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IMPACTS OF BANKING SECTOR ON THE CHINESE ECONOMY: RESEARCH ON THE MONETARY TRANSMISSION MECHANISM

LIAW SHU YEE ZOE

MPHIL

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by
LIAW Shu yee Zoe

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ABSTRACT

**Impacts of Banking Sector on the Chinese Economy:
Research on the Monetary Transmission Mechanism**

by

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Master of Philosophy

Researches on impacts of the banking sector on economic performance are not only provided for those developed economies such as the United Kingdom, the United States, Germany, and Japan, but also for those developing economies, such as South American, Asian and Eastern European countries. In this research, empirical approach has been adopted to explain the monetary transmission mechanism to document the characteristics of the bank lending channel in China since her implementation of the open-door policy. We study how bank loans are transmitted into changes in the economy reflected by variables such as real GDP and inflation. Furthermore, the key economic variable of aggregate investment is decomposed into domestic investment and foreign direct investment in the bank lending channel to study their relationship. Our research comprises two sets of data: first, aggregate time-series data from 1994 Quarter 1 to 2002 Quarter 3 with emphasis on recent economic performance of China and second, unbalanced annual panel data from 1978 to 2002 of provinces are categorized into different regional blocks. Inter-regional comparison is followed by the Granger causality tests. It is found that these two approaches of using the aggregate time-series and panel vector autoregressive (VAR) models give quite different results. The favored panel VAR model provides rich dynamic results which strongly support the hypothesis of multi-directional causality cycle in bank lending channel for China. Also results of causality tests are varied across different regions. The study concludes by with addressing the main issues and policy implications behind the findings.

I declare that this is an original work based primarily on my own research, and I warrant that all citations of previous research, published or unpublished, have been duly acknowledged.

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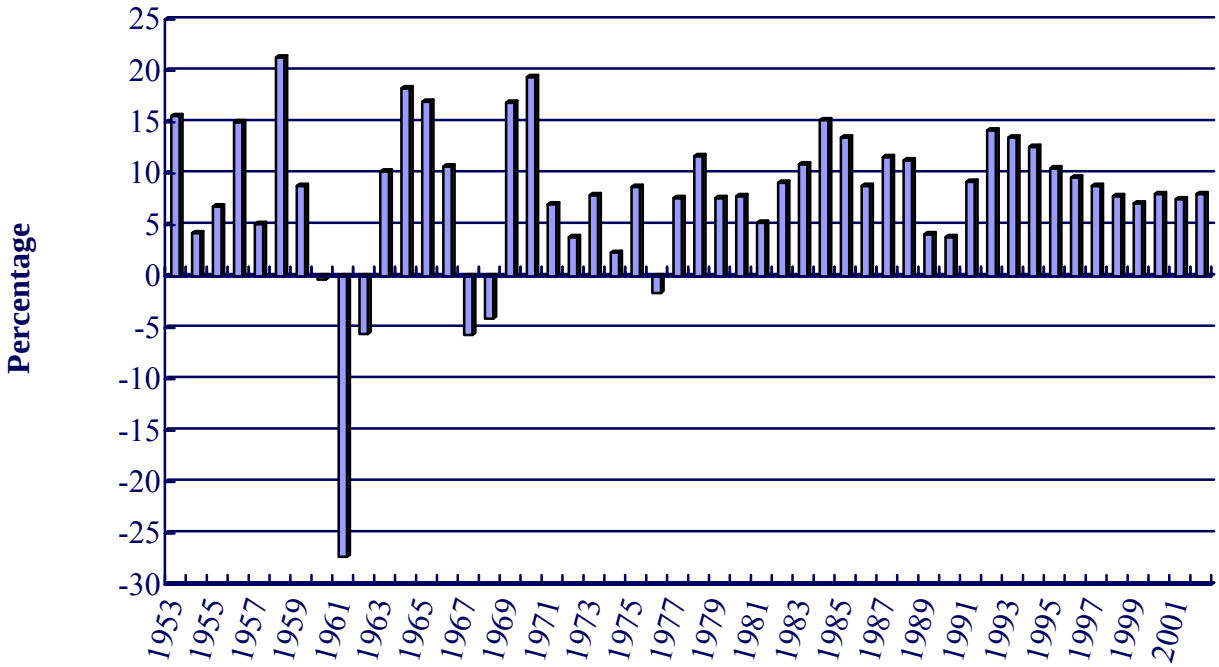
Chapter 1 Introduction

1.1 Introduction

The Chinese economy started the economic reforms and open-door policy and became a mixture of capitalist economy and planned economy after 1979. During the past twenty years, the Chinese economy has undergone many aspects of most dramatic changes since the reform. Within the last decades, China has become an economic power with a gross domestic product approaching that of the United States, and has risen to be one of the world's largest capital importer and absorber. Figure 1.1 has shown the GDP growth rate of China pre- and post- economic reform implemented since 1978.

Figure 1.1 GDP Growth Rate of China from 1952 to 2002



The banks are the backbone of China's financial system. Even though China's economic boom has reached another peak in the post-Deng era, the potential banking crisis began to unfold gradually and steadily; many discussions have largely been dominated by the necessity and the essence of the financial system reform, which in turn led to changes of the monetary transmission mechanism in China.

Table 1.1 Loan loss reserves and non-performing loans in 1990-1995

Country / Region	Non-performing loans as a percentage of total loans	Loan loss reserves as a percentage of total loans
China	25	1
Hong Kong	3.1	2.2
Taiwan	2.6	1.1
Indonesia	11.2	2.6
Thailand	7.6	1.7
Mexico	14.8	3.1
Japan	3.3	1
United States	3.3	1

Source: Tong (2002), T*he Heart of Economic Reform: China's Banking Reform and State Enterprise Restructing* , The Chinese Economy Series, England: ASHGATE Publication

The imperfections and inefficiencies in the banking system of China are ascribed to the corruption and vulnerabilities of the response to political and administrational pressure. Banks credits have been offered to well-connected borrowers who are unlikely to repay their debts. Borrowers do not expect to have to repay loans. Worse still, borrowers can even access more loans regardless of their reliability or creditworthiness. They may continue to borrow and spend even if the interest rates increase. The problematic non-performing loans (NPLs) led to Chinese banks being unable to collect timely payment of interest and principal on more than 40 percent of their loans in early 2004 (Bradsher, 2004). The ratio of NPLs in China is substantially higher than its counterparts before the Asian financial crisis as shown in

Table 1.1. China also has a very low level of loan loss provisions, which means that it is impossible to write off these bad assets using the banks' own loan loss reserves. (Tong 2002)

Hence, considering the factors and conditions stated above, it is of strong interest to examine the monetary transmission mechanism of China to see how the banking sector affects her aggregate economic performance.

The motivation and limitations of this research is illustrated in Section 1.2. Following that, the research framework is provided in Section 1.3. Finally, an overview in Section 1.4 introduces the structure and organization of the whole thesis.

1.2 Motivation and Limitations

We make contributions to the discussion of Chinese performance by focusing on one distinct aspect of China's economy — the mechanism of monetary transmission, which comprises many features of China's past success as well as crucial elements of the transformation process today. This focus has many advantages.

Chinese banks have to quickly adapt to changing circumstances of the economic reforms and have to perpetually transform themselves in order to survive. Hence, the evolution of the bank lending channels that are central to the developments of Chinese economy is in many respects leading to changes that propagate over time to economic sectors and institutions. Hence we need to identify and examine these changes. Furthermore, the bank lending channel is a well-suited testing ground based on a wide range of reliable and publicly available data necessary for empirical research on both aggregate and regional levels. The quarterly and annual data that we

have compiled for our analysis allows us to assess the advantages of time series and panel data analysis. It thus gives us the opportunity to test factors that could not have been observed in most of the previous data sets.

To summarize, changes in the Chinese economy, resulting from new and transformed domestic and international pressures, are likely to be reflected in the reactions of banks and firms. Data that comprise these reactions are readily available. Thus, an empirical investigation of how the bank lending channel works may provide one of the best possible insights into the changes in the Chinese economic system as a whole.

1.3 Research Framework

The aim of this thesis is to provide an analysis of the Chinese economy with well-grounded economic foundations that takes account of specific features of the Chinese economy in general and relationships among all variables in the Chinese economy in particular.

In the credit view literature of monetary economics, there is a transmission mechanism that provides information as to how monetary policy transmits into the macroeconomic performance through some intermediate factors such as bank loans in the bank -lending channel. In this research, we try to expand such a one-way causality mechanism to a multi-directional one. We argue that there should be interactive relationships among all variables in this mechanism. Economic activities and monetary policies should have both direct and indirect dynamic interactions with each other.

We do not promise simple answers to some of the most difficult questions surrounding the workings and stylized facts of the Chinese bank lending channel. By putting particular emphasis on the recent changes of China's financial markets, we want to shed more light on what the relevant picture of the bank lending channel is, how it works, and how the advantages as well as disadvantages are implied in such relationships.

1.4 Overview

The goal of this study is to provide a reasonable description and testable theory, which attempts to give a clear understanding of the complicated system of the bank lending channel in a dynamic environment of deregulated financial markets.

The remainder of the thesis is organized as follows. The second chapter reviews literatures of traditional monetary transmission mechanism and subsequently the formation of a new view of the mechanism.

The third chapter develops a new theoretical framework of the research. It commences with the revision of the classical model of monetary transmission mechanism, the Keynesian model. The legal and institutional changes of China's banking system, as well as the economic development during the last twenty years had a strong influence on the operation of transmission mechanism. Despite a much more liberalized access to various sources of outside finance that are increasingly market-driven, like FDI or issuing shares or bonds, bank loans remain an important source of outside finance. Based on the literature review, an interactive approach and a new paradigm are introduced.

The fourth and fifth chapters introduce the data sets that are used throughout the empirical analysis. Moreover, we underscore the importance of distinguishing causalities between different variables in the bank lending channel, which is necessary for an in-depth assessment of affiliations inside the interactive bank lending channel. In addition, sensitivity analyses of the institutional changes are at the last sub-section of these two chapters, to test how the government interventions have impacts on bank lending channel.

Finally, the sixth chapter concludes the analysis with some remarks concerning the bank lending channel and policy implications in China.

Chapter 2 Literature Reviews

2.1 Introduction

The monetary transmissions mechanism is important as the center of the monetary economics. Imperfections of the monetary transmission mechanism and developments of financial institutions cause the literatures and research to evolve from time to time. Banks remain the dominant source of intermediated credit in China; yet to be specialized in overcoming information problems in credit markets. It is necessary to take an overview about how literatures have interpreted the credit view of monetary transmission mechanism, which section 2.2 will provide. Investment is generally accepted as one of the important elements in the lending channel. Hence, in Section 2.3, the focus shifts to describe the investment activities and discuss the question whether different types of investment have the same impact in the channel. Finally, Section 2.4 provides a conclusion to this chapter.

2.2 What do people say about the transmissions mechanism in credit view?

The pillar of the monetary transmission mechanism oversees the monetary policy transmitted into real income in the economy. Let's take a glimpse as to what evidence literatures give to the existence of the bank lending channel.

B S Bernanke and A S Blinder are two well-known founders of the building block of the credit view. Bernanke (1983) first renewed the research interests in intermediations by directing attention to cyclical changes in bank lending. Bernanke and Lown (1991) suggested that if alternative forms of credit are not easily

substitutable with bank loans, then the economic effect of a fall in bank lending, both directly to small borrowers and indirectly to the macro economy as a whole, might be significant. It is consistent with the findings of Bernanke (1992) that banks and other lenders sometimes ration credits. All that is required for a credit channel is that bank credits and other forms of credits are imperfect substitutes for borrowers. Thus the fact that many bank borrowers have potential alternative credit sources does not eliminate the credit channel, as long as the alternative credit sources are to some extent more expensive or less convenient to the borrower.

Bernanke (1993) made further contributions to the lending view. He stressed that borrowers who do not have good alternatives to banks credits reduce aggregate spending when the central bank reduces the monetary base. The reduction in loans is a supplement to the monetary response. Bank loans decline with deposits or money, as in the traditional monetarist transmission process. In addition, borrowers with restricted alternatives respond disproportionately to a monetary shock.

There are also works done on this issue by other economists such as Benjamin Friedman (1983); Friedman and Kuttner (1993) have done extensive work on the effects of changes in credits or financial markets on portfolio allocation. Meltzer (1995) compared the monetarist and lending models and presented evidence on the importance of the lending channel. He described that credit and intermediation have long been analyzed as part of the transmission process.

Romer and Romer (1994) provided reduced-form model estimates by showing that there is a large negative effect of changes in the federal fund rate on real GDP. Their regression output shows that the effect is highly significant in postwar U.S. data. On

the other hand, many econometric models based on the Jorgenson approach (Jorgenson, 1963; Meltzer, 1995) have found negative interest rate effects on investment. For example, Taylor (1993) found that fixed investment is significantly related to the real interest rate in the United States by using the multi-country model. He found that fixed investment is negatively related to the real interest rate in all of the G-7 countries. Again, Taylor (1995) estimated an empirical model of the monetary transmission mechanism in the G-7 countries of United States, Canada, Germany, France, Japan, Italy and the United Kingdom to answer the question why investment remained so strong despite the rise in interest rates.

Since Taylor (1995) has asserted that the monetary transmission mechanism in other nations causes investment, and investment is now the so-called essence of Chinese economic development, further discussion of different types of investment on the economy will be given at Section 2.3.

However, recent research by Perez (1998) employed a quarterly data model for the United States to give evidence that the availability of commercial and industrial loans does not cause aggregate output, which creates doubts in the bank lending channel that appears no longer to be important.

Since the literatures and empirical works are concentrated on the U.S. and other developed economies, it is one of the reasons that this study investigates the credit channel of China as a developing country. We also discuss how certain parts of the credit channel model are modified to test the mechanism of the lending channel in China.

In fact, most of the empirical studies apply a two-fold examination of this mechanism. First, they test it by using aggregate time-series data. Kashyap and Stein (2000) put forth the idea that one of the most influential of this type of studies is Bernanke's (1983) examination of the Great Depression in the United States. In addition, Friedman and Kuttner (1992) used time-series data to estimate a structural vector autoregressive model. They found that shocks on loans supply have significant real effects. Another example is demonstrated by Kashyap, Stein and Wilcox (1993) who successfully gained insight about the commercial papers as substitutions for bank loans. However, Kashyap and Stein (1994) pointed out that aggregate time-series data provide relatively few episodes where monetary policy shifts and how it affects the lending channel. Li (2002c) who uses time series data of China from 1952 to 1999, finds that there is a Granger causality from economic growth to financial intermediation, and its reverse causality. However, there is no causality among the other elements included in the monetary transmission mechanism. Knowing that limitations are associated with the time-series analysis, this study will start with a quarterly time-series model and be followed by a panel data model for China.

Secondly, there are tests using cross-sectional data. Here data are more difficult to collect, organize and quantify, as the micro-firm level data is not easy to obtain. However the result of such kind of testing is promising. A good example is the empirical works by Gertler and Gilchrist (1992) who use a survey of over seven thousand manufacturing firms to compare and contrast the lending behavior of small and large firms under the monetary contraction. Oliner and Rudebusch (1992) make use of the same sort of data in their subsequent work to comment on Gertler and Gilchrist (1992). Kashyap and Stein (2000) provide an improved test of the lending

channel, which has examined in more detail how the monetary policy affects the lending behavior of individual banks, as opposed to broadly aggregated measures of lending. Although the research methods of these cross-sectional works have advantages, the constraint to our research is the unavailability of firm level data of China with bank loans which hinders the feasibility of such tests. To overcome this problem, this study uses panel data at the provincial level.

2.3 Investment Activities

The credit view emphasizes that banks are important because they produce information in funding specialized investment. The importance of investment is to create aggregate demand and to improve economic infrastructures in China (Chow 1993; Sun 1998) Hence, the bank lending channel plays an essential role for the connection between bank loans and investment and for the connection between investment and aggregate output.

Ownership and source of capital inputs divide aggregate investment into different forms of investments. It is widely acknowledged that foreign direct investment is a key factor for the economic growth in China since her liberalization of economic structure in 1978 (Tsang and Ma, 1997; Tsang and Ma, 2000). It should be noted that the overwhelming foreign investment could also bring benefits as well as the undesirable backlashes: competition is pressure on, and therefore there is a survival problem of domestic enterprises (Ma, 2001b).

On the micro level, Driffield and Hughes (2002) employ panel data in the industry level to test whether domestic investment is crowded out by foreign direct investment in the UK. They found that domestic investment can be stimulated by

FDI, yet in some regions, foreign direct investment has crowded out domestic investment. On the macro level, Harrison and McMillan (2003) have done a research by using firm level data from the Ivory Coast to test whether domestic firms are more credit constrained than foreign firms. In addition, they examine borrowings by foreign firms to see whether they aggravate the credit constraints of local firms. The results suggest that foreign direct investment does have a negative effect on domestic investment in the aspects of bank lending.

However, we believe that the effects of foreign direct investment on domestic investment should be varied across nations. In fact, Borensztein, Gregorio and Lee (1998) investigated in a cross-country regression to see whether the inflow of foreign capital would crowd out domestic investment. They found an opposite result: a strong "crowding-in" effect of foreign investment on domestic investment.

The assumption of bank lending channel is that monetary policy can affect the *aggregate* investment which in turn has impact on the real income of an economy. Nonetheless, we relax this assumption and decompose the *aggregate* investment into domestic investment and foreign direct investment. For the case of China, Sun, Tong and Yu (2002) has studied the panel OLS regression model for the determinant factors of foreign direct investment across China. They found that the cumulative foreign direct investment relative to cumulative domestic investment has a negative impact on the new FDI. In this research, apart from explanation of the mechanism of bank lending channel of China, it is also of great interest to find out whether there is a crowding-out effect (i.e. substitution effect) or a crowding-in effect (i.e. complementary effect) between domestic investment and foreign direct investment across different provinces and metropolises. We will apply the Granger causality test

to test this by using both national level time-series vector autoregressive (VAR) models and provincial level panel VAR models.

2.4 Conclusion

This chapter has given a brief literature review of the credit view of monetary transmission, especially the highlights of the bank lending channel. We provided detailed discussions of existing empirical works which concentrate on the bank lending channel. A lot of effort was put into studying the western economies but not the Chinese economy. On the other hand, the chapter brings out the issue of investment in regard to the bank lending channel. We also reviewed the literatures that examined the relationship between domestic investment and foreign direct investment. Inspired by these literatures, the next chapter will provide a new analytical framework to explain the bank lending channel of China.

Chapter 3 Theoretical Framework

3.1 Introduction

Elaborations have been delivered to the literatures that have addressed the issue of the monetary transmission mechanism in the previous chapter. Our research framework will be discussed in this chapter in detail.

