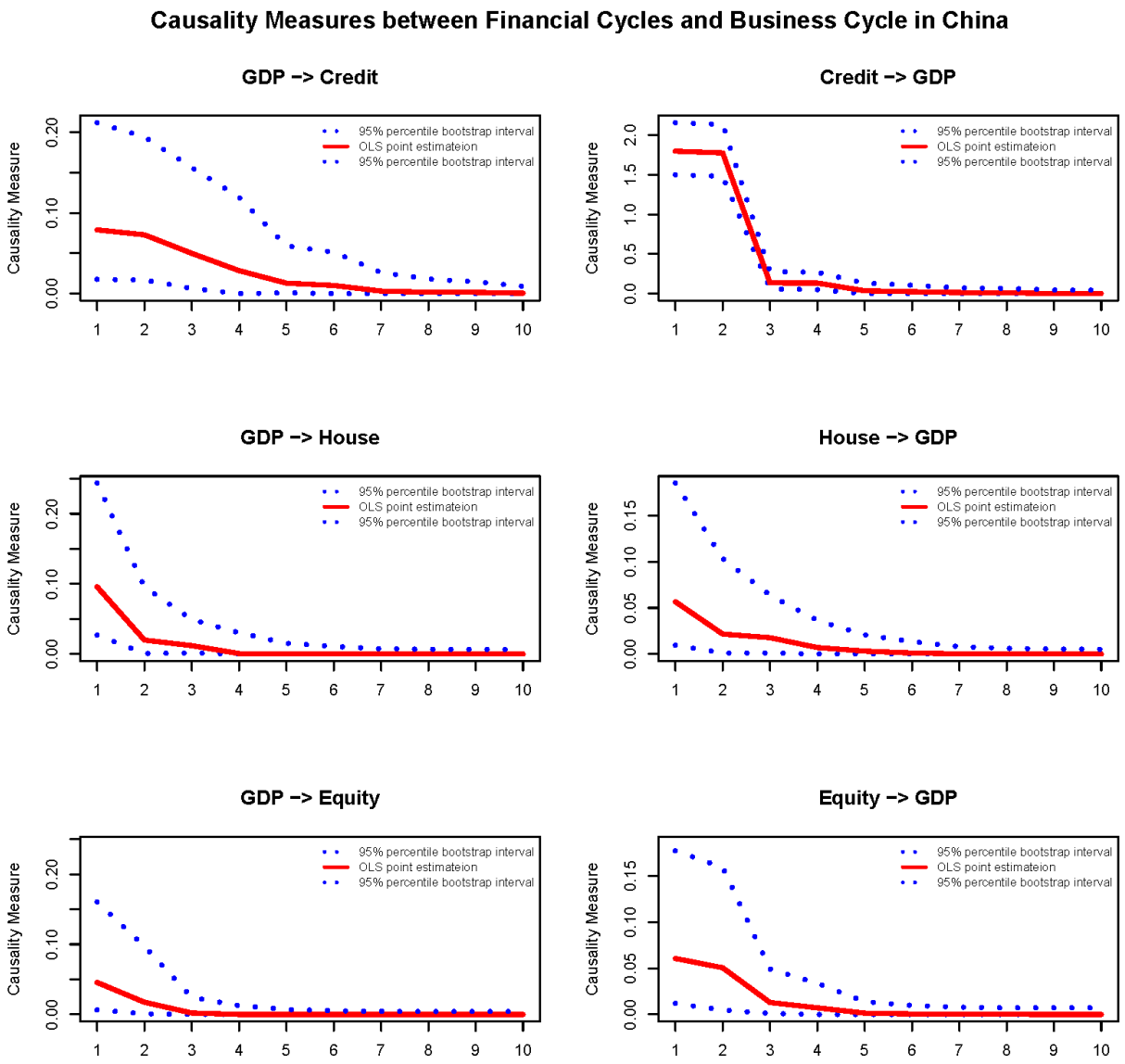
information whether Granger causality runs between the two variables. χ^2 and P-values are reported in the table. **significant at 1% level, and *significant at 5% level.

Table 4.23 Panel Non-Granger Causality Wald Tests for 11 Asian countries

	Causality direction	χ^2 (P-values)	Causality direction	χ^2 (P-values)
Panel data for 11 Asian countries	Credit→GDP	7.689* (0.053)	Credit←GDP	12.350** (0.006)
	House→GDP	15.589** (0.001)	House←GDP	3.165 (0.367)
	Equity→GDP	5.584* (0.120)	Equity←GDP	3.938 (0.268)

Note: Sample period: 1980 Q1-2013 Q4. Arrows indicate the direction of the causalities between financial cycles and business cycles based on the test of null hypothesis of Granger non-causality. A chi-squared test χ^2 provides information whether Granger causality runs between the two variables. χ^2 and P-values are reported in the table. **significant at 1% level, and *significant at 5% level.

Fig. 4.9 Causality measures between Financial Cycles and Business Cycle in China



Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

4.6 Conclusions

The empirical literature about the interactions between business and financial cycles is still quite limited, and the theoretical literature appears still far from being able to explain the linkages between the real economy and the financial sector. In order to understand the linkages between business cycles and financial cycles, our study try to identify the stylized facts underlying this relationship. This chapter fills this gap in the study of the relationship between business and financial cycles in the selected Asian countries.

This chapter examines the linkage between business and financial cycles by using two statistical methodologies, the turning-point analysis and the frequency-based filter, for quite a long time period from 1980 Q1 to 2013 Q4. In addition, we employ dynamic correlation, the Granger causality and the causal strength to measure the co-movements, the direction and strength of causalities among our variables.

We define the business cycle as a succession of the phases of expansion and contraction and analyze it in several ways: we identify the basic characteristics, such as frequency, duration and amplitude, of each series for each country and compare them across countries. We next compare these features between business and financial cycles. Synchronization between any two cycles is examined by calculating the concordance index. We further analyze the links by decomposing the variables into different components and by drawing the graphs of dynamic correlations. Finally, the Granger causality tests and the measures of causal strength are used to study the direction of causality as well as the strength of linkages between our macroeconomic and financial variables.

Our findings are new and interesting. First, financial cycles tend to be deeper and sharper than business cycles, and the duration of business cycles is similar to that of the cycle in asset prices but smaller than that of the cycle in credit. Overall, financial cycles are more outstanding than the cycles in real GDP and employment; this is especially true for the cycle in real GDP.

We also find that cycles in output tend to display a high degree of synchronization with cycles in credit but do not feature much commonality with cycles in employment.

Overall, the highest degree of cross-country synchronization is between cycles in credit and in equity prices, followed by that in real GDP; the synchronization between employments across countries is the least among all the variables.

In the analysis of dynamic correlations, in most countries, this correlation is significantly positive at low frequencies, including the frequency of business cycles while not always different from 0 at higher frequencies.

Finally, Granger causality tests generate mixed results. In general, first, bidirectional causality is detected between credit market and economic growth. Second, house prices and equity prices appear to be important for predicting output growth, while causalities only runs from financial sectors to real economy, but the reverse effects are considered to be poor. However, the measures of causality strength indicate that all the linkages between financial cycles and business cycle in each country are bidirectional and significant, and the causality relationship between credit market and output growth is strongest among all financial markets.

Summary and Conclusions

This dissertation examines the effects of capital inflows and human capital on the economic growth, identify the features of financial cycles, and investigate the interaction between financial cycles and business cycles in selected Asian countries.