From the discussions of the previous chapter, considerable literatures have tried to explain the practicability, validity and feasibility of monetary transmission mechanism in the economy. Up to now, most studies basically concentrate on the situation and experiences in the United States economy. It seems that the traditional bank lending channel has some difficulties in interpreting two historic time periods in the United States: the Great Depression of the 1930s and what Bernanke and Lown (1991) called the “credit crunch” of the early 1990s.

Therefore, there are some doubts as to whether the traditional bank lending channel can successfully explain the whole monetary mechanism. However, subsequent researches modified the theory or tested it in other economies. For example, Taylor (1995) employed an empirical model to examine the monetary transmission mechanism in G-7 countries. The result is promising in that the shifts of monetary policy can stimulate aggregate output (real GDP).

China, a rising economic power, has experienced a great leap in economic reform and now is trying to catch up to the pace of the economic development of its Western counterparts. There is no research by which to apply the concept of Granger causality

to examine the bank lending channel in China. The focus of this research is to investigate the relationship of the banking sector and the Chinese economy from the bank lending channel based on the credit view of the monetary transmission mechanism. It also examines the impact of banking sectors on the Chinese economy.

The structure of the remaining part of this chapter is as follows: the review of the traditional framework of the monetary transmission mechanism is given in Section 3.2 and the designated paradigm and methodologies will be discussed in Section 3.3 followed by a the conclusion.

3.2 Traditional Framework

Economists, monetarists and policy makers have debated for a long time about the effects of monetary policy on economic activity. To summarize their arguments, it is necessary to understand the mechanisms through which monetary policy affects the economy.

Mishkin (2003) described two basic evidences: structural model evidence and reduced-form evidence.

> "Keynesians typically examine the effect of money on economic activity by building a structural model, a description of how the economy operates using a collection of equations that describe the behavior of firms and consumers in many sectors of the economy. These equations then show the channels through which monetary and fiscal policy affect aggregate output spending"

A Keynesian structural model might have behavioral equations that describe the workings of monetary policy with the following systematic and schematic Figure 3.1. The Keynesians examine the channel between money supply and aggregate spending by studying how the link between interest rates and investment influences the economy. The model describes the transmission mechanism of monetary policy as follows: The money supply *M* affects interest rates ***i***, which in turn affects investment spending *I*, which in turn affects aggregate output or aggregate spending *Y*.

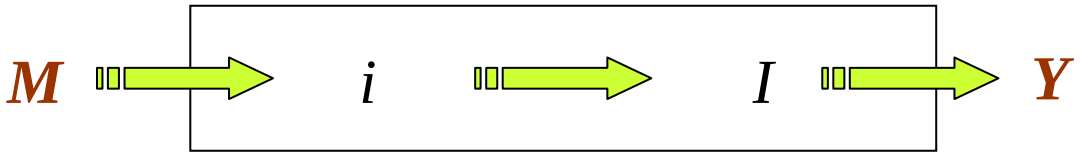


Figure 3.1 The transmission mechanism of Keynesian structural model.

Unlike the Keynesians, Monetarists examine the monetary effects by using reduced-form models, as the economy was supposed to work in a black box in which operations cannot be clearly seen. Therefore there is no structural restriction imposed on how monetary policy affects the economy. In regards to the interest-rate channel in the transmission mechanisms, continuous disagreements and dissatisfactions have driven the monetary research into two directions: other asset price effects and the credit view.

Credit view has five channels in the mechanism. Figure 3.3 provides a general view on all transmission channels of credit view. Balance-sheet channel refers to the fact that the expansionary monetary policy will cause a rise in the equity prices. Thus, due to reduction in adverse selection and moral hazard problems, lending activity,

investment and aggregate demand will be increased.

Another channel that works similar to the balance-sheet channel is called the cash flow channel. Like the previous channel, it starts with expansionary monetary policy, which decreases the nominal interest rate and increases the amount of flowing cash in hand, the results that followed, therefore, are the same as the balance-sheet channel. Adverse selection and moral hazard problems become less severe, leading to an increase in lending and aggregate output.

The unanticipated price level channel has suggests that expansionary monetary policy leads to an unanticipated increase in the price level which raises real net worth, that decreases the possibility of adverse selection and moral hazard problems, thereby causing a rise in investment spending and aggregate output.

Apart from issues concerning the business spending, there is a channel focus on consumer spending, namely, the household liquidity effects. Mishkin (1977) has claimed that the likelihood of suffering from financial distress of consumers will lead to other mechanisms for monetary policy, operating through the link between money and equity prices. “When consumers have a large amount of financial assets relative to their debts, their estimate of the probability of financial distress is low, and they will be more willing to purchase consumer durables or housing.” When stock prices rise, the value of financial assets rises as well, thus increasing consumption and hence aggregate output.

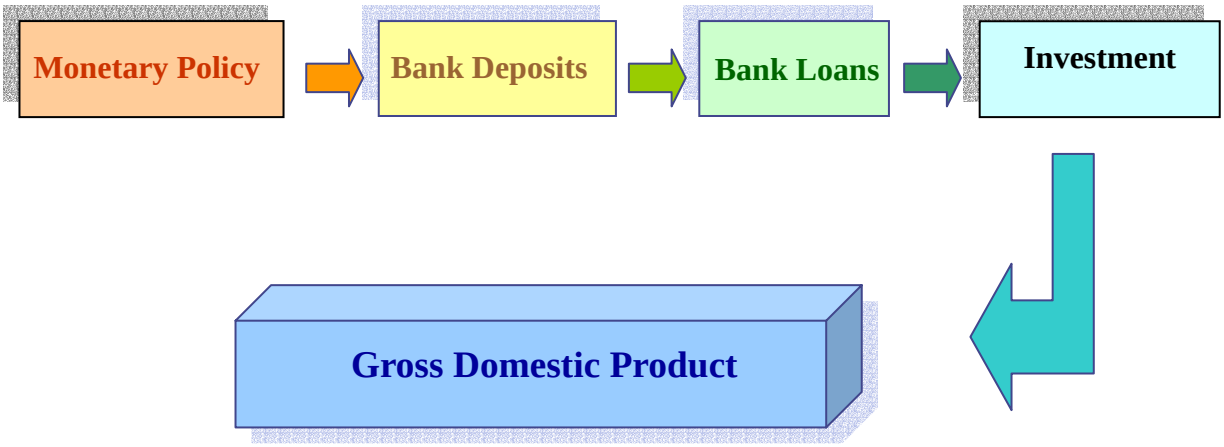
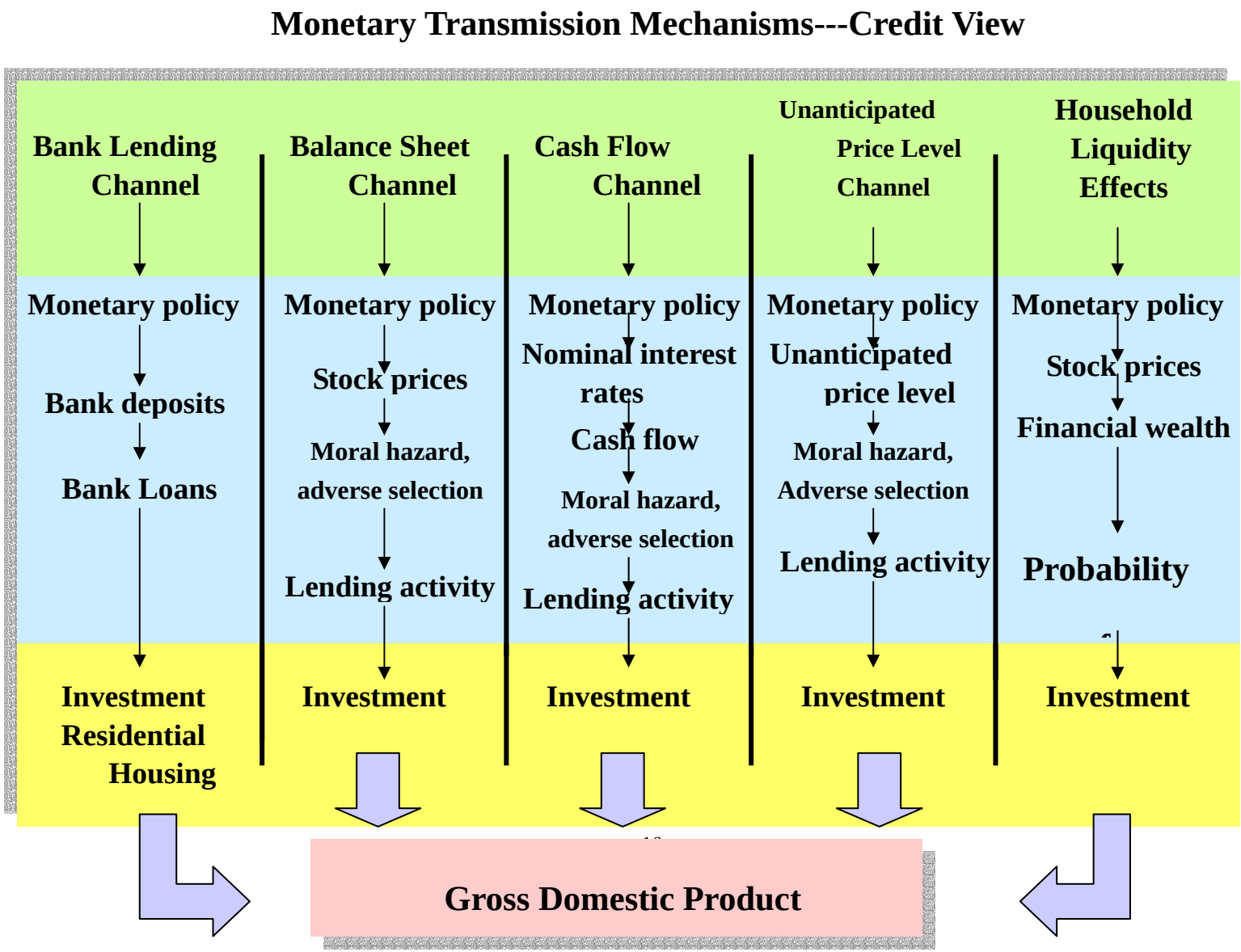


Figure 3.2 Theoretical operation of the bank lending channel

In contrast to the traditional Keynesian transmission mechanism that operates strictly through interest rates, the credit view holds that a bank lending channel allows central bank actions to affect the supply of loans from depository institutions ('banks'), which in turn, affect the real spending of bank borrowers. Increases in bank deposits result in an expansionary monetary policy, which enables the quantity of bank loans to be increased. In other words, access to obtaining bank loans will cause investment and consumer spending. Figure 3.2 is a graphic explanation of how the bank lending channel works in an economy.

Figure 3.3 The link between monetary policy and GDP: Monetary Transmission Mechanisms in Credit View



3.3 An analytical paradigm

Just as in the bank lending channel shown in Figure 3.2, there is a clear mechanism for how the monetary policy transmits into the macroeconomic performance through some intermediate factors. Nevertheless, we try to expand such a one-way causality mechanism depicted in Figure 3.2 to a multi-direction causality mechanism in Figure 3.4. This implies that economic activities and monetary policies have both direct and indirect dynamic interactions with each other.

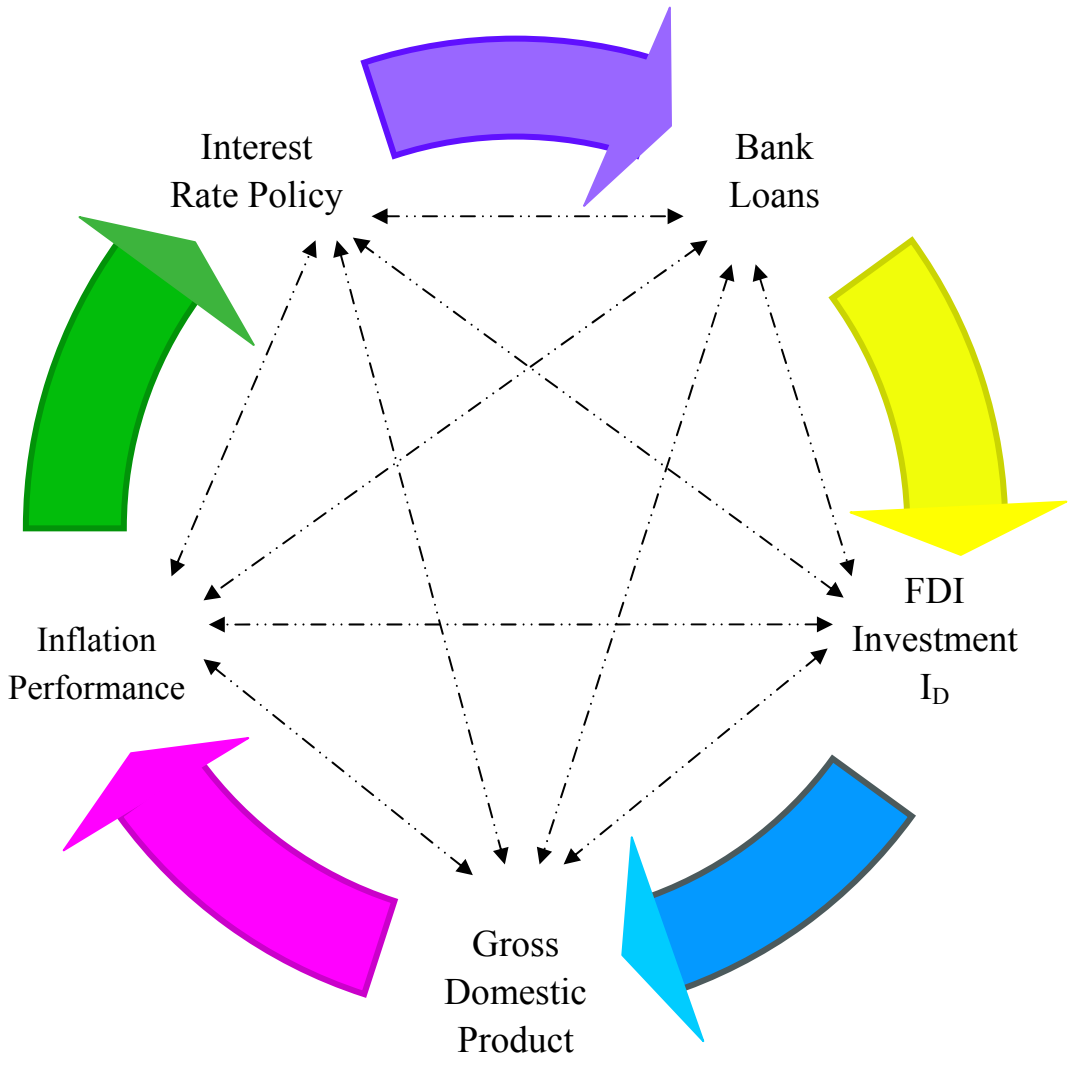


Figure 3.4 Paradigm of the causalities of bank-lending channel

In a comprehensive method to investigate the causalities, we have simplified the

bank lending channel by ignoring the bank deposits, as bank loans can reflect the amount of the deposits. Hence there are total five key factors to be examined in this channel. They are respectively interest rate (monetary policy), bank loans, investment, Gross Domestic Product (economic activity) and inflation performance (economic performance).

In Figure 3.4, the arrows inside the cycle represent the direct causality of each pair of factors. Next we will discuss the interactions of the five factors in the bank lending transmission mechanism based on the paradigm in Figure 3.4.

A Interest Rate Policy

To begin with, the condition of the monetary policy will affect the capacity of bank loans with a negative causality (see Bernanke (1993) and Bernanke and Gertler (1995)). For instance, a decrease in nominal interest rate will increase the capacity of bank loans. Investment is affected by the monetary policy as the interest rate is the crucial indicator of the atmosphere of the investment. It is expected that a negative impact in this pair of causality (Taylor, 1995). He has addressed there will be a fact that economic activity and economic performance are highly related to monetary policy in a negative way. An increase in interest rate reduces people's incentives to consume, which in turn affects GDP (in expenditure approach). Similarly, an upward shift of interest rate can contain inflation, therefore the interest rate is negatively related to inflation.

B Bank Loans

An increase in the amount of bank loans leads to an increase in investment and therefore a positive causality is expected among them. Besides, Bernanke and

Blinder (1992), Bernanke and Gertler (1995) Mishkin (1995) pointed out that underlying loans are positively related to economic output according to the Keynesian theory. There is a positive relation between bank loans and inflation rate. As bank lending can achieve positive growth in investment and economic output, hence in turn it causes inflation. Consequently, the central bank will raise interest rates to control the inflation rate. Hence bank loans are positively related to the interest rate.

C Investment

Positive causalities are expected from investment to both GDP and inflation. Investment is one of the crucial factors that contributes to GDP. An increase of investment will therefore also generate inflation pressure. Monetary policy will then act as an instrument to promptly confine the overheated economy (Bernanke (1992), Bernanke and Gertler (1995)). A positive sign is therefore expected from investment to interest rate

It is also widely accepted that an increase in investment will follow from an increase in GDP since investment requires credits from banks for capital inputs. Hence the increase of the number of potential investment projects will cause a higher incentive for the demand of loans (cf. Sub-section 3.3), as the bank would like to seek potential partners for bank lending.

D Gross Domestic Product (GDP)

Gross Domestic Product is an important indicator of economic activity. Bernanke (1992) believes that strong economic growth may lead to a higher demand for credit to finance spending decisions, thus economic activity positively affects bank loans

(cf. Sub-section 3.3 B for the reverse causality from credit to GDP). This is the main idea of the credit view that regards loans as the third asset besides money and bonds. Banks loans can generate real GDP too.

Aggregate output is an indicator of the necessity of adjustment of monetary policy (cf. Sub-section 3.3 A). When the growth rate of Gross Domestic Product of an economy is believed to be to fast, it may accelerate the inflation. The central bank will set a brake on it by increasing the interest rate. Hence the GDP affects the interest rate positively.

An increase in aggregate output will increase the demand for investment, because potential investors favor a strong economic performance on aggregate spending.

E Inflation Performance

Inflation rate is one of the important indicators of the economic performance. Inflation rate has a direct impact on monetary policy if the central bank intends to stabilize the inflation rate as a target. (Please refer to Sub-section 3.3 A) A positive relationship between inflation and bank loans is expected. A rise in inflation will lead to a fall in the real cost of loans thereby creating an incentive for households and firms to have a demand for more loans (cf. Sub-section 3.3 B).

Howells and Hussein (1999) argued that if bank lending rates are somewhat sticky relative to changes in prices, it is still expected that inflation has a negative impact on investment. The rise in inflation is associated with large variability of the inflation rate; this may generate uncertainty about the future return on investments and discourage firms from undertaking investments (cf. Sub-section 3.3 C). Like the

aggregate output, the inflation rate is another indicator of confidence level for investment. It is because an increase in inflation does worsen the business environment, which defies the investors.

Expectation of negative effect of inflation rate on aggregate output (cf. Sub-section 3.3 D) was reinforced by Mankiw (1995) which points out that though economic growth positively leads to a rise of inflation, conversely, inflation hinders the aggregate output.

Having discussed the theoretical relations in Figure 3.4, we now discuss the empirical test of them. Empirical work on the existence of a bank lending channel generally has focused on the correlations among aggregate output, bank debt, and indicators of monetary policy. Perez (1995) suggested that correlations do not necessarily imply causality. The fact that the movement of one variable is linked to another does not necessarily mean that one variable causes the other.

As such, we have two main foci in this research of the transmission mechanism. Firstly, it is the causality of loans and aggregate output. The links of loans and aggregate output have been shown in Figure 3.5 below: how loans affect the aggregate output.

Figure 3.5 Linkage of the causality loans and aggregate output.

We expected there should be positive two-way causalities between loans and investment and between investment and aggregate output.

However, a negative influence may arise from investment affecting loans. Because investment can be through another channel of financing: the foreign direct investment. Therefore, the second focus of this research is about the investment source. We will investigate two types of investments to consider their causality to the economic activity. Figure 3.6 shows the whole picture of the investment mechanism. There will be two possibilities. One is a negative effect in the causality between domestic investment and foreign direct investment if the crowding out effect occurred. Another is the complementary effect, therefore, a positive sign should be expected in the causality.

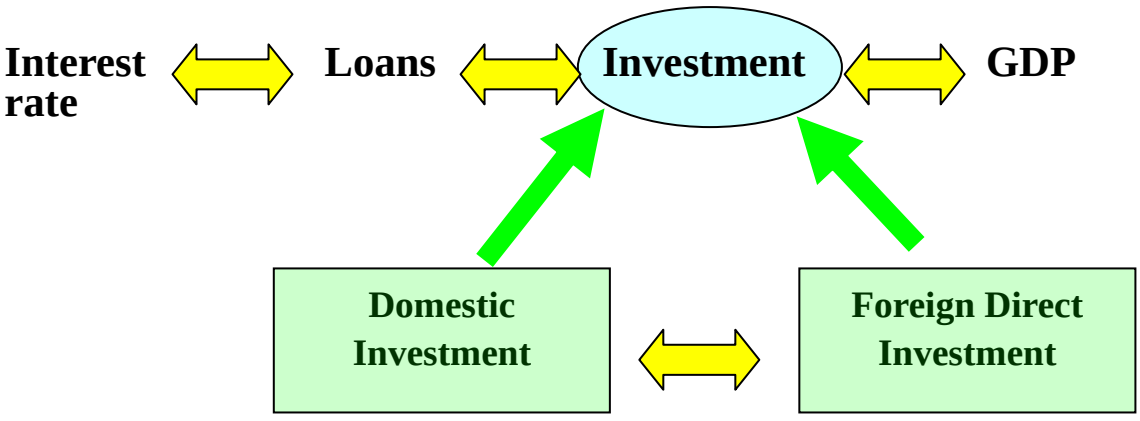


Figure 3.6 Expanded mechanism of investment in relationships to the bank lending channel

As China's economy becomes increasingly market oriented and sophisticated, some indirect causalities of the transmission mechanisms besides the direct ones are

expected. Hence, a vector autoregressive (VAR) time series model and its panel counterpart will be employed as instruments to test the causalities of each pair of the key factors.

3.4 Concluding Remarks

Considerable research has explored the role played by bank lending in the transmission of monetary shocks. Keynesian structural model emphasize on the behavior of the monetary policy which affects aggregate output and investment. Notwithstanding the rapid changes of the economic environment in recent decades doubts and contradictions are raised concerning the validity of the Keynesian model in the modern world. For example, Christiano, Eichenbaum and Evans (1996), based on reduced-form models, claimed that in recent years there has been a great deal of work on developing monetary models and there has also been substantial progress in constructing empirical measures of the transmission mechanism.

Along with new development of monetary economics, we are focusing on the bank lending transmission channel which is expanded from the credit-view theory. The focus is how the economy generates output through credit activities. Therefore, financial intermediators such as banks are important for our study. In the research paradigm, we have focused on how bank loans affect economic output. We include both domestic investment and foreign domestic investment as two important economic activities. These two investment activities might interact with each other to have either a crowding out effect or a complementary effect. The causality test to be implemented in this research will try to identify these effects.

In the remaining part of the thesis, Chapter 4 will apply the vector autoregressive

(VAR) model as a tool to investigate the aggregate effect of bank lending channel on quarterly time series model for China. The regional impacts will be examined by an unbalanced panel VAR model in Chapter 5.

Chapter 4 Aggregate Time Series Model

4.1 Introduction

In the previous chapter, a theoretical framework was built to analyze the credit view of the bank lending channel. In this chapter, we apply the aggregate time series model to conduct the empirical study for China.

There is considerable empirical research to explore the bank lending channel. Benanke and Blinder (1988 and 1992), Romer and Romer (1990) and Bernanke and Gertler (1995) have provided extensive literature review (cf. Chapter 2 for a detailed discussion). Recently, Calza, Manrique and Sousa (2003) studied the behavior of euro aggregate loans to the private sector. In our study, we will follow their approach to model the bank lending channel by using aggregate Chinese quarterly data over the recent nine years.

The remaining part of this chapter is organized as follows: Section 4.2 gives the detailed procedure of how to apply the time series model to conduct the Granger causality tests, Section 4.3, reports the results and analyzes the main findings, Section 4.4 presents concluding remarks.

4.2 Methodology

Basically, the time series model is a common and comprehensible approach to for studying the monetary transmission mechanism. For western economies, there are already enormous literatures which have studied the monetary transmission mechanism in OECD countries. In this section, we employ the method of the time

series model utilized by Calza, Manrique and Sousa (2003) to study the case of China. We now commence with the data description and derivation of the model.

4.2.1 Data Description

The China Statistical Information and Consultancy Service Centre offers two sources that provide our data: China Monthly Statistics (CMS) and China e-monthly Statistics (CEMS), with coverage from 1994 to 2003. Subject to the availability of the data, quarterly data was adopted for the following variables: the aggregate output (GDP), value-added of industrial sector (VA), loans (including total loans, industrial short term loans and total industrial loans[1]) in national banking systems and other banks in China[2]. For the missing value during the sample period, complements of the data are from the CEIC Asian Dataset of China. The lending rate of working capital for 1 year and of capital construction for less than 3 years are collected from the Datastream, which represent the short and long run interest rates, respectively.

Base year of the constant price has been chosen as 1995. All the variables except interest rate must be deflated by the deflator p to obtain the real time series. The symbol $\boldsymbol{p}$ stands for the deflator. There are two deflators in this study. They are respectively, the GDP deflator and value-added deflator, which are calculated as the ratio of current market price series over the constant price series. All the time series are plotted in Fig 4.1. The GDP deflator has sharp fluctuations from the mid 1994 to 1996Q1, then it remains quite steady towards 2003 [cf. Figure 4.1 (b)]. Interestingly,

[1] Total industrial loans are approximated as total loans times industrial short term loans over total short term loans

[2] Before 1995, due to the availability of data, there is no classification of National Banking system and Other Banks by CMS, therefore the figure is from the statistical information of the state owned banks

the value-added deflator has a U-shaped graph showing that it fell to the bottom in 1999. Inflation rate, π, is calculated as $\triangle p*4$ – the annualized inflation rate. From Figure 4.1, we can see that the trend of the two inflation rates based on the GDP deflator and value-added deflator are rather similar.

Increasing trends of real GDP, real value-added of industrial sector, total loans and total industrial loans provided evidence of rapid growth in Chinese economy, with exception of industrial loans which have slowed down gradually after 1999. Though domestic investment and foreign direct investment have been deflated by two different deflators, all of these four variables have strong upward trends in Figure 4.1b.

Interest rates are regulated by the People's Bank of China that leads to the downward shapes for both interest rates of working capital 1 year and of capital construction less than 3 years.

Real GDP, real value-added, all bank loans and, all real investments have taken the natural logarithm. All variables except interest rates have been subject to the X-11 seasonal adjustment[3]. Table 4.1 provides a brief review of statistical information of all variables.

[3] X-11 is the quarterly seasonal adjustment program adopted by the United Sates Bureau of the Census & Statistical Research Division

Table 4.1a Descriptive statistics of quarterly time series

Sample: 1994:1 2003:3

	Y_{GDP}	Y_{VA}	$LOANS_{ttl}$	$LOANS_{stindustrial}$	$LOANS_{ttlindustrial}$	$i_{(working\ capital\ 1\ yr)}$	$i_{(capital\ construction\ less\ than\ 3\ yrs)}$	π_{GDP}
Mean	7.552082	6.471497	8.715258	7.387688	7.825030	7.970000	8.589231	-0.011685
Median	7.631466	6.491703	8.895450	7.647176	8.063598	6.390000	6.660000	-0.004631
Maximum	7.945290	7.009233	9.428653	7.780721	8.427605	12.06000	13.50000	0.317032
Minimum	6.647772	5.938381	7.791130	6.435085	6.854890	5.310000	5.490000	-0.496494
Std. Dev.	0.302426	0.299198	0.477237	0.437421	0.494041	2.590054	3.112614	0.166907
Skewness	-1.108111	-0.000756	-0.484435	-1.024790	-0.689420	0.387845	0.397442	-0.874656
Kurtosis	3.907850	2.005878	2.011776	2.468706	2.071620	1.423179	1.438097	4.562363
Jarque-Bera	9.320725	1.605955	3.112354	7.098161	4.374887	5.018096	4.990995	8.939237
Probability	0.009463	0.447993	0.210941	0.028751	0.112203	0.081346	0.082455	0.011452
Sum	294.5312	252.3884	339.8951	280.7322	297.3511	310.8300	334.9800	-0.455703
Sum Sq. Dev.	3.475535	3.401746	8.654679	7.079489	9.030843	254.9184	368.1579	1.058601
Observations	39	39	39	38	38	39	39	39
Missing Data:				1994Q1	1994Q1			

Note: For definitions of the variables, see Appendix

Table 4.1b Descriptive statistics of quarterly time series

Sample: 1994:1 2003:3

	π_{VA}	$I_{D,GDP}$	$I_{D,VA}$	FDI_{GDP}	FDI_{VA}	GDPDEFLATOR	VADEFLATOR	TIME
Mean	-0.012855	6.134363	6.320239	4.500862	4.681285	1.024895	0.863043	19.00000
Median	-0.014676	6.169845	6.429682	4.506922	4.700999	1.006068	0.834418	19.00000
Maximum	0.364964	6.964793	7.073197	5.005306	5.143843	1.203490	1.062901	38.00000
Minimum	-0.555012	5.347888	5.448467	4.158996	4.262739	0.945368	0.741697	0.000000
Std. Dev.	0.155350	0.421247	0.451764	0.176164	0.195795	0.062380	0.095265	11.40175
Skewness	-0.706942	0.084618	-0.246980	0.587498	-0.386382	1.359244	0.631875	0.000000
Kurtosis	5.906863	2.352515	2.144885	3.735724	3.282382	4.126757	2.226743	1.798421
Jarque-Bera	16.10875	0.671816	1.462828	2.882856	1.015356	14.07211	3.475406	2.346162
Probability	0.000318	0.714689	0.481228	0.236590	0.601892	0.000880	0.175924	0.309412
Sum	-0.475638	220.8371	227.5286	162.0310	168.5263	39.97090	32.79563	741.0000
Sum Sq. Dev.	0.868814	6.210703	7.143175	1.086184	1.341751	0.147869	0.335790	4940.000
Observations	37	36	36	36	36	39	38	39
Missing Data:	1994Q1 to Q2	1994Q1 toQ3	1994Q1 toQ3	1994Q1 toQ3	1994Q1 toQ3		1994Q1	

Figure 4.1(a) Multiple graphs of time series

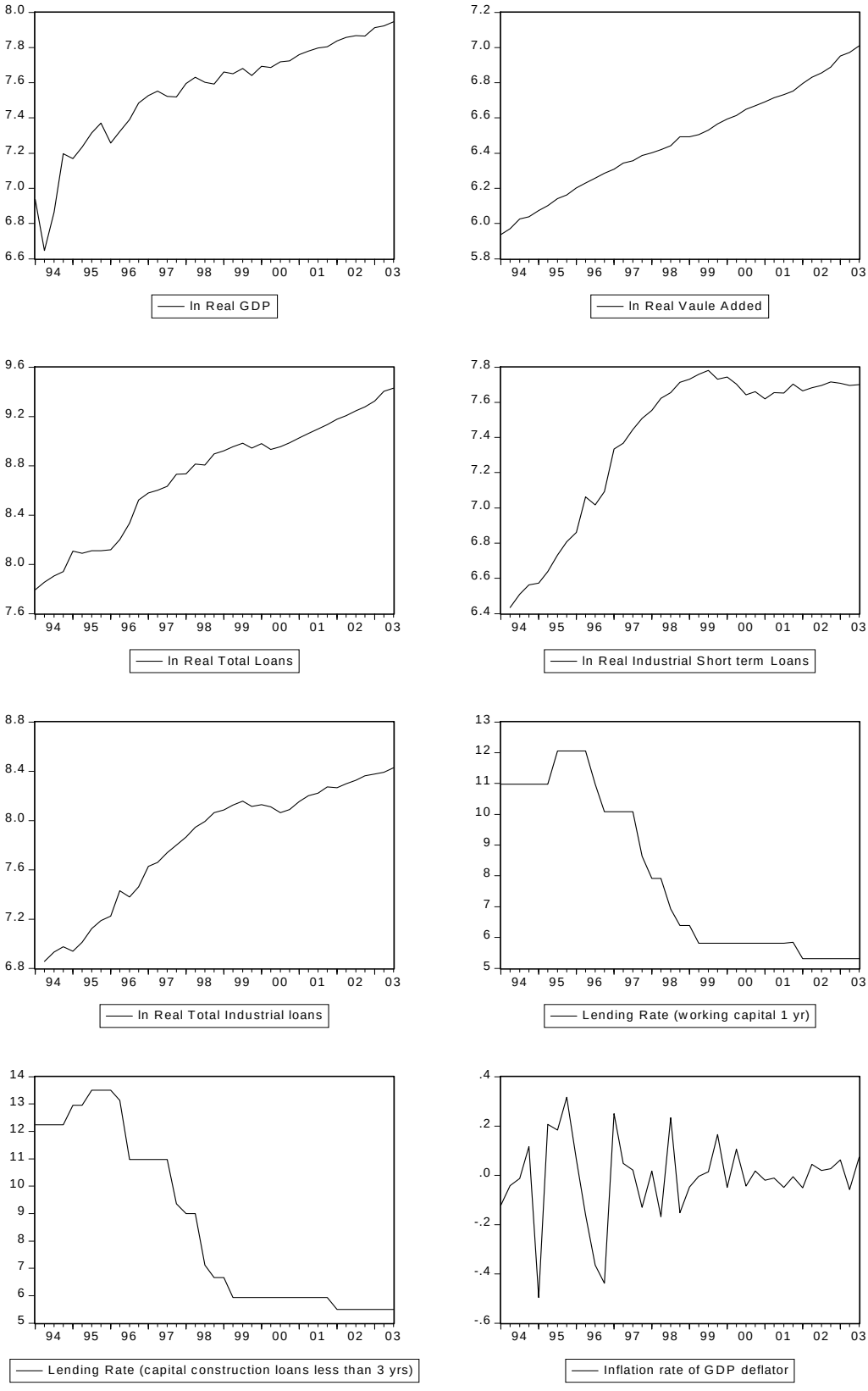
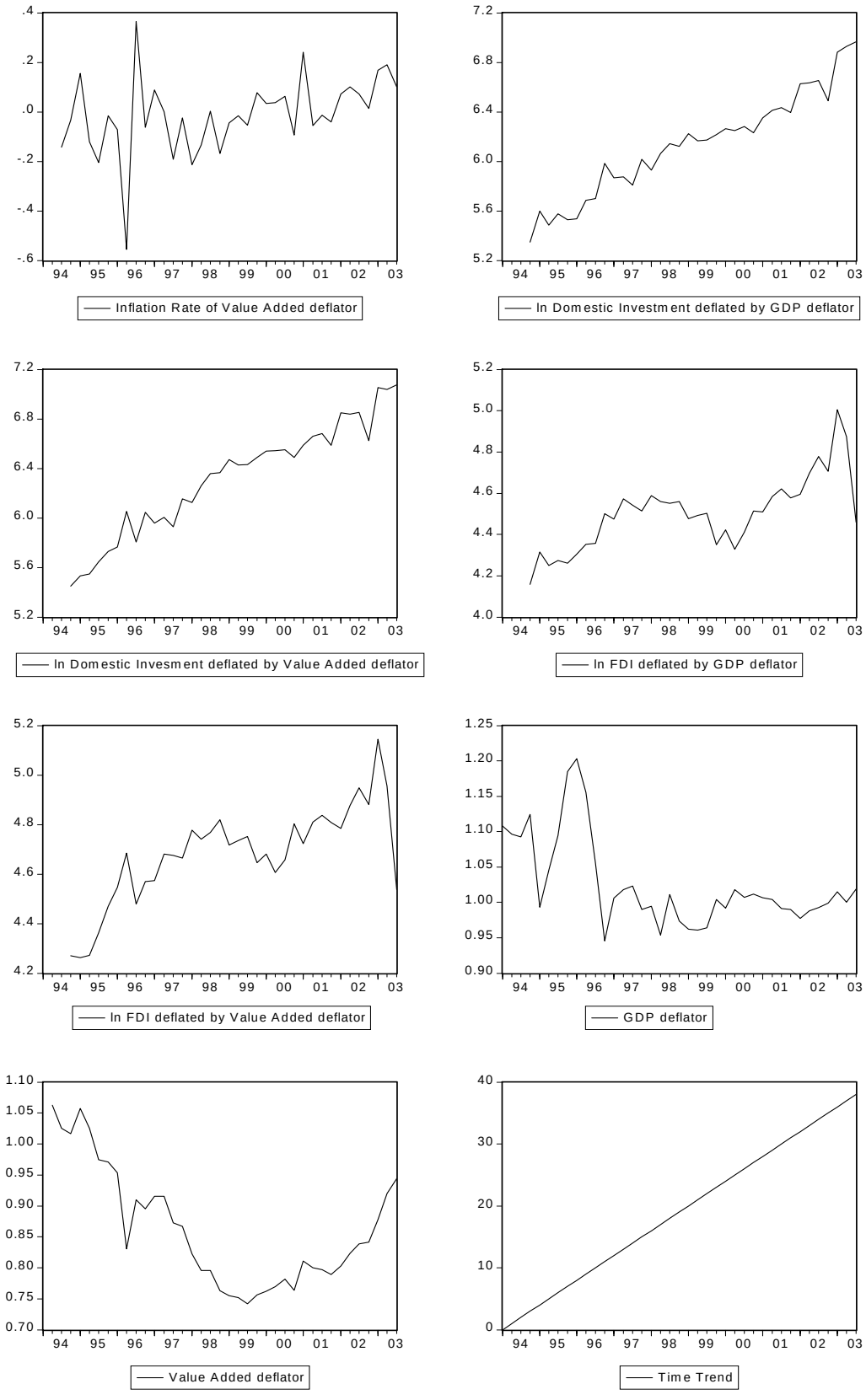


Figure 4.1(b) Multiple graphs of time series



4.2.2 The Model

According to literatures and previous theoretical work on the bank lending channel (cf. Chapter 3), the determinants of the loans issued by the banking sector in China to the economy can be modeled as a function of lending rate, inflation rate, domestic investment and foreign direct investment. The basic model is specified in the log-linear form:

$$Y_t = f(loans_t, i_t, \pi_t) + \varepsilon_t \qquad (1)$$

where f(.) is the functional form, Y and loans denote logs of real GDP and real value of the loans.The nominal interest rate is represented by i and π stands for the annualized inflation rate[4]. The error term is $\boldsymbol{\varepsilon_t}$.