In Chapter Two, we assess the effects of various types of capital inflows (including foreign investment, foreign aid, long-term debt and openness to trade) and human capital (in the forms of education enrollment and education expenditures) on the growth process, using yearly data over the period 1970 – 2010 and 8 Asian countries (China, India, Indonesia, Japan, South Korea, Malaysia, Thailand and Vietnam). We employ stationary tests, VAR techniques, the Granger-non-causality tests, measures of the strength of causality, impulse response functions, cointegration analysis and VECMs modeling, as well as panel data analysis to investigate the effects across countries. Our results suggest that capital inflows affect the growth process in the Asian countries both in the short and long term. In the majority of these countries, per capita real GDP and its growth rate respond positively to four of the components in capital inflows: foreign investment, openness to trade, public investment and human capital; on the other hand, capital inflows of aid and long-term debt seem to have adverse or insignificant effects on economic growth in some cases. The evidence further indicates that there exists significant Granger-causality between capital inflows and economic growth in both directions across multiple horizons; among these multiple directions, causality is strongest between foreign capital and economic growth. In general, foreign investment is growth enhancing and the evidence suggests that aid capital and long-term debt capital tend to lead the growth of economy, but not from the latter to the former.

We could have several interpretations from the analyses in this chapter. First, the empirical result of the positive causation running from foreign investment to growth imply that governments could create favorable conditions and provide more incentives for foreign investment. Second, the adverse effect of aid and long-term debt should warn them to regulate the foreign funds to ensure the efficient utilization. Third, liberalization of international trade can benefit long-term growth, governments could encourage the openness of trade by reducing tariff and constrains on the policies of trade. Fourth, with relatively high level of workforce, foreign technology can be

adopted by domestic country through foreign investment. Therefore, government should undertake reforms on education and enhance the education investment.

In Chapter Three, we examine financial cycles in credit, house prices and equity prices from a variety of perspectives. First, we investigate their core empirical characteristics: frequency, duration, amplitude and slope with two statistic methodologies, turning-point analysis and frequency-based filter. Second, we examine the relationship between financial cycles and financial crisis. Third, we analyze the synchronization of financial cycles within a country and across countries, as well as the dynamic correlation between different financial cycles.

To our knowledge, we are the first to use this type of analysis for Asian countries. Our findings are as follows. First, there exist financial cycles in Asian countries: both the turning-point and frequency-based filters show the characteristics of financial cycles in the selected Asian countries are very different from those in the advanced countries (Drehmann, 2012): (1) the estimated cycle duration in the advanced countries (8 to 18 years) is 1.5 times longer than that in the selected Asian countries (6 to 12 years); (2) the cycle amplitude in the advanced countries is 7 times stronger in the expansion phase and 4 times stronger in the contraction phase than those in the sample countries. Second, the financial cycle displays a skewed shape, with, on average, longer and stronger expansion than contraction. Third, cycles in house and equity prices are more noticeable than in credit. Fourth, the peaks of the financial cycles tend to be followed very closely by financial crises, and the cycles with the peaks close to crises having had longer expansion periods and greater amplitude. Fifth, the degree of synchronization across countries is higher for the cycles in credit and equity prices than for those in house prices, but are weaker than those in advanced countries (see Claessens, 2011A). Finally, the degree of dynamic correlations among the three financial cycles depends on the level of frequencies and the correlation becomes weaker at higher frequencies.

Although many existing models include various patterns observed in financial markets, the models are yet to incorporate the quantitative features as highlighted by our work. The financial markets in most Asian countries are in earlier stages of liberalization and development, so that they tend to be more turbulent and fragile, consequently, the methodologies used in our study need

to be improved. Although the methods are not perfect, our study shows that there exist financial cycles and that they behave very differently from those in advanced economies.

These findings in Chapter 3 provide some meaningful implications. We argue that they are consistent with the view that financial markets in these Asian countries are still in the earlier stage of development and these cycles are not prominent as those of advanced countries. This may reflect a stable and mature financial system is always accompanied by financial liberalization and prospective monetary policy. Our results shed some light on the term and amplitude of financial cycles in these countries, so policy responses should take into account for the expected recessions. Based on our work, additional empirical analyses may be carried out regarding the determinants of the duration and amplitude of financial cycles, the role of financial institutions, as well as the relations with global fluctuations.

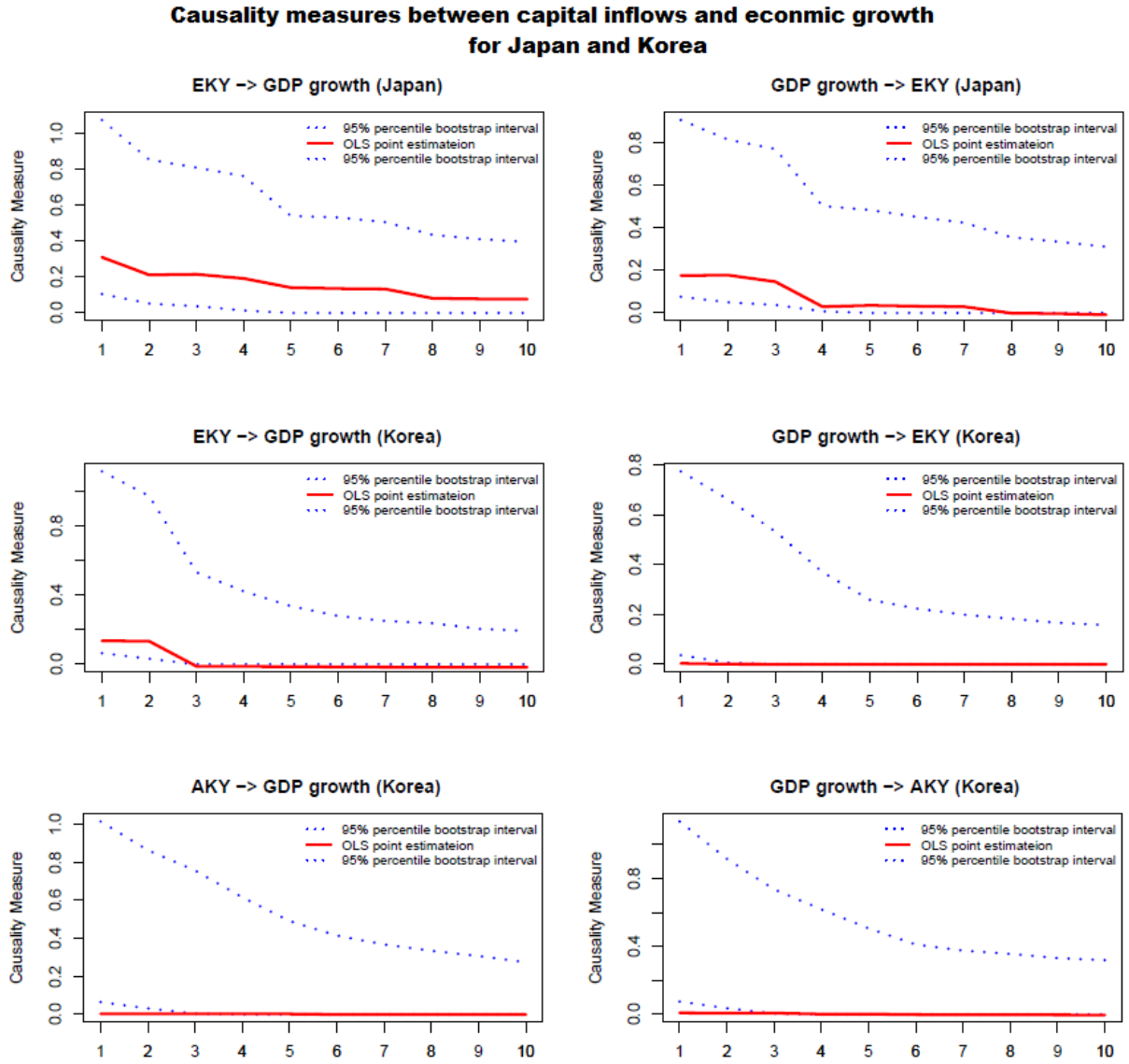
In Chapter Four, we proceed to investigate the features of business cycles on a dataset of 11 Asian countries for the period 1980Q1 – 2013Q4, and compare their characteristics with those of financial cycles. Because the cyclical variations in financial and business cycles are usually highly correlated and reinforce each other, the financial cycles influence and are influenced by the business cycles. However, the empirical literature about the interactions between business and financial cycles is still quite limited, and the theoretical literature appears still far from being able to explain the variety of linkages between the real economy and the financial sector. This chapter contributes to the literature on the relationship between business and financial cycles in our selected Asian countries.