To consider the impacts of investments (domestic investment I_D and foreign ones FDI) in the process of bank lending channel, equation (1) is expanded as the following:

$$Y_t = f(loans_t, i_t, \pi_t, I_{Dt}, FDI_t) + \varepsilon_t \qquad (2)$$

Equations (1) and (2) are just two examples of the whole banking-lending channel mechanism, which actually is estimated by the time series Vector Autoregressive (VAR) model. Define $Z_t = (loans_t, Y_t, i_t, \pi_t)$, or $Z_t = (loans_t, Y_t, i_t, \pi_t, I_{Dt}, FDI_t)$.

[4] Adopting the method used by Calza, Manrique and Sousa (2003), π should refer to the rate of expected inflation in principle. But since inflation expectations are not directly observable and there are several difficulties in their estimation, the conventional approach in the empirical work consists of taking contemporaneous inflation as a proxy (implicitly relying on the assumption that expectations are- on average- in line with the outcomes).

The VAR equations are expressed as follows:

VAR (q): $$Z_t = \beta_0+\beta_1 Z_{t-1}+\beta_2 Z_{t-2}+\ldots\beta_q Z_{t-q}+\varepsilon_t \quad (3)$$

The number of lags (*q*) in each VAR is set to minimize the value of Schwarz Criteria as Table 4.2 shows. To avoid the pre-test bias that may arise from the integration and cointegration tests on the time series vector *Zt*, we apply the surplus lag estimation (Lukepohl and Burda, 1997) to test the Granger causality from one variable to another. That is, we estimate a VAR with *q+1* lag and then only apply the Wald test on the coefficients of the variables with lags up to *q* to conduct the Granger causality test.

VAR (q+1): $$Z_t = \beta_0+\beta_1 Z_{t-1}+\beta_2 Z_{t-2}+\ldots\beta_q Z_{t-q}+\beta_{q+1} Z_{t-(q+1)}+\varepsilon_t \quad (4)$$

Based on the availability of data, variables are grouped in 20 different vector autoregressive (VAR) models. Table 4.3 has listed the summary of different combination of the variables in each named VAR.

We now take VAR 5 as an example to demonstrate how to obtain the result of each pairs of causality (see Statistic Appendix in this chapter).

First of all, it is required to consider the Schwarz Criteria in every vector autoregression with different lags (see, for example, Table 4.9 for lag 3) to find the optimal lags *(q)* (see summary results in Table 4.10). The optimal lag *q* is in 3 with a minimized Schwarz Criteria -5.279003.

Table 4.2 Summary of Schwarz Criteria in VARs.

VAR code	1 Lag	2 Lags	3 Lags	4 Lags	5 Lags
VAR 1	-5.15 †	-4.9	-4.2	-4.47	-3.35
VAR 2	-4.36 †	-4.2	-4.02	-4.29	3.35E-3
VAR 3	-8.69 †	-5.9	-3.26	-5.52	NA
VAR 4	-7.88 †	-5.02	-2.55	-5.64	NA
VAR 5	-4.84	-5.01	-5.28 †	-4.68	-3.56
VAR 6	-3.97	-4.24	-4.98 †	-4.43	-3.36
VAR 7	-8.62 †	-5.84	-4.63	-6.52	NA
VAR 8	-7.78 †	-4.97	-4.08	-5.03	NA
VAR 9	-7.9 †	-6.83	-5.27	-4.34	-2.57
VAR 10	-9.39 †	-6.54	-4.25	-2.84	NA
VAR 11	-8.29 †	-7.03	-5.4	-4.03	-2.19
VAR 12	-8.06 †	-6.51	-5.15	-3.41	-1.35
VAR 13	-9.84 †	-6.84	-3.82	-1.2	NA
VAR 14	-9.58 †	-6.51	-3.64	-0.25	NA
VAR 15	-7.64 †	-6.43	-4.69	-3.72	-1.94
VAR 16	-8.89 †	-5.93	-3.43	-2.25	NA
VAR 17	-8.03 †	-6.64	-4.86	-3.39	-1.59
VAR 18	-7.74 †	-6.33	-4.68	-2.8	-0.82
VAR 19	-9.24 †	-6.17	-3	-0.63	NA
VAR 20	-9.02 †	-6	-2.87	0.36	NA

Note: † denotes optimal lag for the VAR. for definitions of each VAR, see Table 4.3.

According to Lukepohl and Burda (1997), lags *(q+1)* will be adopted to conduct the Granger causality tests based on system estimation of VAR. The system estimation is therefore based on 4 lags (Table 4.11). The advantage of the system estimation is its efficiency in estimating the parameters.

Table 4.3 Selected Variables of the linkage of Bank Lending Channel in each Vector Autoregression

Name of the VAR	Economics Output	Bank Loans	Monetary Policy	Economic Performance	Investment	Investment	Time Trend
VAR1	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Working Capital 1 yr)	π (GDP Deflator)			
VAR2	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Capital Construction less than 3 yr)	π (GDP Deflator)			
VAR3	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Working Capital 1 yr)	π (GDP Deflator)	**I_D deflated by GDP delfator**	**FDI deflated by GDP deflator**	
VAR4	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Capital Construction less than 3 yr)	π (GDP Deflator)	**I_D deflated by GDP delfator**	**FDI deflated by GDP deflator**	
VAR5	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Working Capital 1 yr)	π (GDP Deflator)			**TIME**
VAR6	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Capital Construction less than 3 yr)	π (GDP Deflator)			**TIME**
VAR7	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Working Capital 1 yr)	π (GDP Deflator)	**I_D deflated by GDP delfator**	**FDI deflated by GDP deflator**	**TIME**
VAR8	$\mathbf{Y}_{GDP}$	$\mathbf{LOANS}_{ttl}$	i (Capital Construction less than 3 yr)	π (GDP Deflator)	**I_D deflated by GDP delfator**	**FDI deflated by GDP deflator**	**TIME**
VAR9	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{st}$industrial	i (Working Capital 1 yr)	π (Value Added Deflator)			
VAR10	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{st}$industrial	i (Working Capital 1 yr)	π (Value Added Deflator)	**I_D deflated by Value Added delfator**	**FDI deflated by Value added deflator**	
VAR11	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Working Capital 1 yr)	π (Value Added Deflator)			
VAR12	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Capital Construction less than 3 yr)	π (Value Added Deflator)			
VAR13	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Working Capital 1 yr)	π (Value Added Deflator)	**I_D deflated by Value Added delfator**	**FDI deflated by Value added deflator**	
VAR14	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Capital Construction less than 3 yr)	π (Value Added Deflator)	**I_D deflated by Value Added delfator**	**FDI deflated by Value added deflator**	
VAR15	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{st}$industrial	i (Working Capital 1 yr)	π (Value Added Deflator)			**TIME**
VAR16	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{st}$industrial	i (Working Capital 1 yr)	π (Value Added Deflator)	**I_D deflated by Value Added delfator**	**FDI deflated by Value added deflator**	**TIME**
VAR17	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Working Capital 1 yr)	π (Value Added Deflator)			**TIME**
VAR18	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Capital Construction less than 3 yr)	π (Value Added Deflator)			**TIME**
VAR19	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Working Capital 1 yr)	π (Value Added Deflator)	**I_D deflated by Value Added delfator**	**FDI deflated by Value added deflator**	**TIME**
VAR20	$\mathbf{Y}_{VA}$	$\mathbf{LOANS}_{ttlindustrial}$	i (Capital Construction less than 3 yr)	π (Value Added Deflator)	**I_D deflated by Value Added delfator**	**FDI deflated by Value added deflator**	**TIME**

Note: For definitions of the variables, see Appendix

Finally, based on the system estimation of VAR 5 with 4 lags, we apply the Wald test in Table 4.4 to test the hypothesis of no Granger causality, i.e., that all parameters of the variables of first 3 lags are zeros. The Wald test provides the p-value from the chi-squared distribution. If the p-value is below, say, 5% (0.05), then the hypothesis is rejected and Granger causality is found. In addition, the sum of the coefficients of the first 3 lags is also presented, which provide the long-run effect of the independent variable on the dependent variable.

4.3 Empirical Results

Surprisingly, results from the various VARs have shown a weak causality in the bank lending channel (Table 4.4). The results somehow cannot even give evidence to support the traditional view of the monetary transmission mechanism. There may be no direct causality but there exists indirect causality among variables in the proposed bank lending channel explained in Chapter 3.

4.3.1 The Causality between bank loans and economic output

Figure 4.2 provides a clear picture how bank lending channel works from the estimated model. It shows the significant direct and indirect causalities within the channel. There is no direct causality from bank loans to real GDP. This is probably due to the fact that the power of the time series model is relatively weak. We will try to examine this pair of causality by using a panel model in the next chapter.

Table 4.4 Causality Test of VAR 5

Wald Test

System Estimation: VAR5

Null Hypothesis:	Chi squared statistic	Probability	Conclusion	Sum of Coefficients
For equation Y_{GDP}:				
Coefficients of $LOANS_{ttl}$ (-1) to $LOANS_{ttl}$ (-3) are all zeros	2.69711	0.440719	$LOANS_{ttl} \neq> Y_{GDP}$	0.108883
Coefficients of ***i*** (-1) to ***i*** (-3) are all zeros	2.375429	0.498225	***i*** $\neq> Y_{GDP}$	0.022229
Coefficients of π (-1) to π (-3) are all zeros	9.293084	0.025638**	π => YGDP	-0.38769
For equation $LOANS_{ttl}$:				
Coefficients of Y_{GDP} (-1) to Y_{GDP} (-3) are all zeros	7.77649	0.050864**	Y_{GDP} => $LOANS_{ttl}$	-0.72473
Coefficients of ***i*** (-1) to ***i*** (-3) are all zeros	6.232434	0.100833*	i =>$LOANS_{ttl}$	-0.02317
Coefficients of π (-1) to π (-3) are all zeros	5.724646	0.125803	$\pi \neq>$ LOANSttl	-0.15023
For equation i:				
Coefficients of Y_{GDP} (-1) to Y_{GDP} (-3) are all zeros	11.026694	0.010367***	Y_{GDP} => ***i***	5.669402
Coefficients of $LOANS_{ttl}$ (-1) to $LOANS_{ttl}$ (-3) are all zeros	8.01345	0.045735**	$LOANS_{ttl}$ => ***i***	-2.27337
Coefficients of π (-1) to π (-3) are all zeros	12.63435	0.005498***	π => i	2.236776
For equation π:				
Coefficients of Y_{GDP} (-1) to Y_{GDP} (-3) are all zeros	7.532479	0.05673*	Y_{GDP} => π	3.029775
Coefficients of $LOANS_{ttl}$ (-1) to $LOANS_{ttl}$ (-3) are all zeros	2.007328	0.570887	$LOANS_{ttl} \neq> \pi$	-0.52809
Coefficients of ***i*** (-1) to ***i*** (-3) are all zeros	6.909065	0.074853*	***i*** => π	0.147483

Notes: $\neq>$ means no Granger Causality.

=> means there is Granger Causality.

***, ** and * denotes for 1%, 5% and 10% significance, respectively.

Probability of χ^2 distribution with 3 degrees of freedom

	[9.08947]	[0.38950]	[4.12192]	[-0.24937]
TIME	0.014331	0.010363	0.063053	-0.022653
	[6.93574]	[2.69052]	[2.03626]	[-1.55602]

R-squared	0.994221	0.994606	0.990392	0.541839
Adj. R-squared	0.990806	0.991418	0.984715	0.271107
Sum sq. resids	0.009646	0.033515	2.166324	0.478851
S.E. equation	0.02094	0.039031	0.313798	0.147533
F-statistic	291.1406	312.0335	174.4447	2.001386
Log likelihood	96.96284	74.54523	-0.493017	26.67614
Akaike AIC	-4.609047	-3.363624	0.805168	-0.70423
Schwarz SC	-3.993234	-2.747811	1.420981	-0.088417
Mean dependent	7.613428	8.787393	7.719167	-0.007743
S.D. dependent	0.218382	0.421329	2.538127	0.172805

Determinant Residual Covariance	2.27E-10
Log Likelihood (d.f. adjusted)	195.3606
Akaike Information Criteria	-7.742255
Schwarz Criteria	**-5.279003**

Table 4.10 Summary of Schwarz Criteria for VAR5 with different lags

	1 Lag	2 Lags	3 Lags	4 Lags	5 Lags	6 Lags
Determinant Residual Covariance	9.33E-09	1.59E-09	2.27E-10	7.30E-11	3.64E-11	1.25E-12
Log Likelihood (d.f. adjusted)	135.6285	164.8306	195.3606	209.8191	215.6533	264.9322
Akaike Information Criteria	-5.875183	-6.7476	-7.742255	-7.875377	-7.509018	-9.753469
Schwarz Criteria	-4.840918	-5.006067	**-5.279003**	-4.675803	-3.558437	-5.037203

.

Table 4.11 System Estimation of VAR 5

System: VAR5

Estimation Method: Least Squares (Marquardt)

Sample: 1995:1 2003:3

Included observations: 35

Total system (balanced) observations 140

Equation: $Y_{GDP} = C(1)* Y_{GDP}(-1) + C(2)* Y_{GDP}(-2) + C(3)$
$* Y_{GDP}(-3) + C(4)* Y_{GDP}(-4) + C(5)*LOANS_{ttl}(-1) + C(6)$
$* LOANS_{ttl}(-2) + C(7)* LOANS_{ttl}(-3) + C(8)* LOANS_{ttl}(-4) + C(9)*\boldsymbol{i}(-1)$
$+ C(10)*\boldsymbol{i}(-2) + C(11)*\boldsymbol{i}(-3) + C(12)*\boldsymbol{i}(-4) + C(13)*\pi(-1)$
$+ C(14)*\pi(-2) + C(15)*\pi(-3) + C(16)$
$*\pi(-4) + C(17) + C(18)*TIME$

Observations: 35

R-squared	0.996512	Mean dependent var	7.625348
Adjusted R-squared	0.993024	S.D. dependent var	0.209351
S.E. of regression	0.017486	Sum squared resid	0.005198
Durbin-Watson stat	1.843789		

	Coefficient	Std. Error	t-Statistic	Prob.
$Y_{GDP}(-1)$	-0.221563	0.18989	-1.166795	0.2474
$Y_{GDP}(-2)$	-0.008176	0.099415	-0.082238	0.9347
$Y_{GDP}(-3)$	0.070239	0.065866	1.066393	0.29
$Y_{GDP}(-4)$	0.161365	0.065148	2.476911	0.0157
$LOANS_{ttl}(-1)$	-0.044438	0.187165	-0.237425	0.813
$LOANS_{ttl}(-2)$	0.343595	0.245326	1.400563	0.1659
$LOANS_{ttl}(-3)$	-0.190332	0.264978	-0.718295	0.475
$LOANS_{ttl}(-4)$	0.161059	0.227892	0.706733	0.4821
$\boldsymbol{i}(-1)$	0.017946	0.015213	1.179692	0.2422
$\boldsymbol{i}(-2)$	-0.007211	0.013054	-0.552353	0.5825
$\boldsymbol{i}(-3)$	0.011494	0.013139	0.874806	0.3848
$\boldsymbol{i}(-4)$	-0.003451	0.011878	-0.290563	0.7723
$\pi(-1)$	-0.12021	0.051036	-2.355401	0.0214
$\pi(-2)$	-0.117333	0.052873	-2.219171	0.0298
$\pi(-3)$	-0.150144	0.063008	-2.38291	0.02

π (-4)	0.023334	0.03642	0.640693	0.5239
Constant Term	4.87288	1.093359	4.456798	0
TIME	0.012353	0.00356	3.469777	0.0009

Equation: $LOANS_{ttl}$ = C(19)* Y_{GDP} (-1) + C(20)* Y_{GDP} (-2) + C(21)
* Y_{GDP} (-3) + C(22)* Y_{GDP} (-4) + C(23)* $LOANS_{ttl}$ (-1) + C(24)
* $LOANS_{ttl}$ (-2) + C(25)* $LOANS_{ttl}$ (-3) + C(26)* $LOANS_{ttl}$ (-4) + C(27)
* ***i*** (-1) + C(28)* ***i*** (-2) + C(29)* ***i*** (-3) + C(30)* ***i*** (-4) + C(31)
* π (-1) + C(32)* π (-2) + C(33)* π (-3) +
C(34)* π (-4) + C(35) + C(36)*TIME

Observations: 35

R-squared	0.99696	Mean dependent var	8.81157
Adjusted R-squared	0.993921	S.D. dependent var	0.401343
S.E. of regression	0.031292	Sum squared resid	0.016646
Durbin-Watson stat	2.034889		

	Coefficient	Std. Error	t-Statistic	Prob.
Y_{GDP} (-1)	-0.54529	0.339815	-1.604667	0.1132
Y_{GDP} (-2)	0.046209	0.177907	0.259739	0.7959
Y_{GDP} (-3)	-0.225644	0.11787	-1.914357	0.0598
Y_{GDP} (-4)	0.43377	0.116584	3.720654	0.0004
$LOANS_{ttl}$ (-1)	0.413332	0.334939	1.234053	0.2214
$LOANS_{ttl}$ (-2)	0.284403	0.43902	0.647813	0.5193
$LOANS_{ttl}$ (-3)	0.612624	0.474187	1.291946	0.2007
$LOANS_{ttl}$ (-4)	-0.691572	0.407821	-1.695773	0.0945
i (-1)	-0.062877	0.027223	-2.309677	0.0239
i (-2)	0.042419	0.023361	1.815794	0.0738
i (-3)	-0.002713	0.023512	-0.115403	0.9085
i (-4)	0.025492	0.021256	1.199294	0.2346
π (-1)	-0.085049	0.09133	-0.931221	0.355
π (-2)	-0.078463	0.094617	-0.829271	0.4099
π (-3)	0.13286	0.112756	1.178301	0.2428
π (-4)	-0.083408	0.065174	-1.279773	0.205
Constant Term	5.147532	1.956605	2.630848	0.0105
TIME	0.019779	0.006371	3.104353	0.0028

Equation: $\boldsymbol{i}$ = C(37)* Y_{GDP} (-1) + C(38)* Y_{GDP} (-2) + C(39)
* Y_{GDP} (-3) + C(40)* Y_{GDP} (-4) + C(41)* $LOANS_{ttl}$ (-1) + C(42)
* $LOANS_{ttl}$ (-2) + C(43)* $LOANS_{ttl}$ (-3) + C(44)* $LOANS_{ttl}$ (-4) + C(45)
* $\boldsymbol{i}$ (-1) + C(46)* $\boldsymbol{i}$ (-2) + C(47)* $\boldsymbol{i}$ (-3) + C(48)* $\boldsymbol{i}$ (-4) + C(49)
* π (-1) + C(50)* π (-2) + C(51)* π (-3) +
C(52)* π (-4) + C(53) + C(54)*TIME

Observations: 35			
R-squared	0.995864	Mean dependent var	7.626
Adjusted R-squared	0.991729	S.D. dependent var	2.511949
S.E. of regression	0.228456	Sum squared resid	0.887268
Durbin-Watson stat	2.237542		

	Coefficient	Std. Error	t-Statistic	Prob.
Y_{GDP} (-1)	4.860501	2.480924	1.959149	0.0542
Y_{GDP} (-2)	-1.378414	1.298868	-1.061242	0.2923
Y_{GDP} (-3)	2.187315	0.860543	2.541785	0.0133
Y_{GDP} (-4)	-2.877496	0.851159	-3.380678	0.0012
$LOANS_{ttl}$ (-1)	-1.433267	2.445324	-0.586126	0.5597
$LOANS_{ttl}$ (-2)	7.966257	3.2052	2.485417	0.0154
$LOANS_{ttl}$ (-3)	-8.806363	3.461951	-2.543758	0.0132
$LOANS_{ttl}$ (-4)	-0.353627	2.977425	-0.118769	0.9058
$\boldsymbol{i}$ (-1)	0.799135	0.198753	4.020737	0.0001
$\boldsymbol{i}$ (-2)	-0.102482	0.170554	-0.600875	0.5499
$\boldsymbol{i}$ (-3)	0.338911	0.171655	1.97437	0.0524
$\boldsymbol{i}$ (-4)	-0.410839	0.155183	-2.647456	0.0101
π (-1)	0.840159	0.666785	1.260016	0.212
π (-2)	1.900823	0.690784	2.751691	0.0076
π (-3)	-0.504206	0.82321	-0.612489	0.5423
π (-4)	0.830589	0.475826	1.745573	0.0854
Constant Term	4.491346	14.2848	0.314414	0.7542
TIME	-0.019055	0.046515	-0.409643	0.6834

Equation: π = C(55)* Y_{GDP} (-1) + C(56)* Y_{GDP} (-2) +
C(57)* Y_{GDP} (-3) + C(58)* Y_{GDP} (-4) + C(59)* $LOANS_{ttl}$ (-1) +
C(60)* $LOANS_{ttl}$ (-2) + C(61)* $LOANS_{ttl}$ (-3) + C(62)* $LOANS_{ttl}$ (-4) +

C(63)* ***i*** (-1) + C(64)* ***i*** (-2) + C(65)* ***i*** (-3) + C(66)* ***i*** (-4) + C(67) * π (-1) + C(68)* π (-2) + C(69)* π (-3) + C(70)* π (-4) + C(71) + C(72)*TIME

Observations: 35

R-squared	0.779595	Mean dependent var	-0.011282
Adjusted R-squared	0.559189	S.D. dependent var	0.173999
S.E. of regression	0.115524	Sum squared resid	0.22688
Durbin-Watson stat	2.195533		

	Coefficient	Std. Error	t-Statistic	Prob.
Y_{GDP} (-1)	2.173881	1.254538	1.732814	0.0877
Y_{GDP} (-2)	0.229002	0.656803	0.348662	0.7284
Y_{GDP} (-3)	0.626892	0.435154	1.44062	0.1543
Y_{GDP} (-4)	-1.582995	0.430409	-3.677885	0.0005
$LOANS_{ttl}$ (-1)	1.454301	1.236536	1.176109	0.2437
$LOANS_{ttl}$ (-2)	-1.664957	1.620785	-1.027253	0.3079
$LOANS_{ttl}$ (-3)	-0.317438	1.750618	-0.181329	0.8566
$LOANS_{ttl}$ (-4)	1.621717	1.505606	1.077119	0.2852
i (-1)	0.249458	0.100504	2.482059	0.0155
i (-2)	-0.157411	0.086245	-1.825162	0.0724
i (-3)	0.055436	0.086802	0.638648	0.5252
i (-4)	-0.110983	0.078472	-1.4143	0.1618
π (-1)	0.10772	0.337175	0.319477	0.7503
π (-2)	-0.226041	0.349311	-0.647104	0.5197
π (-3)	-0.468106	0.416275	-1.124511	0.2648
π (-4)	0.253135	0.240613	1.052043	0.2965
Constant Term	-19.57736	7.22345	-2.710251	0.0085
TIME	-0.059082	0.023521	-2.511825	0.0144
Determinant residual covariance		4.06E-12		

Data Annex

Variables	Explanation
FDI deflated by GDP deflator	Natural logarithm in Foreign Direct Investment deflated by GDP deflator
FDI deflated by vaule added deflator	Natural logarithm in Foreign Direct Investment deflated by Value Added deflator
GDP deflator	GDP in market price over GDP in constant price
I_D deflated by GDP deflator	Natural logarithm in Domestic Investment deflated by GDP deflator
I_D deflated by value added deflator	Natural logarithm in Domestic Investment deflated by Value Added deflator
$LOANS_{ttl}$	Natural logarithm in nominal total loans deflated by GDP deflator
$LOANSst_{insdustrial}$	Natural logarithm in industrial short term loans deflated by value added deflator
$LOANS_{ttlindustrial}$	Natural logarithm in nominal total industrial loans deflated by GDP deflator
$i_{(\text{working capital 1 yr})}$	Lending rate of working captial 1 year
$i_{(\text{capital construction loans less than 3 yrs})}$	Lending rate of capital construction loans less than 3 years
π(GDP deflator)	Inflation rate calculated as: $\triangle p*4$, where p equals to GDP deflator
π(Value Added deflator)	Inflation rate calculated as: $\triangle p*4$, where p equals to value added deflator
TIME	Time Trend
Value added deflator	Value Added in current market price over Value Added in constant price
Y_{GDP}	Real GDP in natural logarithm
Y_{VA}	Real Value Added of Industrial Sector in logarithm

Chapter 5 Panel VAR Model

5.1 Introduction

In the previous chapter, we employed aggregate time series VAR models as the first step to conduct causality tests for the banking sector of China. In this chapter, we will introduce annual panel VAR models to examine the causality chain of the bank lending channel in China.

Similar to the previous chapter, the model of this chapter is an extension of the study of Calza, Manrique and Sousa (2003). The bank loans and the aggregate output are the main focus of our study. In addition, we are also interested in the performance of rapid industrializations of Mainland China in the past twenty years (Ma, et al, 2003; Ma, 2001b; Tsang and Ma, 1997, 2000). Therefore, a more specific causality test has been designed for the industrial sector of the Chinese economy. The bank lending channels of different regional blocks are also compared. The remainder of this chapter is organized as follows: Section 5.2 gives the elaboration of the methodology to derive the panel VAR model in this chapter, Section 5.3 presents the findings and policy implications of the empirical study and finally, Section 5.4 concludes this chapter.

5.2 Methodology

Given the unsatisfactory and unexpected results acquired from aggregate time series VAR models in the previous chapter, in this chapter we use the panel VAR model to examine the bank lending channel in China. Due to the availability of the variables across different regions in China, an unbalanced panel model will be employed to

examine the causality of variables in the bank lending channel.

5.2.1 Data Description

The book entitled "Comprehensive statistical data and materials for 50 years of new China" contains the annual data coverage from 1957 to 1998. We select the post-reform data from 1977 to 1998. Statistical information of the 27 provinces and 4 metropolises is provided in this book. Table 5.1 is the list of the categorization of the 27 provinces and 3 metropolises into 6 regional blocks.

Table 5.1 Classification of provinces and metropolis into different regional blocks

Metropolis	**Northeast**	**Coastal**	**Central**	**Southwest**	**Northwest**
Beijing	Liaoning	Guangdong	Henan	Guangxi	Inner Mongolia
Tianjin	Jilin	Fujian	Hubei	Sichun	Shannxi
Shanghai	Heilongjiang	Jiangsu	Hunan	Guizhou	Gansu
		Zhejiang	Anhui	Yunan	Qinghai
		Hainan	Jiangxi	Tibet	Ningxia
		Shandong	Shanxi		Xingjiang
		Hebei			

Chongqing metropolis is excluded from the model as the economic data of this city is only available after 1992. Besides, to utilize the most updated data, we collected the information from statistical yearbooks for each individual province or metropolis for the period of 1999 to 2003. Annual data includes the national aggregate output (GDP) and GDP of the industrial sector (iGDP), both in constant prices. All variables of total bank loans and industrial loans of the national banking system, as well as foreign direct investment actually utilized in each year, have been deflated by appropriate deflators available to obtain their constant price series. We have two deflators available, namely the GDP deflator and the industrial GDP (iGDP) deflator.

Expected inflation rate and domestic investment[1] are derived by the author (cf. footnote 2 in Section 5.2.2). The annual lending interest rate is collected from International Financial Statistical Book of the IMF, which is the year-ended prime rate for working capital of one year.

Figure 5.1 provides the volume of total China bank loans in 1978, 1990 and 2002. In 2002, the volumes of bank loans in Beijing and Shanghai have similar levels to those of Guangdong, Jiangsu and Zhejiang, while the provinces , except Sichuan, only have bank loans below five hundred billion yuan in 2002. It is found that bank loans decrease from east to west, with the lowest ones in the Northwest regional block.

Figure 5.2 provides the amount of Gross Domestic Product of China in 1978, 1990 and 2002. Other Coastal provinces experienced relatively good records when compared with their counterparts in 2002. Guangdong, Jiangsu and Shandong are the richest provinces from the data. They represent the pioneering economic development in the Pearl River Delta, Yangtze River Delta, and Yellow River Delta according to their geographical location. The output differentials also varied from the coastal areas to the inland ones.

Figure 5.3 provide the inflation rates across different regions. There is no explicit pattern indicating which region has inflation or deflation. Yet there are two provinces that are outlying areas. One is Hubei in which -0.002% deflation has been recorded and another one is Tibet which experienced 0.1% inflation in 2002.

[1] Domestic investment equals to gross capital formation minus respective foreign direct investment.