Our results suggest that financial cycles tend to be deeper and sharper than business cycles; cycles in output tend to display high-level synchronization with cycles in credit, whereas they do not feature much commonality with cycles in financial variables other than credit. The dynamic correlations between business cycles and financial cycles in most countries are significantly positive at low frequencies while not significant at higher frequencies. Finally, though Granger-causality tests generate mixed results between the financial and business variables, there exists strong bidirectional causality between credit and real GDP: credit has a very high predictive power for the growth of economy, and real GDP helps to predict the growth of credit.

Our analyses provide insights into the interactions between financial cycles and business cycles, and enrich the literature of the role of financial markets in the real economy. Although not all booms lead to financial crises, many asset prices booms and extensive credit expansions have been followed by busts with adverse real economic consequences. An extension of our study would be to see how financial liberalization can affect the business cycles.

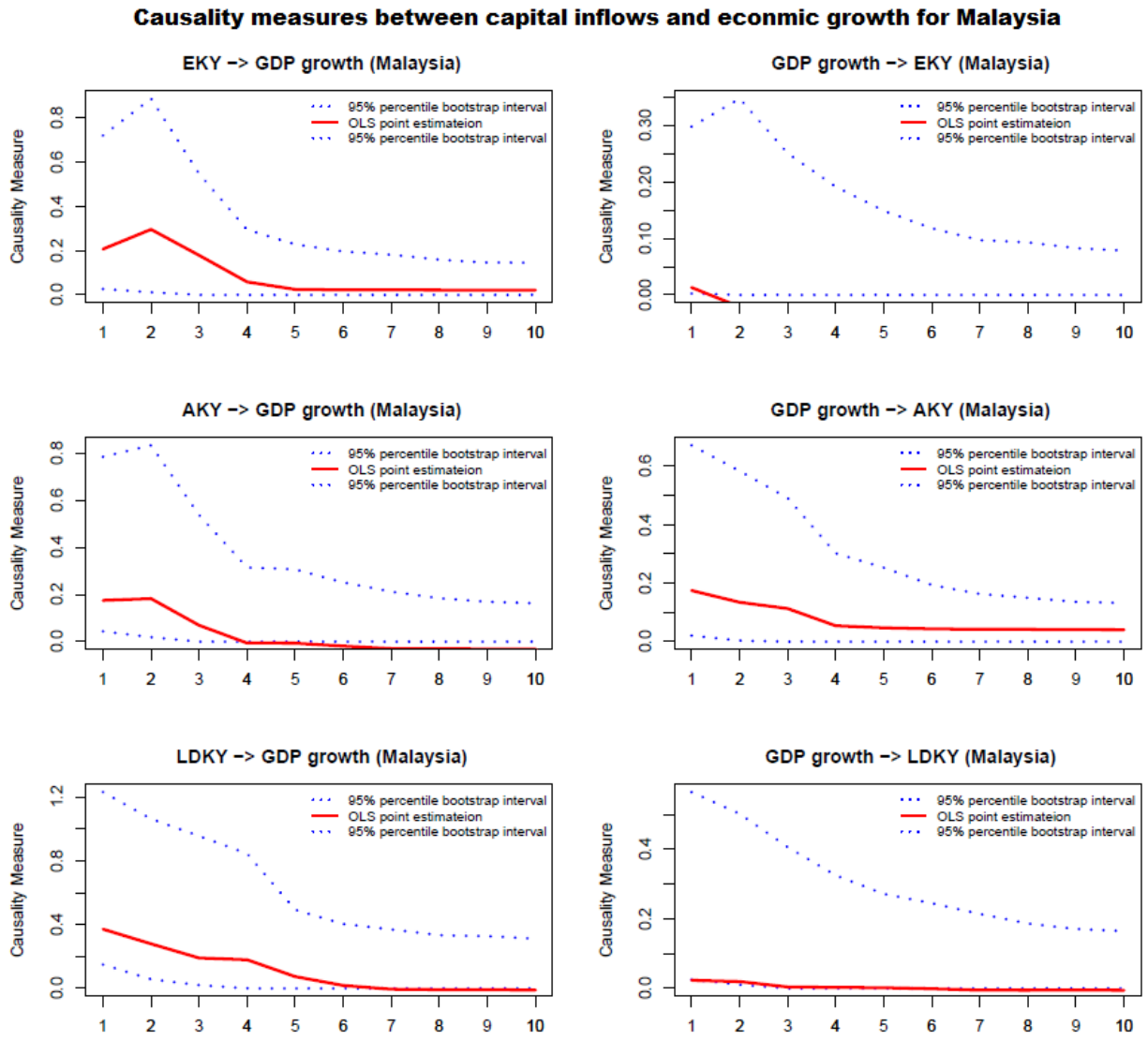
Appendix

Figure 2.10 Causality measure between capital inflows and economic growth for Japan and Korea



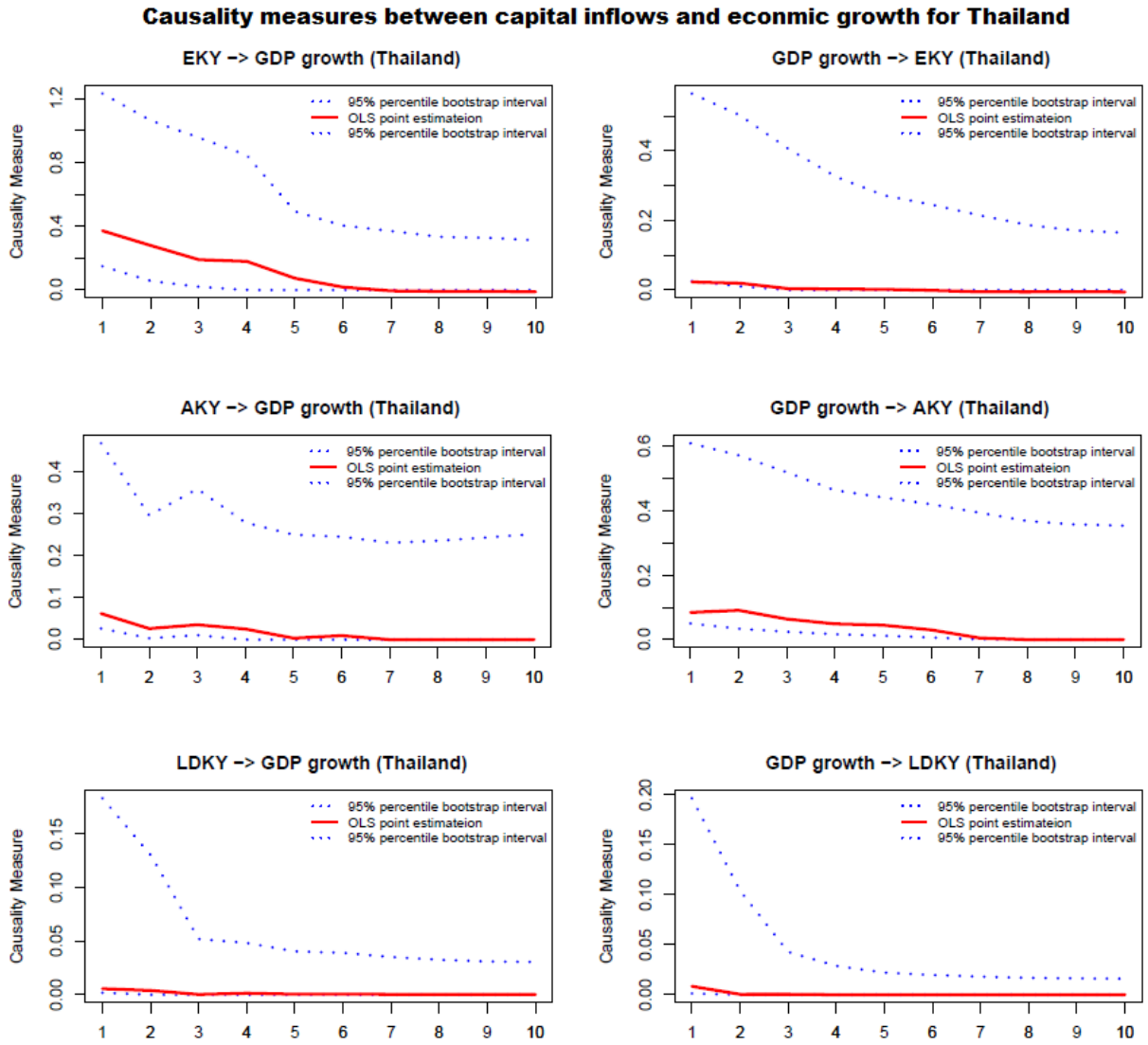
Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Figure 2.11 Causality measure between capital inflows and economic growth for Malaysia