Figure 5.1 Nominal Total Loans of China in specific year

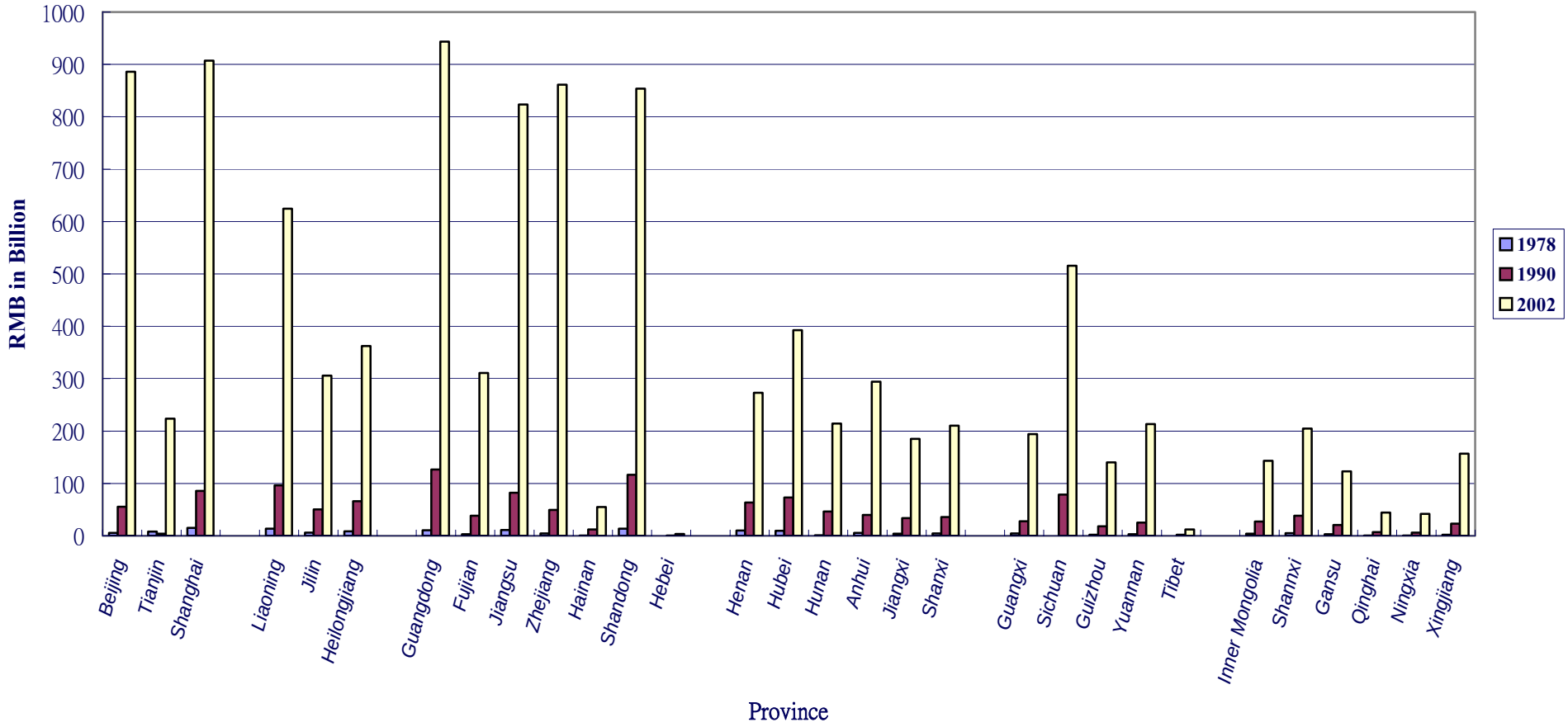


Figure 5.2 Nominal GDP of China in specific year

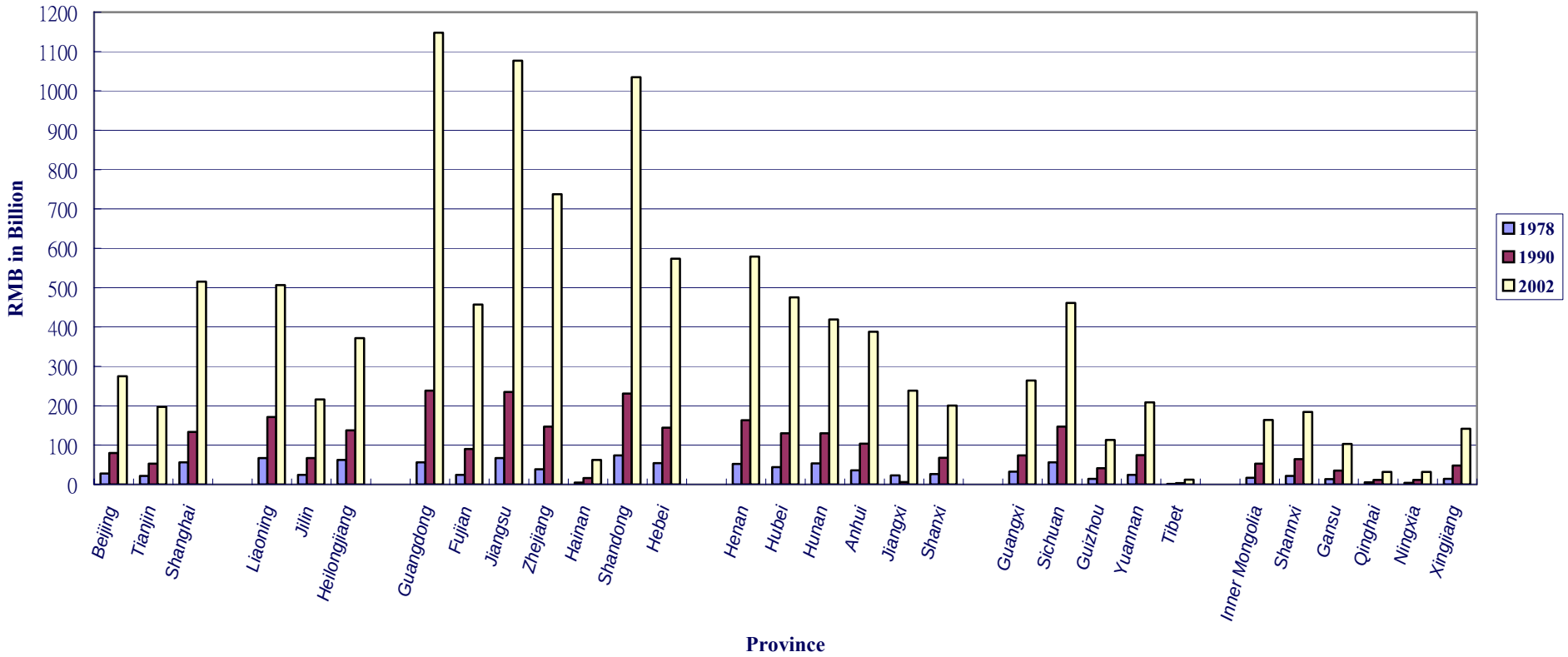


Figure 5.3 Inflation Rate of China in specific year

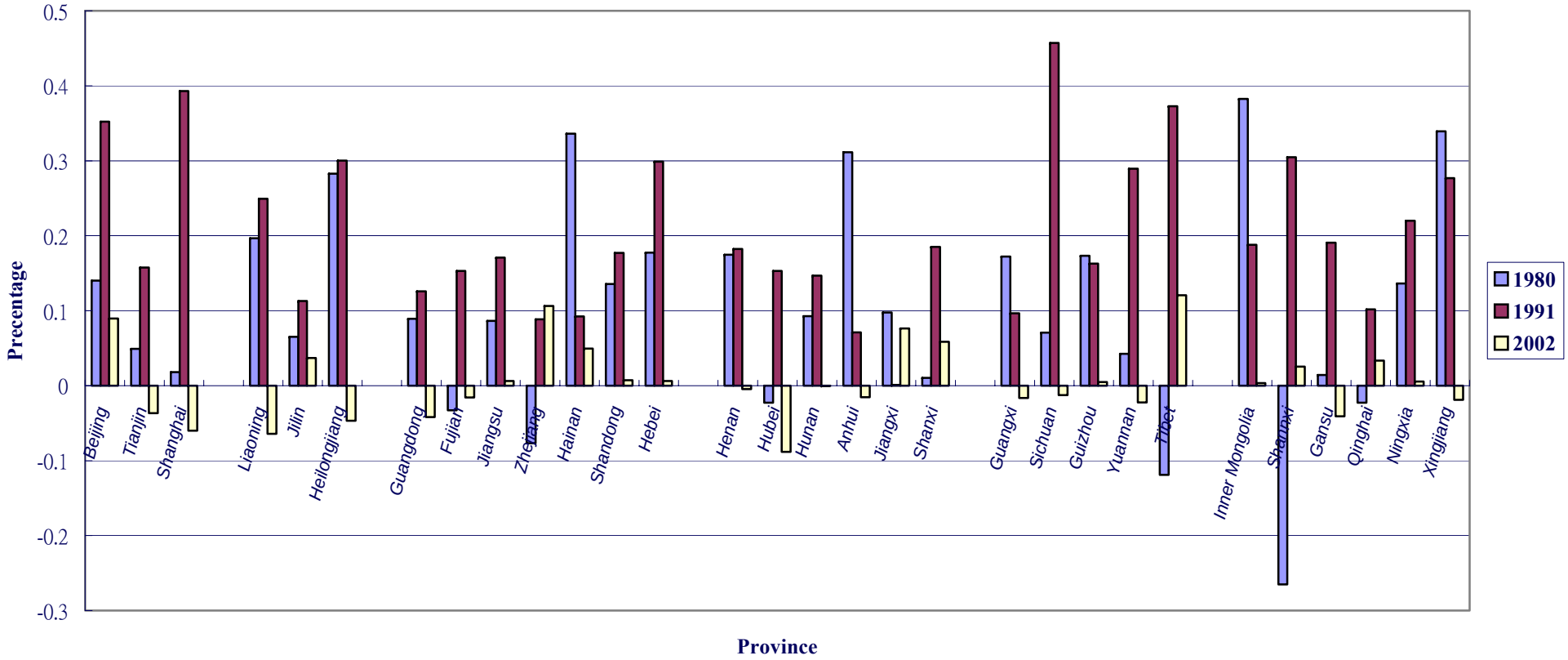
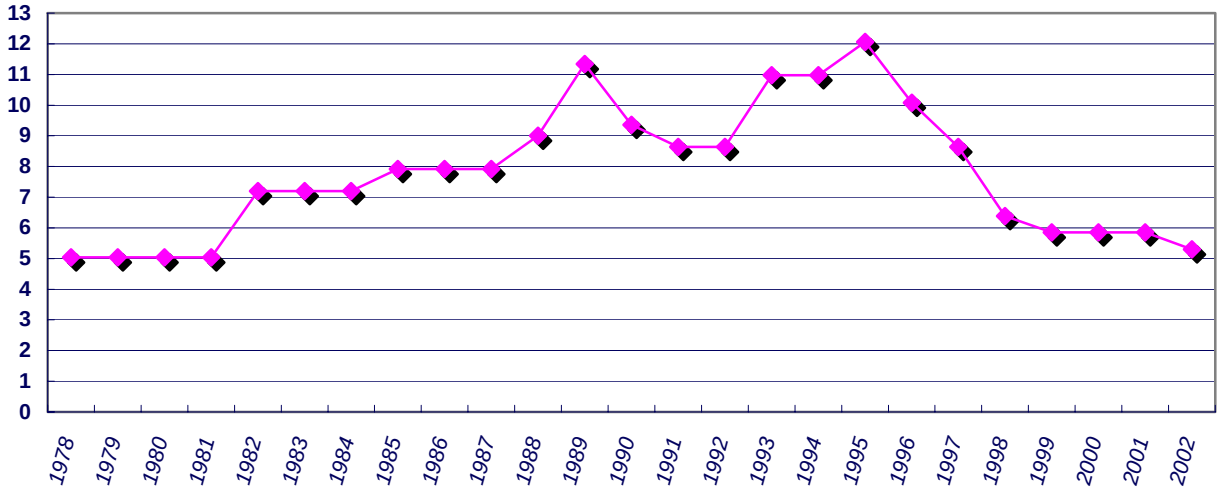


Figure 5.4 shows interest rate changes in China from 1978 to 2002. The interest rate climbed up to its peak in 1990 and then fell in 1992 due to the administrative policy of soft landing policy for the economy in the early 1990s. The year 1996 is another climax of the interest rate. After that, it gradually decreased from 12% to around 5%.

Figure 5.4 Lending Rate of China from 1978 to 2002



Figures 5.5 and 5.6 illustrate domestic investment and foreign direct investment of China in various years. For the foreign direct investment, other coastal regions have adsorbed substantial capacity of foreign capital inflow. For example, Guangdong and Jiangsu has experienced 93.81 and 84.3 billion RMB in 2002. Shandong has had strong performance in domestic investment, which experienced 387 billion RMB. Provinces in the central region share the amount of domestic investment almost equally.

Figure 5.5 Domestic Investment of China in specific year

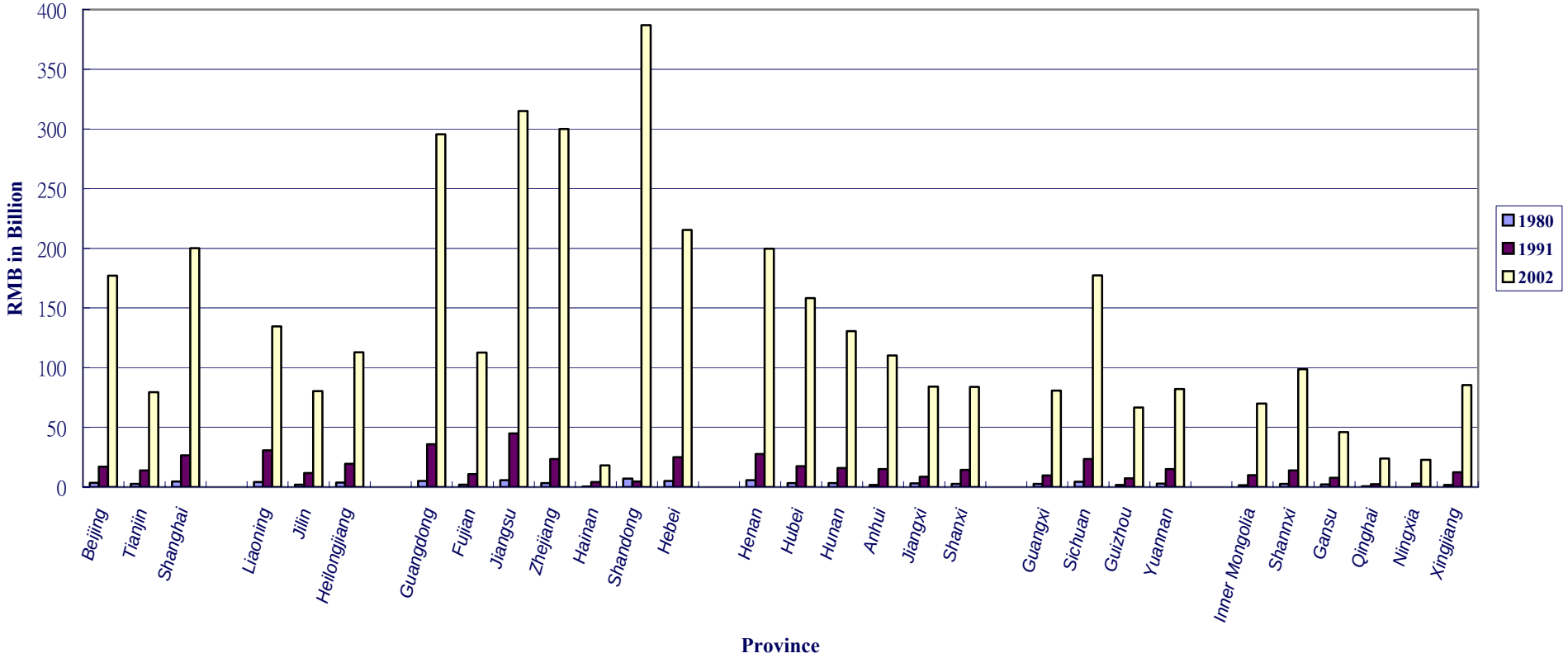
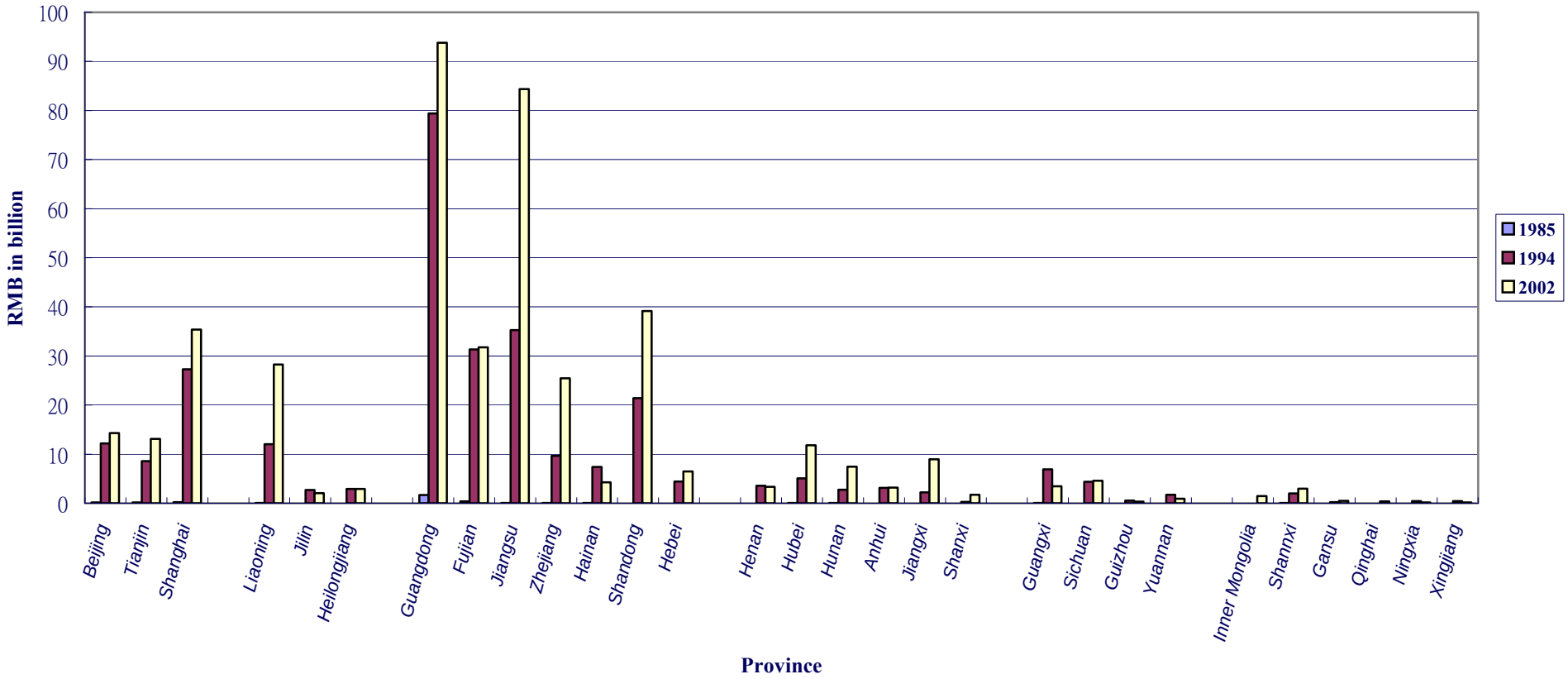


Figure 5.6 Foreign Direct Investment of China in specific year



5.2.2 The Model

According to literatures and previous theoretical work on the bank lending channel (cf. Chapter 3 and Chapter 4), the basic specification of panel VARs is the same as that of time series VARs in Chapter 4. The difference is that we will first examine the time series VARs in each province or metropolis. We will then compute the Granger causality statistic of panel VARs by adopting the Fisher equation reviewed by Maddala and Wu (1999) as a simple way to investigate unbalanced panel model. The classification of provinces and metropolises into 6 different regional blocks is based on the grouping method of Demurger, Sachs, Woo, Bao and Chang (2002), which is according to the geographical and economic characteristics of various locations.

The determinants of the loans issued by the banking sector include lending rate, inflation rate, domestic investment and foreign direct investment. The basic model is specified in the log-linear form:

$$Y_{jt} = f_j(loans_{jt}, i_{jt}, \pi_{jt}) + \varepsilon_{jt} \qquad (1)$$

where $f_j(.)$ is the functional form for province j, subscripts j and t indicate province j and year t respectively, Y and loans denote the natural logarithms of real GDP and real value of the loans. The nominal interest rate is represented by *i;* and π stands for the annualized inflation rate[2]. The error term is ε_{jt}.

[2] Adopting the method used by Calza, Manrique and Sousa (2003), π should refer to the rate of expected inflation in principle. But since inflation expectations are not directly observable and there are several difficulties in their estimation, the conventional approach in the empirical work consists of taking contemporaneous inflation as a proxy (implicitly relying on the assumption that expectations are on average in line with the outcomes).

To consider the impacts of investments (domestic investment I_{Djt} and foreign ones FDI_{jt}) in the process of bank lending channel, equation (1) is expanded to the following:

$$\mathbf{Y_{jt} = f_j(\ loans_{jt}\ ,\ i_{jt}\ ,\ \pi_{jt}\ ,\ I_{D\ jt}\ ,\ FDI_{jt}\ ) + \varepsilon_{jt}} \qquad \mathbf{(2)}$$

Equations (1) and (2) are just two examples of the whole banking-lending channel mechanism, which is actually estimated by the provincial time series Vector Autoregressive (VAR) model. Define Z_{jt} = ($loans_{jt}$, Y_{jt}, i_{jt}, π_{jt}), or Z_{jt} = ($loans_{jt}$, Y_{jt}, i_{jt}, π_{jt}, $I_{D\,jt}$, FDI_{jt}) for each province j. The VAR equations are expressed as follows:

$$\textbf{VAR } (q_j): \qquad \mathbf{Z_{jt} = \beta_{j0}+\beta_{j1}Z_{j,t-1}+\beta_{j2}Z_{j,t-2}+\ldots\beta_{jq}Z_{j,t-qj}+\varepsilon_{jt}} \qquad \mathbf{(3)}$$

where $\boldsymbol{\beta_{j0}}$ to $\boldsymbol{\beta_{jq}}$ are parameters.

The number of lags (q_j) in each VAR is set to minimize the value of Schwarz Criteria as in Table 5.2. To avoid the pre-test bias that may arise from the integration and cointegration tests on the time series vector Z_{jt}, we apply the surplus lag estimation (Lukepohl and Burda, 1997; Sun and Ma, 2004) to test the Granger causality from one variable to another. That is, we estimate a VAR with q_j+1 lag and then only apply the Wald test on the coefficients of the variables with lags up to q_j to conduct the Granger causality test.

$$\textbf{VAR } (q_j+1): \quad \mathbf{Z_{jt} = \beta_{j0}+\beta_{j1}Z_{j,t-1}+\beta_{j2}Z_{j,t-2}+\ldots\beta_{jq}Z_{j,t-q}+\beta_{j,qj+1}Z_{j,t-(qj+1)}+\varepsilon_{jt}} \quad \mathbf{(4)}$$

Based on the availability of data, variables are grouped into 4 different panel vector autoregressive (PVAR) models. Table 5.3 lists the summary of different

combinations of the variables in each named panel VAR model.

We now take PVAR Model 2 as an example to demonstrate how to obtain the result of each pair of causality (see Statistical Appendix of this chapter).

First of all, it is required to consider the Schwarz Criteria in every provincial VAR with different lags (see, for example, Table 5.2a for lag 1) to find the optimal lags *(qj)* (see summary results in Tables 5.2 (a) and (b)). For example, in PVAR Model 2, the optimal lag *qj* for Beijing is in 1 with a minimized Schwarz Criteria -3.32.

According to Lukepohl and Burda (1997), lags *(qj+1)* will be adopted to conduct the Granger causality tests based on system estimation of VAR for Beijing, for example. The system estimation is therefore based on 2 lags. The advantage of the system estimation is its efficiency in estimating the parameters.

Following that, based on the system estimation of Beijing's VAR with 2 lags, we apply the Wald test to test the hypothesis of no Granger causality, for example, from loans to GDP, i.e., the parameter of variable loans with first lag is zero in the equation of GDP. Suppose the probability of this hypothesis, i.e. the p-value, is p_j for province j. Then we repeat the same test for all other provinces in panel VAR Model 2 to obtain their p-value p_j. Finally we employ the following Fisher equation (Maddala and Wu, 1999) to compute the Wald statistic for the PVAR model:

$$-2 \Sigma \log p_j \sim \chi 2$$

with 2N degrees of freedom. N is the number of provinces in the panel VAR.

Table 5.2 (a) Summary of Schwarz Criteria in Panel VAR Models

Model 1				Model 2			
Regions	1 Lag	2 Lags	3 Lags	Regions	1 Lag	2 Lags	3 Lags
Beijing	1.05	1.56	**0.43†**	Beijing	**-3.32†**	/	NA
Tianjin	**5.04†**	7.46	8.58	Tianjin	**11.51†**	16.02	/
Shanghai	**-2.86†**	-0.71	0.09	Shanghai	**-2.28†**	-2.21	/
Liaoning	**-2.13†**	-0.06	1.74	Liaoning	**-3.04†**	/	NA
Jilin	**-1.54†**	-0.37	-0.31	Jilin	**5.42†**	/	NA
Heilongjiang	**-3.63†**	-1.58	-3.24	Heilongjiang	**-3.22†**	/	NA
Guangdong	**5.1†**	6.33	7.08	Guangdong	**7.3†**	8.25	/
Fujian	**-2.05†**	-1.71	-0.63	Fujian	-0.36	**-3.75†**	/
Jiangsu	**-1.33†**	-1.13	1.17	Jiangsu	**-5.89†**	/	NA
Zhejiang	**-0.39†**	0.53	0.39	Zhejiang	**-2.72†**	/	NA
Hainan	**2.36†**	4.48	4.67	Hainan	**3.89†**	3.97	NA
Shandong	**-2.22†**	-1.26	-2.07	Shandong	**1.85†**	/	NA
Hebei	**-2.74†**	-1.63	-2.61	Hebei	**-4.84†**	/	NA
Henan	**3.53†**	5.64	5.09	Henan	**5.73†**	/	NA
Hubei	**-1.91†**	-0.73	-0.19	Hubei	**-4.18†**	/	NA
Hunan	0.04	**-0.57†**	-0.42	Hunan	**0.04†**	/	NA
Anhui	**-0.53†**	1.22	2.88	Anhui	**-3.44†**	/	NA
Jiangxi	**4.27†**	5.98	6.6	Jiangxi	**4.44†**	/	NA
Shanxi	**-0.52†**	1.27	2.5	Shanxi	**0.96†**	/	NA
Guangxi	**2.14†**	2.61	/	Guangxi	**3.46†**	/	NA
Sichuan	**0.12†**	1.6	/	Sichuan	**-3†**	/	NA
Guizhou	**2.8†**	5.53	5.198	Guizhou	**-5.54†**	/	NA
Yuannan	**1.49†**	2.6	4.03	Yuannan	**2.16†**	/	NA
Tibet	**1.53†**	3.51	1.87	Tibet	NA	NA	NA
Inner Mongolia	**-1.76†**	0.66	-0.32	Inner Mongolia	NA	NA	NA
Shannxi	**-1.4†**	-0.66	0.38	Shannxi	**-3.7†**	/	NA
Gansu	**2.34†**	4.77	5.11	Gansu	**2.2†**	/	NA
Qinghai	**-0.43†**	1.12	0.13	Qinghai	**3.61†**	/	NA
Ningxia	7.43	4.08	**3.03†**	Ningxia	NA	NA	NA
Xingjiang	**3.71†**	5.73	7.69	Xingjiang	**-1.71†**	/	NA

Note: † denotes optimal lag for the VARs for definitions of each VAR, see Table 5.3.

'/' means not available that E-view could not provide the Schwarz Criteria

"NA" means not applicable that not enough observations for E-View to estimate

Table 5.2 (b) Summary of Schwarz Criteria in Panel VAR Models

Model 3				Model 4			
Regions	1 Lag	2 Lags	3 Lags	Regions	1 Lag	2 Lags	3 Lags
Beijing	**-0.49†**	1.36	2.93	Beijing	**-1.53†**	/	NA
Tianjin	**1.21†**	2	2.42	Tianjin	**7.89†**	10.97	-
Shanghai	9.49	8.08	**6.07†**	Shanghai	7.41	**5.31†**	/
Liaoning	**-0.03†**	1.22	1.92	Liaoning	**-1.57†**	/	NA
Jilin	**4.78†**	6.29	7.65	Jilin	**8.8†**	/	NA
Heilongjiang	**-0.99†**	-0.9	1.62	Heilongjiang	**-0.56†**	/	NA
Guangdong	**1.1†**	1.39	3.61	Guangdong	**3.21†**	5.08	NA
Fujian	NA	NA	NA	Fujian	NA	NA	NA
Jiangsu	**1.54†**	2.63	4.49	Jiangsu	**-1.25†**	/	NA
Zhejiang	**0.32†**	1.06	0.66	Zhejiang	**-3.43†**	/	NA
Hainan	2.9	3.97	**0.49†**	Hainan	**5.37†**	6.91	NA
Shandong	**-0.13†**	1.8	2.83	Shandong	**4.23†**	/	NA
Hebei	**1.64†**	3.36	5.09	Hebei	**1†**	/	NA
Henan	**-1.51†**	0.56	1.14	Henan	**-2.56†**	/	NA
Hubei	**0.15†**	0.27	/	Hubei	**-1.66†**	/	NA
Hunan	3.48	**1.49†**	2.98	Hunan	**0.75†**	/	NA
Anhui	**-0.12†**	0.4	1.15	Anhui	**-1.76†**	/	NA
Jiangxi	**5.52†**	7.38	10.23	Jiangxi	**6.19†**	/	NA
Shanxi	**-0.86†**	0.74	0.21	Shanxi	**0.55†**	/	NA
Guangxi	**0.88†**	1.94	/	Guangxi	**1.1†**	/	NA
Sichuan	**0.89†**	2.26	/	Sichuan	**1.98†**	/	NA
Guizhou	**-0.49†**	0.81	1.54	Guizhou	**-4.3†**	/	NA
Yuannan	**-0.21†**	0.94	2.67	Yuannan	**2.83†**	/	NA
Tibet	**7.18†**	8.49	10.8	Tibet	NA	NA	NA
Inner Mongolia	**-0.78†**	1.2	2.48	Inner Mongolia	NA	NA	NA
Shannxi	**2.15†**	2.67	3.62	Shannxi	**1.66†**	/	NA
Gansu	**3.65†**	5.87	7.02	Gansu	**4.99†**	/	NA
Qinghai	**0.29†**	0.98	3.25	Qinghai	**7.69†**	/	NA
Ningxia	**0.52†**	0.18	1.12	Ningxia	NA	NA	NA
Xingjiang	**1.59†**	2.69	3.46	Xingjiang	**4.22†**	/	NA

Note: † denotes optimal lag for the VARs for definitions of each VAR, see Table 5.3

'/' means not available that E-view could not provide the Schwarz Criteria

"NA" means not applicable that not enough observations for E-View to estimate

Table 5.3 Structure of Panel VAR Models

Model 1: $GDP_{j,t} = f(Loans_{j,t}, i_{j,t}, \pi_{j,t}) + \varepsilon_{j,t}$

Provinces included: 30

Coastal Metropolis	Beijing	Tianjin	Shanghai				
Northeast	Liaoning	Jilin	Heilongjiang				
Other Coastal	Guangdong	Fujian	Jiangsu	Zhejiang	Hainan	Shandong	Hebei
Central	Henan	Hubei	Hunan	Anhui	Jiangxi	Shanxi	
Southwest	Guangxi	Sichuan	Guizhou	Yuannan	Tibet		
Northwest	Inner Mongolia	Shannxi	Gansu	Qinghai	Ningxia	Xingjiang	

Model 2: $GDP_{j,t} = f(Loans_{j,t}, i_{j,t}, \pi_{j,t}, I_{D,j,t}, FDI_{jt}) + \varepsilon_{j,t}$

Provinces included: 27

Coastal Metropolis	Beijing	Tianjin	Shanghai				
Northeast	Liaoning	Jilin	Heilongjiang				
Other Coastal	Guangdong	Fujian	Jiangsu	Zhejiang	Hainan	Shandong	Hebei
Central	Henan	Hubei	Hunan	Anhui	Jiangxi	Shanxi	
Southwest	Guangxi	Sichuan	Guizhou	Yuannan			
Northwest	Shannxi	Gansu	Qinghai	Xingjiang			

Model 3: $iGDP_{j,t} = f(iLoans_{j,t}, i_{j,t}, \pi_{2,j,t}) + \varepsilon_{j,t}$

Provinces included: 29

Coastal Metropolis	Beijing	Tianjin	Shanghai			
Northeast	Liaoning	Jilin	Heilongjiang			
Other Coastal	Guangdong	Jiangsu	Zhejiang	Hainan	Shandong	Hebei
Central	Henan	Hubei	Hunan	Anhui	Jiangxi	Shanxi
Southwest	Guangxi	Sichuan	Guizhou	Yuannan	Tibet	
Northwest	Inner Mongolia	Shannxi	Gansu	Qinghai	Ningxia	Xingjiang

Model 4: $iGDP_{j,t} = f(iLoans_{j,t}, i_{j,t}, \pi_{2,j,t}, I_{D2,j,t}, FDI_{2,j,t}) + \varepsilon_{j,t}$

Provinces included: 26

Coastal Metropolis	Beijing	Tianjin	Shanghai			
Northeast	Liaoning	Jilin	Heilongjiang			
Other Coastal	Guangdong	Jiangsu	Zhejiang	Hainan	Shandong	Hebei
Central	Henan	Hubei	Hunan	Anhui	Jiangxi	Shanxi
Southwest	Guangxi	Sichuan	Guizhou	Yuannan		
Northwest	Shannxi	Gansu	Qinghai	Xingjiang		

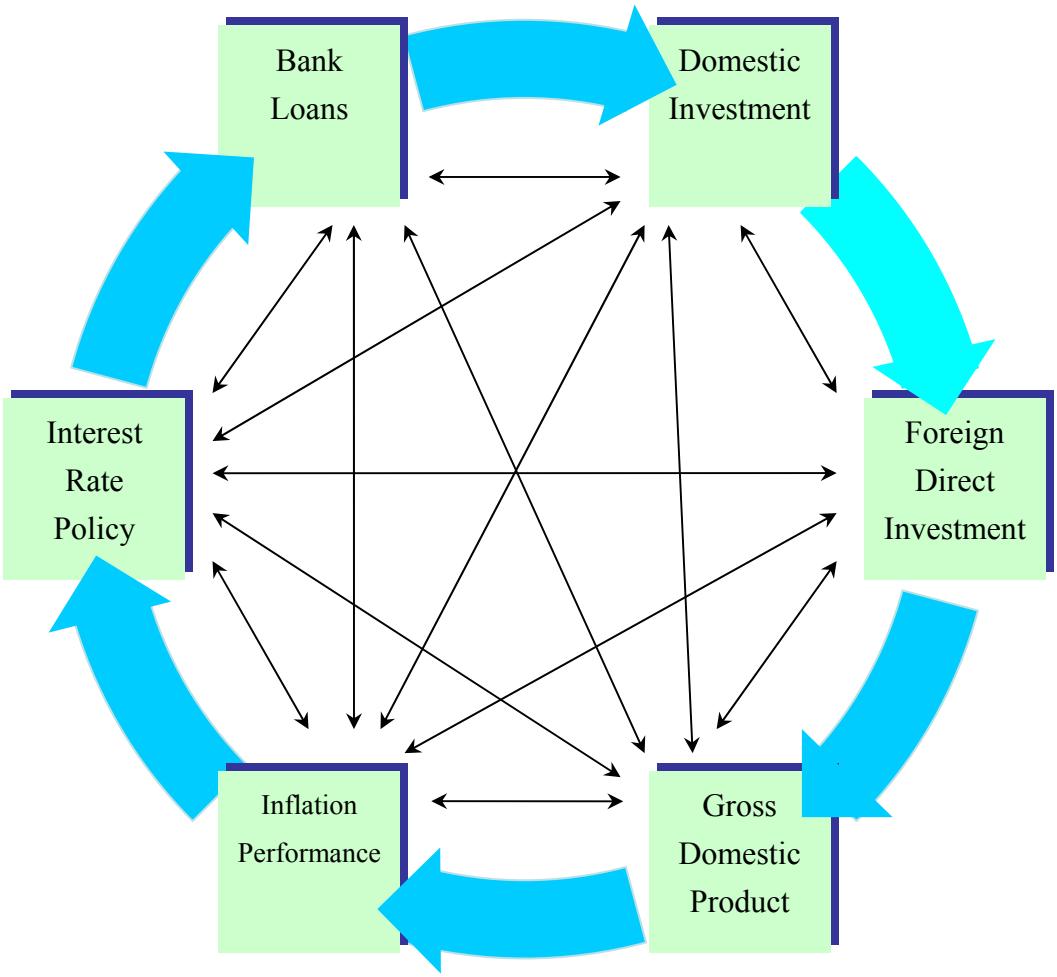
The Wald test provides the p-value based on the chi-squared distribution. If the p-value is below, say, 5% (0.05), then the hypothesis is rejected and Granger causality is found.

5.3 Empirical Results

The availability of the data is a constraint for the whole research. The observations of each province or metropolis are different. To tackle this problem, an unbalanced panel model is therefore adopted to exhaust all potential data as fully as possible. It is found that the results varied from the grouping of variables in different equations. Fortunately, the panel model provides fruitful results for discussion. Tables 5.4 (a) to (f) give the results of Model 2, which is the representative PVAR model (other PVAR models give similar results). Based on the theoretical paradigm of the bank lending channel, the Granger causality tests provide evidence that the bank lending channel in China has an interactive and dynamic relationship. All the causality pairs are significant. This means that all the factors within the bank lending channel have a direct causality to each other. There are multi-causalities within the bank lending channel. For example, the statistics show that there is direct causality from bank loans to GDP, and the reverse causality from GDP to bank loans also exists.

One should be cautious to jump to the conclusion that there are causalities of the aggregate bank lending because it is highly possible that a neutralization effect of the aggregation may exist. The comparison and contrast of the similarities and differences in causalities among different regional blocks are important in explaining the unsatisfactory results of the quarterly aggregate time series model in the previous chapter (c.f. Section 4.3 of Chapter 4).

Figure 5.7 Linkages of Bank Lending Channel of China of Panel Model



The hypothesized impacts and causalities are addressed in Chapter 3. The following discussion is constructed from the above diagram, Figure 5.7, which provides a visual aid for the transmission mechanism of panel model in the bank lending channel of China. Each arrow represents the causality from one variable to another. In the following discussion, panel VAR Model 2 has been taken as an example for the elaboration of the research findings of bank lending channel of the Chinese economy. Other panel VAR models give similar results. However, the panel VAR tests do not provide the signs of significant impact of causality in the overall panel model. The discussions of these signs are based therefore on the results of time series models in each province or metropolis. This can give a picture of the

differences among the provinces.

5.3.1 The Determinants of Interest Rate Policy

5.3.1 (a) Bank loans as a Determinant Variable (Bank Loans => Interest Rate)

Our discussion begins with the interest rate policy. From the previous chapter's aggregate time series VAR models, there is a Granger causality from bank loans to interest rate and the coefficient is negative. The results of panel VARs (c.f. Table 5.4a) suggest that there is a strong Granger causality from bank loans to interest rate in the whole country.

The blocks of Other Coastal, Southwest and Northwest regions also show that bank loans have significant impact on interest rate. However, it seems that not all provinces have the same sign of the impacts. Provinces of the Northwest region consistently have positive causality. The reason is that the Northwest region is a less developed area in China. The capacity of loans ready for lending is always inadequate. An increase of demand for loans can raise the interest rate in order for banks to choose potential borrowers.

Provinces included in the other coastal regions have different results. There is a positive causality for 4 provinces and a negative causality for the other 3 provinces. The negative causality suggests that an increase in supply of bank loans leads to a decrease in interest rate in certain provinces.

5.3.1 (b) Domestic Investment as a Determinant Variable (I_D => Interest Rate)

There is no Granger causality from domestic investment to interest rate in the previous chapter's aggregate time series model. In the panel model, they have a

significant causality. In the national PVAR model, there is a very strong causality from domestic investment to interest rate at the 1% significance level.

Table 5.4a Causality Test of Panel VAR Model 2: for equation of Interest Rate
Wald Test
System Esatimation: Panel VAR Model 2

Null Hypothesis:	Regions	Chi squared Statistic	Conclusion	Signs of significant impact
For equation i :				
Coefficient of GDP(-1) is zero	Costal Metropolis	5.42	GDP =\=> ***i***	
	Northeast	8.19	GDP =\=> ***i***	
	Other Coastal	476.31***	GDP ==> ***i***	(+)
	Central	21.9**	GDP ==> ***i***	(+ + / - - - -)
	Southwest	7.12	GDP =\=> ***i***	
	Northwest	9.21	GDP =\=> ***i***	
	National	**531.14*** **	**GDP ==> i**	
Coefficient of LOANS(-1) is zero	Costal Metropolis	7.22	LOANS =\=> ***i***	
	Northeast	5.15	LOANS =\=> ***i***	
	Other Coastal	476.8***	LOANS ==> ***i***	(+ + + + / - - -)
	Central	10.79	LOANS =\=> ***i***	
	Southwest	18.24**	LOANS ==> ***i***	(+ + / - -)
	Northwest	458.76***	LOANS ==> ***i***	(+)
	National	**977.14*** **	**LOANS ==> i**	
Coefficient of π (-1) is zero	Costal Metropolis	6.82	π ==> ***i***	
	Northeast	3.81	π =\=> ***i***	
	Other Coastal	473.34***	π ==> ***i***	(+ ++ / - - - -)
	Central	20.02	π =\=> ***i***	
	Southwest	37.10***	π ==> ***i***	(+)
	Northwest	63.13***	π ==> ***i***	(+ + + / -)
	National	**604.23*** **	**π ==> *i***	
Coefficient of I_D (-1) is zero	Costal Metropolis	9.03	I_D =\= > ***i***	
	Northeast	3.41	I_D =\= > ***i***	
	Other Coastal	477.30***	I_D == > ***i***	(+ + / - - - - -)
	Central	44.30***	I_D == > ***i***	(+)
	Southwest	7.6	I_D =\= > ***i***	
	Northwest	8.23	I_D =\= > ***i***	
	National	**549.87*** **	**I_D == > *i***	
Coefficient of FDI (-1) is zero	Costal Metropolis	16.13**	FDI ==> ***i***	(+ + /-)
	Northeast	14.05*	FDI ==> ***i***	(+ + / -)
	Other Coastal	471.22***	FDI ==> ***i***	(+ + + + / - - -)
	Central	74.44***	FDI ==> ***i***	(+ + + + / - -)
	Southwest	10.69	FDI =\=> ***i***	
	Northwest	9.73	FDI =\=> ***i***	
	National	**596.26*** **	**FDI ==> *i***	

Note: =\=> means no Granger Causality
==> means there is Granger Causality
***, ** and * denotes for 1%, 5% and 10% significance
Null hypothesis of Fujian in Other Coastal is to test all coeffiecients from 1 lag to 2 lags are zeroes

There are two regional blocks that show significant Granger causality: they are Other Coastal and the Central regions. Interestingly, 6 provinces in the central region all have a consistent positive Granger causality. The reason behind this is that the Central region has less foreign investment than the Coastal region. Therefore, to a certain extent, domestic investment plays an essential role for economic development for the Central region. In order to finance the investment projects, investors need to borrow from banks or other non-banking intermediaries. Therefore, with the implementation of continuous and new investment projects, demand for loans increases and it leads to an increase in interest rate.

5.3.1 (c) Foreign Direct Investment as a Determinant Variable (FDI => Interest Rate)

Similar to the impact of domestic investment on interest rate, there is no causality from foreign direct investment to interest rate in the previous chapter's aggregate time series model.

The panel model, however, provides significant evidence for this causality at the national level. Furthermore, Coastal Metropolis, Northeast, Other Coastal and Central blocks also all show Granger causality from foreign direct investment to interest rate. Among 16 provinces and 3 metropolises in these regional blocks, 12 of them show that foreign direct investment has positive effect on interest rate, despite the fact that the Northeast block only has 10% significance. The reason for the positive causality is similar to the reason for the positive causality from domestic investment to interest rate. Increase in interest rate is a subsequent response of keen foreign investment project seeking domestic finance for working capital for example.