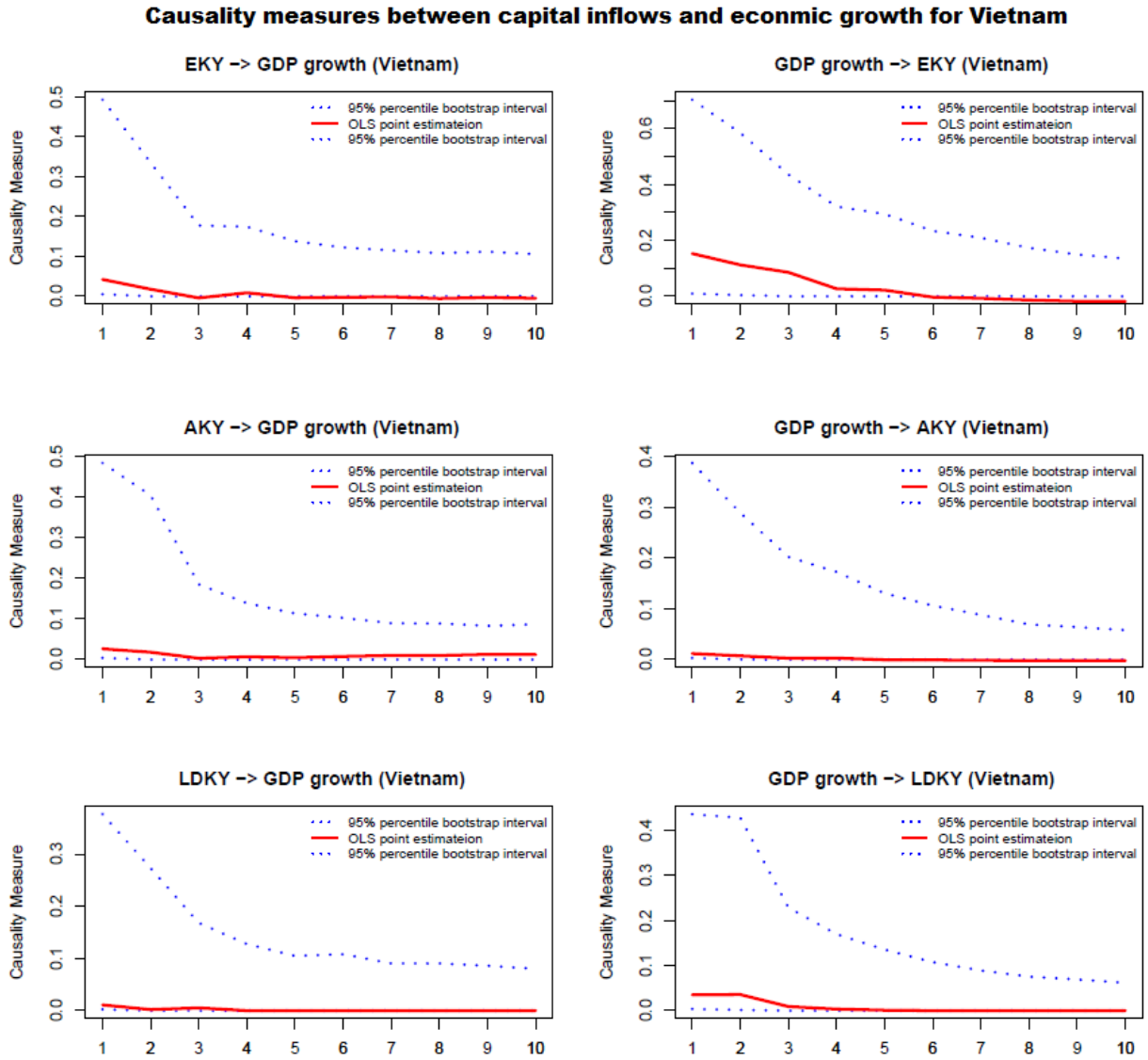
Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Figure 2.12 Causality measure between capital inflows and economic growth for Thailand



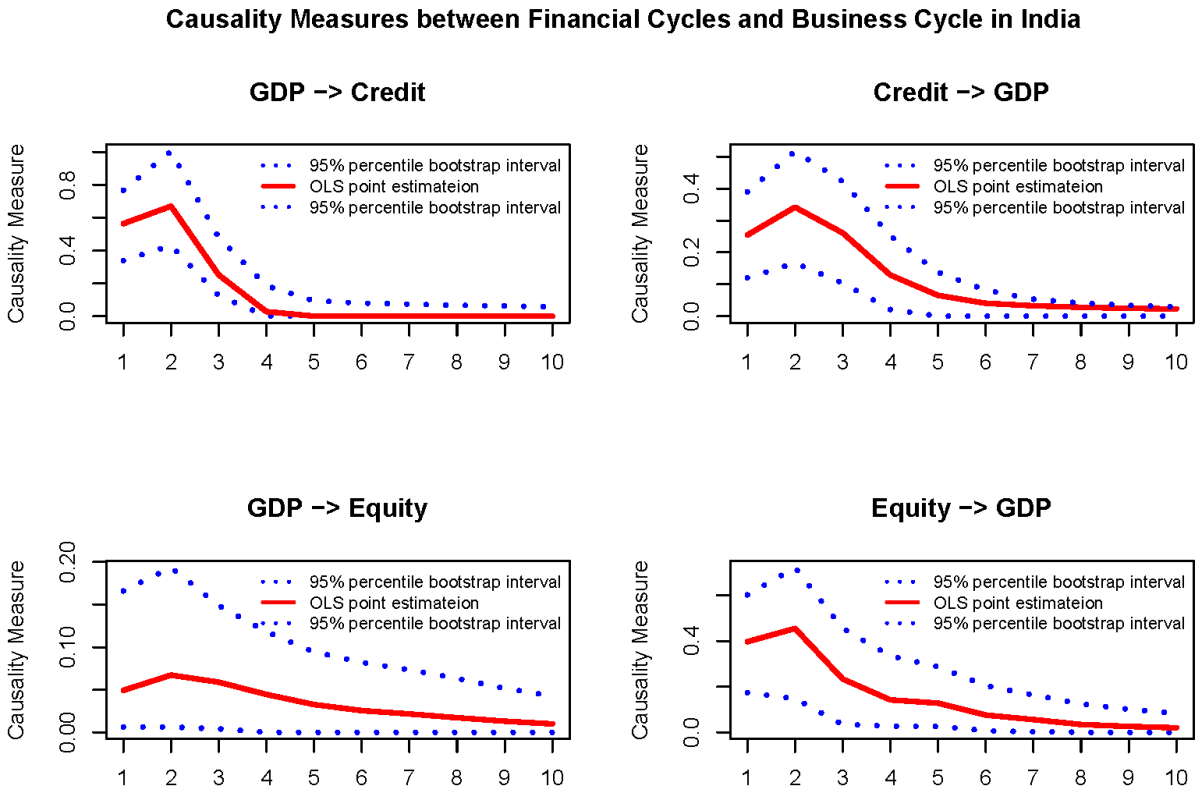
Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Figure 2.13 Causality measure between capital inflows and economic growth for Vietnam



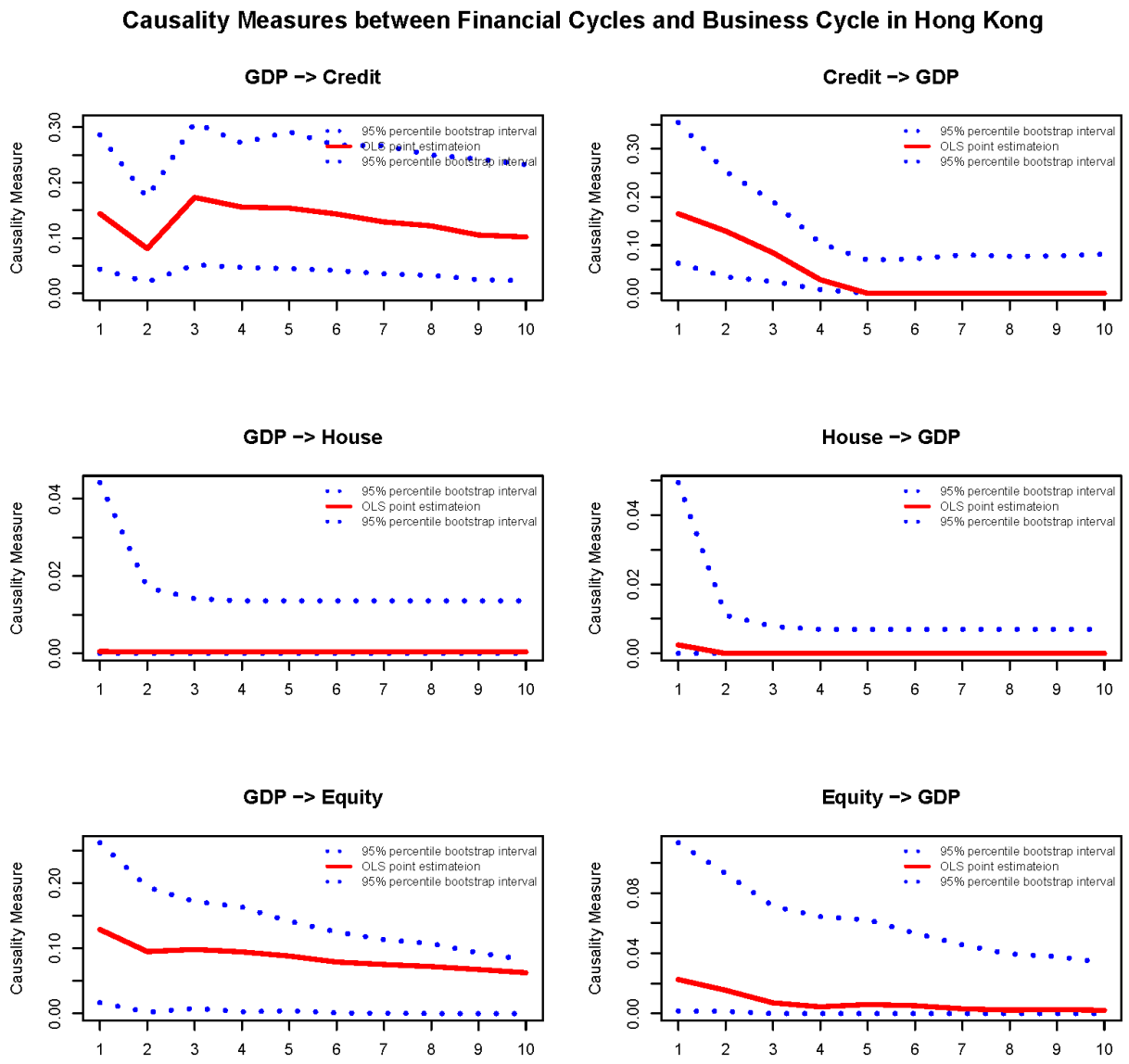
Note: the model is VAR model with k=4 and horizon=10. EKY, AKY and LDKY represent equity capital, aid capital and long-term debt capital from 1960 to 2013 respectively. The arrow indicates the causality direction, for example, EKY → GDP denotes the causality that runs from equity price to GDP growth. The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.10 Causality measures between Financial Cycles and Business Cycle in India



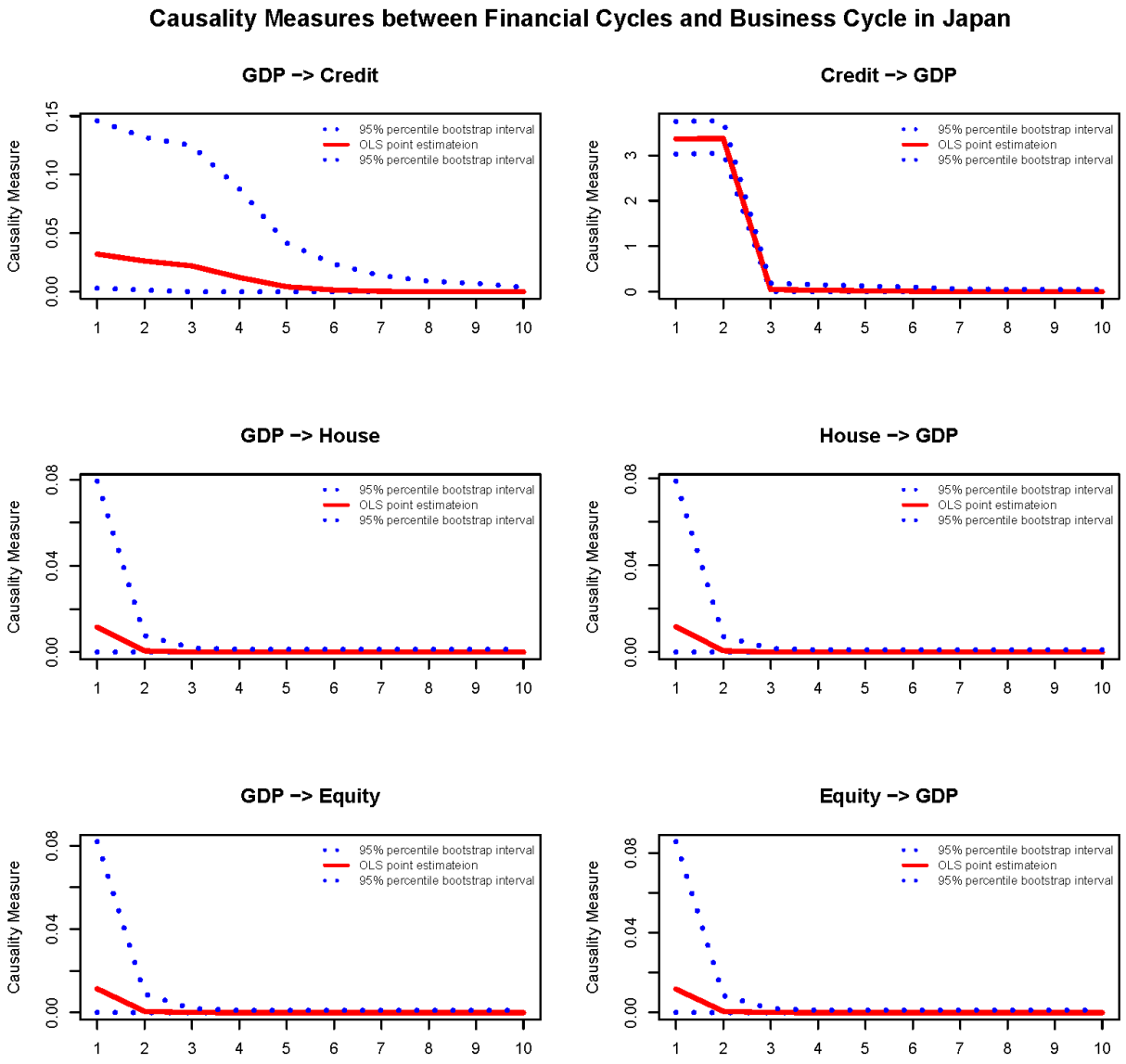
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.11 Causality measures between Financial Cycles and Business Cycle in Hong Kong



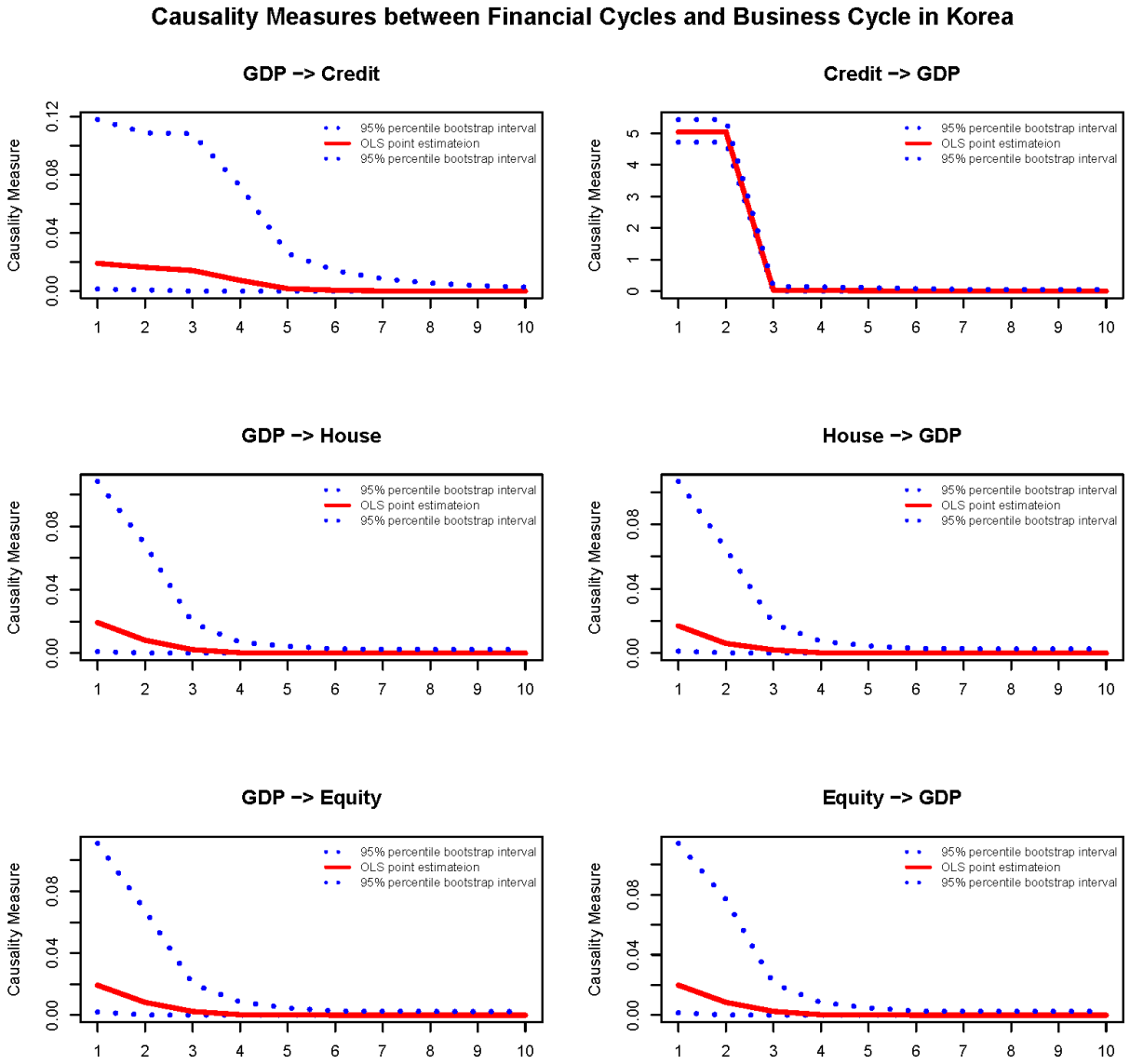
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.12 Causality measures between Financial Cycles and Business Cycle in Japan



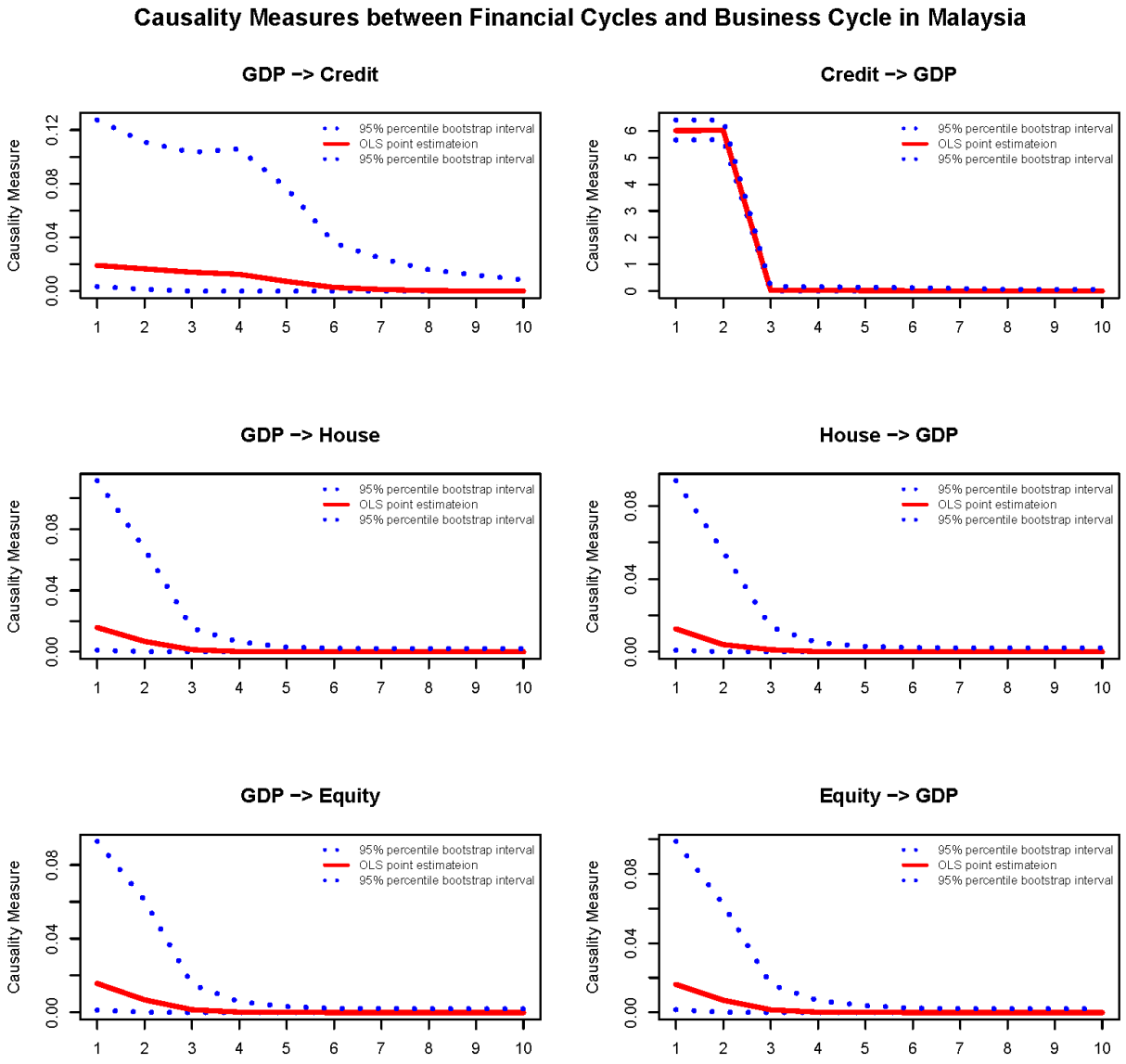
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.13 Causality measures between Financial Cycles and Business Cycle in Korea



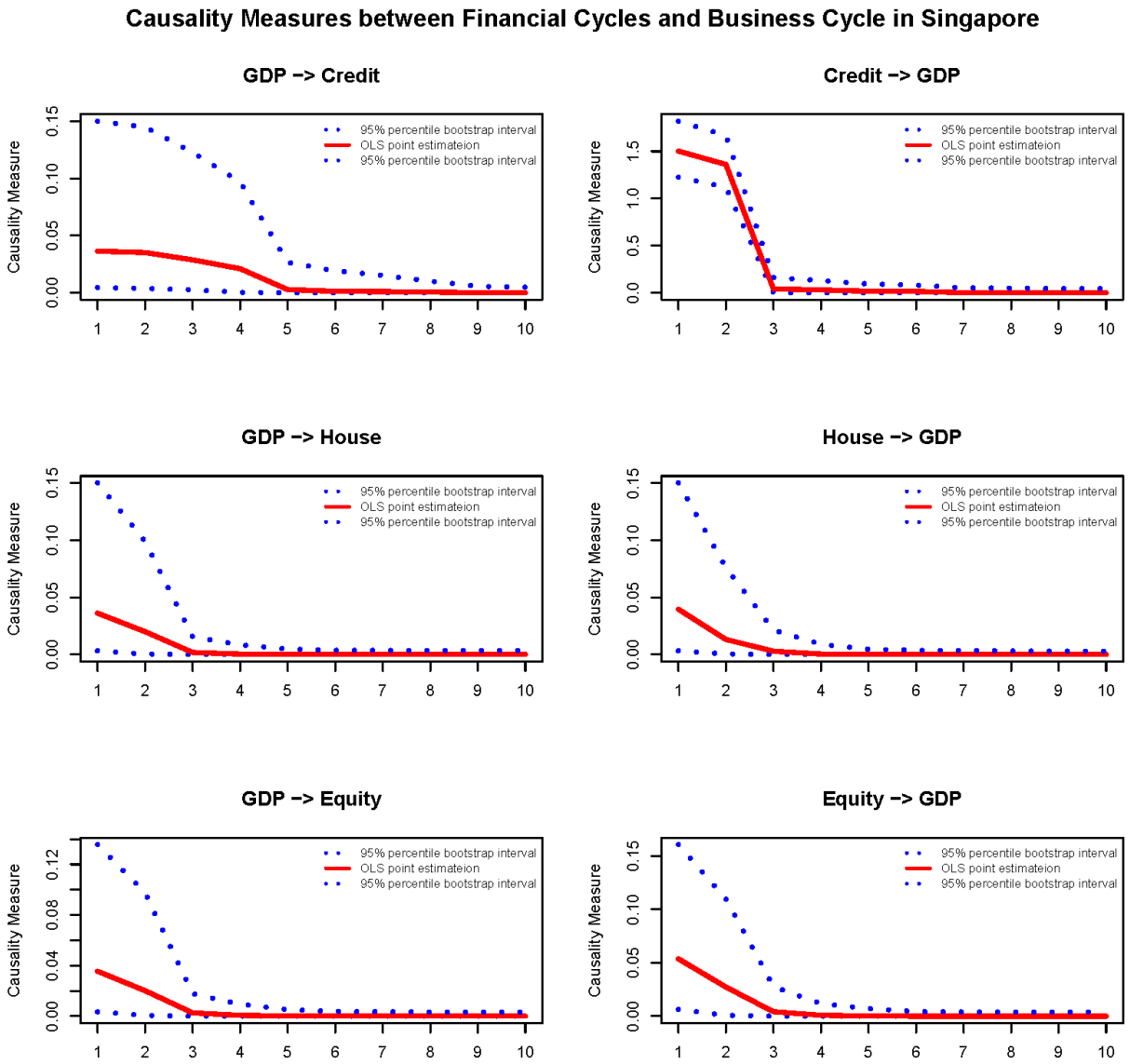
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.14 Causality measures between Financial Cycles and Business Cycle in Malaysia



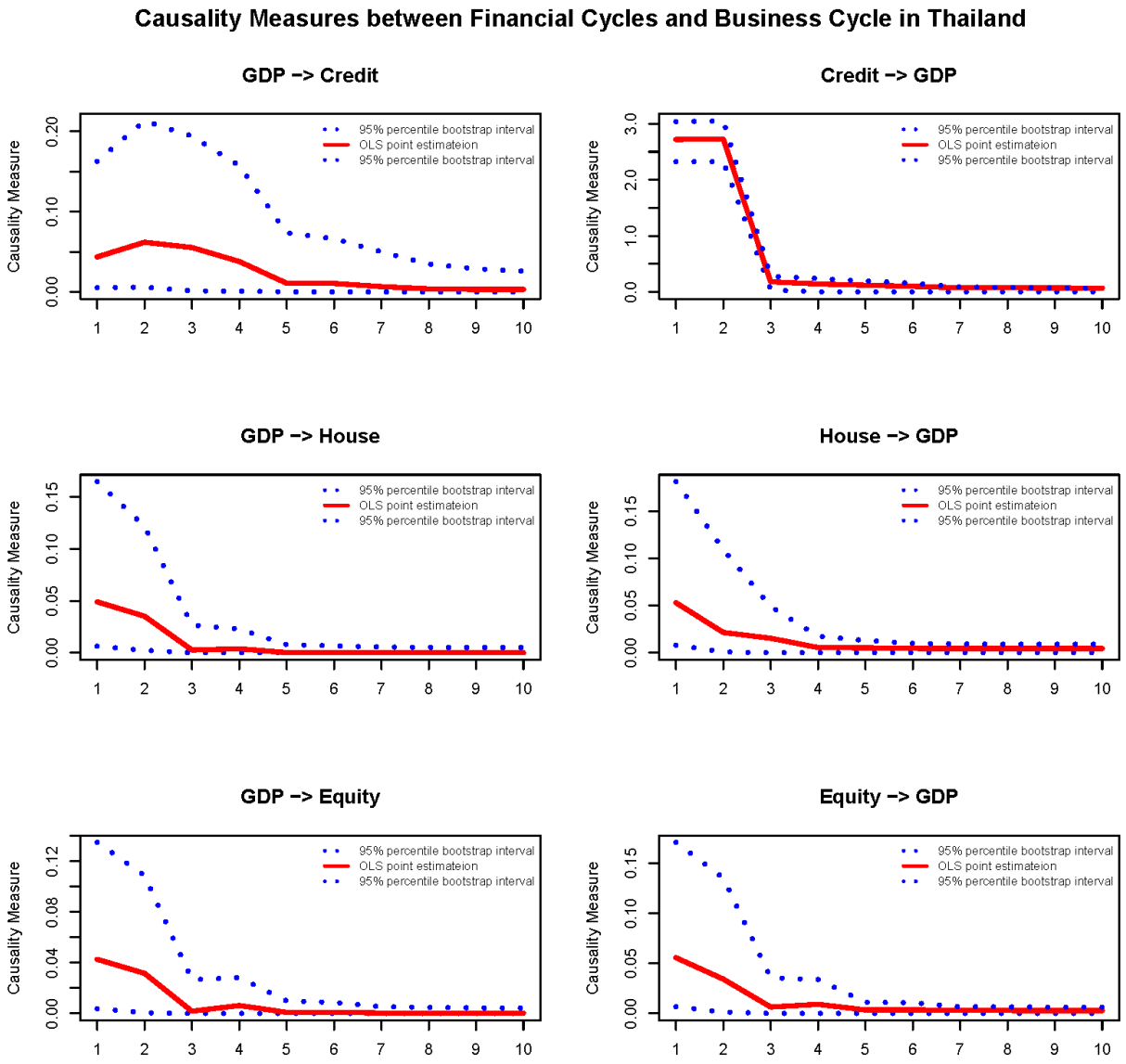
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.15 Causality measures between Financial Cycles and Business Cycle in Singapore



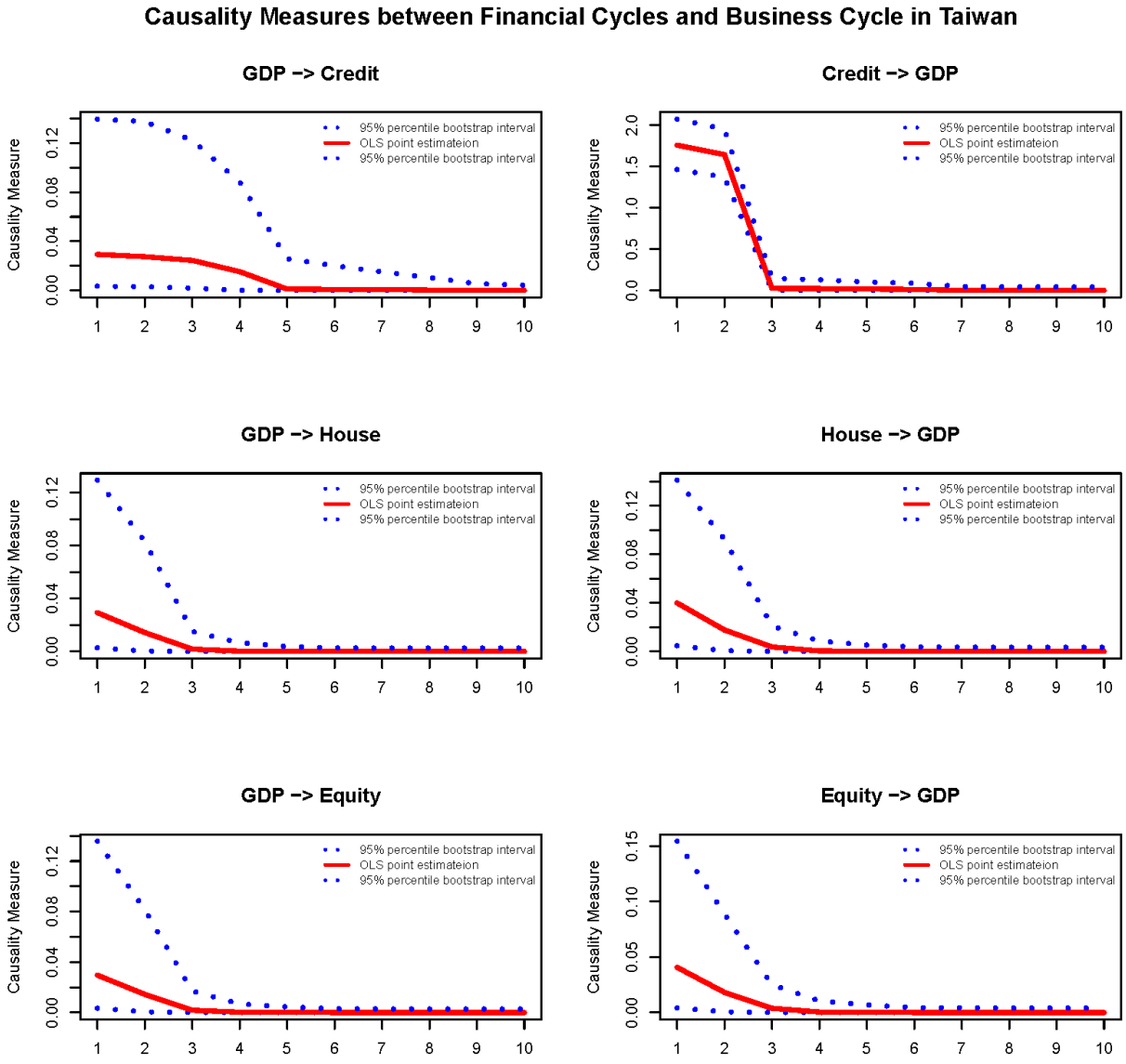
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.16 Causality measures between Financial Cycles and Business Cycle in Thailand



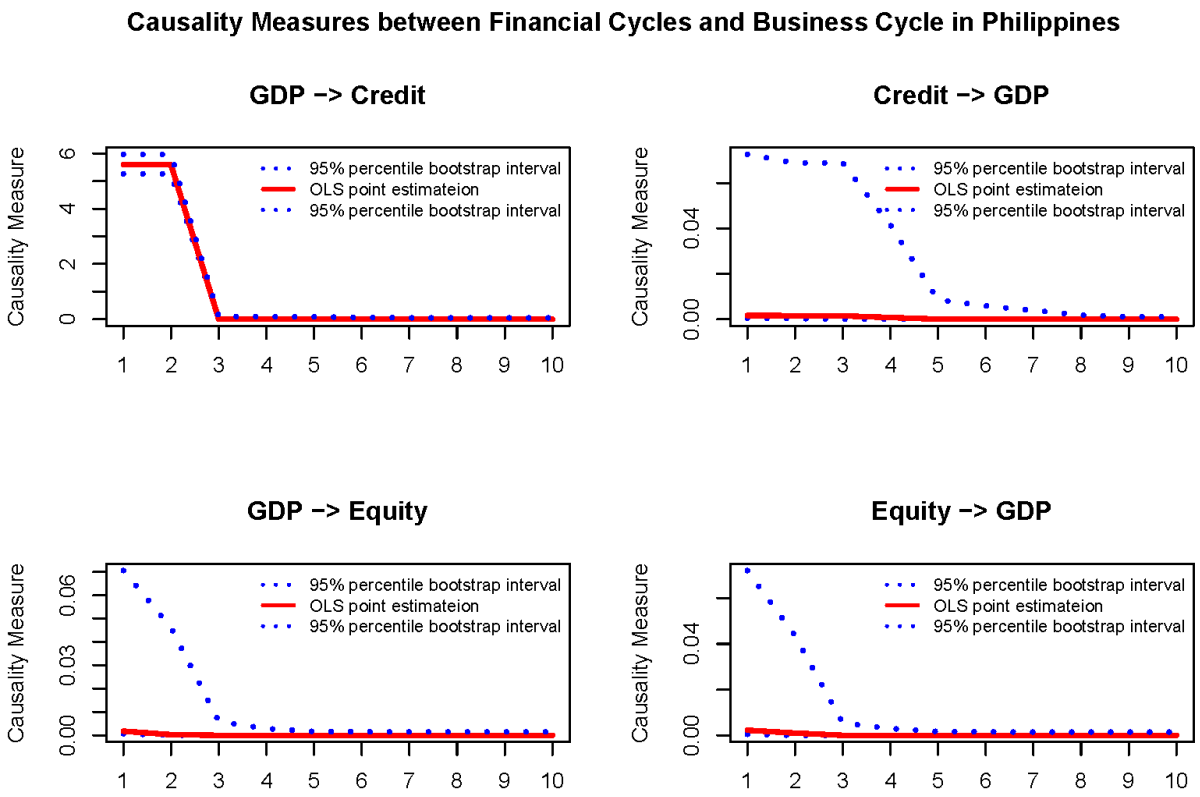
Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.17 Causality measures between Financial Cycles and Business Cycle in Taiwan



Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

Fig. 4.18 Causality measures between Financial Cycles and Business Cycle in Philippines



Note: the model is VAR model with k=3 and horizon=10. Sample period: 1980 Q1-2013 Q4 EKY. The arrow indicates the causality direction, for example, GDP → Credit denotes the causality that runs from output growth to credit cycle (measured as growth rate of credit). The red lines indicate the point estimates of causality measures, and the dotted lines describe the 95% confidence interval.

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