However, it is noted that no causalities could be found from either domestic investment or foreign direct investment to interest rate in the aggregate time series model in Chapter 4. The reasons are two-fold. From the economic viewpoint, the effects from different regions may have neutralized each other and therefore insignificant results are shown in aggregate level. The second perspective is from the econometric side. The limited observations affect the power of the aggregate time series test. Therefore, it can not detect the results found from the panel model.

5.3.1 (d) Economic Output as a Determinant Variable (GDP => Interest Rate)

Interest rate is adjusted according to the economic performance. The panel model in the national level provided significant results to support this conventional argument. Gross Domestic Product positively affected interest rate. The block of other coastal regions is grouped by provinces along the coastal line of China. Seven of them consistently provide the positive causality of economic output on interest rate. The direct causality suggests that Gross Domestic Product can directly affect the level of interest rate.

5.3.1 (e) Inflation Rate as a Determinant Variable (Inflation=> Interest Rate)

Inflation is the result of excessive economic growth from a monetarist viewpoint. The interest rate policy can adjust the money supply and therefore alleviates the pressure of inflation. Thus, the expected sign of impact of inflation on interest rate is positive. In panel VAR blocks of Other Coastal, Southwest and Northwest, there is significant causality from inflation rate to interest rate at the 1% significance level. Southwest and Northwest provinces provide significant results that interest rate is sensitively affected by inflation rate. Because an enormous development project in

the western region in the latest triennium has accelerated the pace of economic growth in this region. Hence, inflation is partly created by economic development. Consequently, inflation could lead interest rate to react sensitively.

5.3.2 The Determinants of Bank Loans

Based on Table 5.4b, the causalities are discussed as follows.

5.3.2 (a) Interest Rate as a Determinant Variable (Interest Rate => Bank Loans)

The empirical results in the previous chapter's aggregate time series model suggest that there was a negative impact of interest rate on bank loans. The results of panel VARs also support this conclusion, except for the Fujian and Yuannan from the other coastal and Southwest regions respectively. An increase in interest rate can defy the incentive for borrowing from banks, as firms are concerned about their the ability to pay back the outstanding loans and interests.

5.3.2 (b) Domestic Investment as a Determinant Variable (I_D => Bank Loans)

Domestic investment shows positive impact on bank loans in the panel VAR models, although no Granger causality could be found between them in aggregate time series model in the previous chapter. Increasing domestic investment projects require capital to invest. The main financing sources in China are bank loans. The total effects from Northeast and Other Coastal blocks give evidence that domestic investment has significant impact on bank loans, which makes the national panel VAR model also significant in this relationship. These 2 regional blocks have relatively long established economic development records since the economic reform in 1978. They are the beneficiaries of the open-door policy. The reason why results of the aggregate time series model in Chapter 3 gave no causality is that these two regional blocks include 10 provinces, 5 of them showing positive impact and the

remaining ones showing negative impact. The neutralization effects from aggregation therefore occur and no causality exists in the aggregate time series model.

Table 5.4b Causality Test of Panel VAR Model 2: for equation of Bank Loans
Wald Test
System Estimation: Panel VAR Model 2

Null Hypothesis:	Regions	Chi squared Statistic	Conclusion	Signs of significant impact
For equation LOANS :				
Coefficients of GDP(-1) is zero	Costal Metropolis	19.08***	GDP ==> LOANS	(+ + / -)
	Northeast	15.12**	GDP ==> LOANS	(-)
	Other Coastal	67.52***	GDP ==> LOANS	(+ + + + / - -)
	Central	11.18	GDP =\=> LOANS	
	Southwest	24.91***	GDP ==> LOANS	(+ + / - -)
	Northwest	6.29	GDP =\=> LOANS	
	National	**144.08*** **	**GDP ==> LOANS**	
Coefficient of ***i*** (-1) is zero	Costal Metropolis	1.47	i =\=>LOANS	
	Northeast	12.6	i =\=>LOANS	
	Other Coastal	46.49***	i ==>LOANS	(+ / - - - - - -)
	Central	9.44	i =\=>LOANS	
	Southwest	18.03**	i ==>LOANS	(+ / - -)
	Northwest	3.22	i =\=>LOANS	
	National	**91.26****	**i ==>LOANS**	
Coefficient of π (-1) is zero	Costal Metropolis	18.89***	π ==> LOANS	(+ / - -)
	Northeast	5.15	π =\=> LOANS	
	Other Coastal	462.68***	π ==> LOANS	(+ / - - - - - -)
	Central	14.19	π =\=> LOANS	
	Southwest	24.57***	π ==> $LOANS_t$	(-)
	Northwest	6.09	π =\=> LOANS	
	National	**531.57*** **	**π ==> LOANS**	
Coefficient of I_D (-1) is zero	Costal Metropolis	2.38	I_D =\=> LOANS	
	Northeast	18.44**	I_D ==> LOANS	(+ / - -)
	Other Coastal	465.04***	I_D ==> LOANS	(+ + + + / - -)
	Central	9.6	I_D =\=> LOANS	
	Southwest	12.89	I_D =\=> LOANS	
	Northwest	2.35	I_D =\=> LOANS	
	National	**510.7*** **	**I_D ==> LOANS**	
Coefficient of FDI (-1) is zero	Costal Metropolis	10.23	FDI =\=> LOANS	
	Northeast	2.39	FDI =\=> LOANS	
	Other Coastal	82.92***	FDI ==> LOANS	(+ + + + + + / -)
	Central	4.84	FDI =\=> LOANS	
	Southwest	5.93	FDI =\=> LOANS	
	Northwest	3.58	FDI =\=> LOANS	
	National	**109.9*** **	**FDI ==> LOANS**	

Note: =\=> means no Granger Causality

==> means there is Granger Causality

***, ** and * denotes for 1%, 5% and 10% significance

Null hypothesis of Fujian in Other Coastal is to test all coeffiecients from 1 lag to 2 lags are zeroes

5.3.2 (c) Foreign Direct Investment as Determinant Variable (FDI=>Bank Loans)

In the previous chapter's aggregate time series model VAR 4, there was evidence of weak causality from foreign direct investment to bank loans. The result suggests that an increase in foreign direct investment also leads to an increase in bank loans.

The panel VAR models provide various results for this pair of causality. Other Coastal regional block is the only block which shows a significant result of this pair of causality, which is strong enough to make the national panel VAR model also significant in this relationship. All provinces in this region, except Hainan, give positive impact. Because the Coastal region has long been the area which receives a large amount of foreign investment inflow. Similar to the causality from domestic investment to bank loans, foreign investors also acquire bank loans as a source of external finance for their working capital, therefore, an increase in foreign direct investment also leads to an increase in bank loans from the Chinese banking sector.

As to the relationship between foreign direct investment and domestic investment, please refer to subsection 5.3.3(c) and 5.3.4(c).

5.3.2 (d) Economic Output as Determinant Variable (GDP=>Bank Loans)

Interestingly, the panel VARs show that the Granger causality from Gross Domestic Product to bank loans is significant at the 1% level. However, it is difficult to predict the sign of the total impact. Because some provinces have positive impact and the remaining ones have a negative one. For the positive ones, such as Beijing, Tianjin and Shandong, the reason for positive effect is that an increase in national income (i.e. GDP) leads to an increase in aggregate spending. Investment and household

consumption required an increase in demand for loans.

Shanghai, Guangdong and the whole Northeast region, however, have negative impacts. It is obvious to say that they experienced the speedy pace of economic growth. However, the continuous and tremendous increase in Gross Domestic Product may make people not willing to borrow and banks may be reluctant to lend (Zhao, Ma, et al, 2002) as they fear that the rapid economic growth might be just a bubble. Therefore, bank loans are conversely decreased.

5.3.2 (e) Inflation rate as Determinant Variable (Inflation => Bank Loans)

An increase of inflation rate causes a decrease in bank loans. The previous chapter's aggregate time series VARs provide the evidence that for an 1% increase in inflation rate results in an almost a 0.2% decrease in bank loans is resulted (c.f. VAR 3, 4, 6, 7 and 8 of Chapter 4).

From the group of Coastal Metropolis and Jiangsu from Other Coastal block, the panel VARs results of all the provinces except Shanghai are consistent with the result of previous aggregate time series VARs. Negative causalities suggest that the rise of inflation rate delays investment and consumption, so it leads to a decrease in the size of bank loans. Southwest region gives evidence for this type of causality, as the signs of significant impacts of all provinces are negative.

5.3.3 Determinants of Domestic Investment

The discussion here concentrates on the results of Table 5.4c on the following page.

5.3.3 (a) Interest Rate as a Determinant Variable (Interest Rate => I_D)

Results of panel VAR Model 2 provide significant results of Granger causality from

interest rate to domestic investment, although no Granger causality could be found for this pair of variables from the aggregate time series model in the previous chapter. Results of the Southwest regional block strongly support the analytical paradigm of monetary transmission mechanism in Section 3.3A. Negative impact represents that interest rate is a crucial indicator for domestic investment. Local firms are sensitive to the level of interest rate. With increasing interest rate, the cost and the risks of investment by local enterprises also increased. Therefore, interest rate has negative impact on domestic investment.

5.3.3 (b) Bank Loans as a Determinant Variable (Bank Loans => I_D)

Refering to the previous discussion, an increase in the amount of bank loans leads to an increase in investment and therefore a positive causality is expected among them. Though aggregate time series VARs in the previous chapter could not provide any evidence to support the above argument, satisfactory results are obtained in the panel VARs of Coastal Metropolis, Other Coastal and Southwest regional blocks. Hence, at the national level the impact is also significant.

As capital is needed for domestic investment, bank loans provide opportunities for local firms to invest. This is the normal relationship of several areas like Beijing, Shanghai, Guangdong, Fujian, Shandong, and Sichuan. However, some surprising results happened in Tianjin, Hainan, Hebei and Yuannan which have negative impact of bank loans on domestic investment. The story behind this may be related to the crowding out effect of competition for bank loans between domestic investment and foreign direct investment in these areas. This issue will be discussed in Subsection 5.3.3(c) below.

Table 5.4c Causality Test of Panel VAR Model 2: for equation of Domestic Investment
Wald Test
System Estimation: Panel VAR Model 2

Null Hypothesis:	Regions	Chi squared Statistic	Conclusion	Signs of significant impact
For equation I_D :				
Coefficient of GDP(-1) is zero	Costal Metropolis	20.31***	GDP ==> I_D	(+ + / -)
	Northeast	5.72	GDP =\=> I_D	
	Other Coastal	466.6***	GDP ==> I_D	(+ + + + + / - -)
	Central	31.92***	GDP ==> I_D	(+ + + + / - -)
	Southwest	569.01***	GDP ==> I_D	(+ + + / -)
	Northwest	8.78	GDP =\=> I_D	
	National	**1102.33*** **	**GDP ==> I_D**	
Coefficient of LOANS(-1) is zero	Costal Metropolis	12.64*	LOANS ==> I_D	(+ + / -)
	Northeast	4.87	LOANS =\=> I_D	
	Other Coastal	461.43***	LOANS ==> I_D	(+ + + + + / - -)
	Central	13.12	LOANS =\=> I_D	
	Southwest	111.63***	LOANS ==> I_D	(+ + + / -)
	Northwest	2.75	LOANS =\=> I_D	
	National	**606.43*** **	**LOANS ==> I_D**	
Coefficient of ***i*** (-1) is zero	Costal Metropolis	8.79	i =\=> I_D	
	Northeast	5.64	i =\=> I_D	
	Other Coastal	462.48***	i ==> I_D	(+ + + / - - - -)
	Central	13.51	i =\=> I_D	
	Southwest	99.69***	i ==> I_D	(-)
	Northwest	4.33	i =\=> I_D	
	National	**594.43*** **	**i ==> I_D**	
Coefficient of π (-1) is zero	Costal Metropolis	3.27	π =\=> I_D	
	Northeast	7.4	π =\=> I_D	
	Other Coastal	464.53***	π ==> I_D	(+ / - - - - -)
	Central	7.62	π =\=> I_D	
	Southwest	86.8***	π ==> I_D	(-)
	Northwest	3.14	π =\=> I_D	
	National	**572.75*** **	**π ==> I_D**	
Coefficient of FDI (-1) is zero	Costal Metropolis	14.12*	FDI ==> I_D	(+ + / -)
	Northeast	7.83	FDI =\=> I_D	
	Other Coastal	71.76***	FDI ==> I_D	(+ + + + + / - -)
	Central	20	FDI =\=> I_D	
	Southwest	497.8***	FDI ==> I_D	(+ + / - -)
	Northwest	10.26	FDI =\=> I_D	
	National	**621.72*** **	**FDI ==> I_D**	

Note: =\=> means no Granger Causality
==> means there is Granger Causality
***, ** and * denotes for 1%, 5% and 10% significance
Null hypothesis of Fujian in Other Coastal is to test all coeffiecients from 1 lag to 2 lags are zeroes

5.3.3 (c) Foreign Direct Investment as Determinant Variable (FDI => I_D)

Literatures suggest that there is likely a crowding out effect of foreign direct

investment on domestic investment (Taylor, 1998; Harrison and McMillan, 2003). Because with the continuous influx of foreign direct investment, local firms face credit constraints from bank lending. Taylor (1998) and Harrison and McMillan (2003) have similar empirical results found in different states of the U.S. and countries in the Ivory Coast. In this research, panel VARs provide two insights into this pair of variables. If foreign direct investment has negative impact on domestic investment, there is a crowding out and substitution effect. However, positive impact of foreign direct investment implies that there is no crowding out effect but there is a complementary effect between this pair of variables. The result is quite interesting that 4 provinces (Tianjin, Hainan, Hebei, and Yuannan) have experienced the crowding-out effect while the others experienced the complementary effect.

The Chinese Government is keen on providing substantial benefits for foreign corporations in order to attract their investment. The local officials rush to adsorb the foreign investment. Yet, they have overlooked the crowding out effect which influenced the operation of domestic firms. Domestic investment of Beijing, Fujian, Heibei, Sichuan and Guizhou is reduced because of foreign direct investment.

5.3.3 (d) Economic Output as Determinant Variable (GDP => I_D)

In the previous chapter's aggregate time series model, Gross Domestic Product positively affects domestic investment. When the aggregate GDP increases, it leads to a rise in domestic investment.

Panel VARs provide diversified results which give another story behind this pair of causality. Coastal Metropolis, Other Coastal and Central, Southwest blocks have significant result of the causality from Gross Domestic Product to domestic

investment, which leads to a significant result in the national panel VAR. As discussed in Chapter 4, positive impact means that the performance of GDP affects the confidence of investors. Therefore, promising figures of GDP can make local firms bounce up to invest. On the other hand, negative impact may result due to the strong competition for banking loans from foreign investors. Conversely, it causes domestic investment to decrease. A sound performance of aggregate output also attracts foreign investors to crush in. That hinders the expansion of domestic investment and more seriously, it leads to the contraction in local firms.

5.3.3 (e) Inflation Rate as Determinant Variable (Inflation => I_D)

Although there are exceptional results obtained from Jiangsu, the results of the remaining provinces from Other Coastal and Southwest regional blocks have negative impact of inflation rate on domestic investment. Other Coastal region has long been the destination for foreign capital. With the encouragement from the central government, the Southwest region aims to attract more foreign direct investment to mobilize the western economic exploration in China. If there is an increase in inflation rate, this leads to an uncertainty about the future return on investments and discourages investment from foreigners. The above result is in contrast to the aggregate time series VARs in Chapter 4 where no causality was found in this pair of variables. Because limited observations reduced the power of the time series test.

5.3.4 Determinants of Foreign Direct Investment (FDI)

5.3.4 (a) Interest Rate as a Determinant Variable (Interest Rate => FDI)

The result of the national panel VAR model indicates the Granger causality from interest rate to foreign direct investment. However, the signs of significant impact in

provinces show positive relationship of this pair of variables which contradicts the expected sign in Chapter 3.

Domestic investments are sensitive to interest rate. A rise in interest rate can decrease investments of domestic firms. As there is keen competition between domestic firms and foreign invested firms, the credit constraints of domestic firms provide an opportunity for foreign direct investment to expand[3] into the domestic market. Therefore, there is a positive causality from interest rate to foreign direct investment.

5.3.4 (b) Bank Loans as a Determinant Variable (Bank loans => FDI)

The result of the causality from bank loans to foreign direct investment in the previous chapter's aggregate time series VARs is positive only in 10% significance. The panel VARs succeed in providing results at the 5% significant level for the positive impact of bank loans on foreign direct investment in Southwest regional block. An increase in bank loans contributes to an increase in investment. It is consistent with the findings in the US by Bernanke (1993) and Bernanke and Gertler (1995).

However, the results from the Northwest region indicate that there is a negative impact of bank loans on foreign direct investment. An increase in bank loans cannot attract more foreign capital inflow, conversely, the bank loans decease foreign direct investment. A great gap of economic growth hinders the incentives of foreign

[3] Obviously, they are still subject to the constraints of government regulations, FDI quota, market restricting, and constraints on the joint venture ownership share on, which we do not have quantitative control variables.

investment. Besides, lack of the discipline and excessive intervention of local government coexist in Northwest regions (Li and Ma, 1996). The potential bank loans' increase apparently seems to be able to attract foreign investment project, but in the Northwest region, it leads to a decrease of foreign direct investment. It is because of the keen competition between domestic firms and foreign firms. An increase of bank loans provides a source of capital inputs to local enterprises to invest in the market, which in turn deters foreign competitors from investing.

5.3.4 (c) Domestic Investment as Determinant Variable (I_D=>FDI)

Again, we consider the impact of domestic investment on foreign direct investment that may appear in either positive or negative sign. In the previous aggregate time series VARs in Chapter 4 we showed that there was a negative impact of domestic investment on foreign direct investment but the reverse causality did not exist from foreign direct investment to domestic investment. Recalling the discussion in Section 5.3.3(c), there is a possibility of foreign direct investment crowding out domestic investment in some provinces. Meanwhile, a complementary effect was found in other provinces.

Yet the signs of significant impact in provinces varied. There are three cases in China. First, Bejing, Fujian and Hebei show that there is a crowding out effect between domestic investment and foreign direct investment. Investment projects either from local or from foreign firms can crowd out their competitors given the financial resource constraint and competition.

Second, positive impacts are found in Shanghai and Guangdong for both the causality from domestic investment to foreign direct investment and its reverse

causality. This implies a strong complementary effect between the composition of investments in these two areas. Different natures of investment can assist each other for establishment and development.

Table 5.4d Causality Test of Panel VAR Model 2: for equation of Foreign Direct Investment
Wald Test
System Estimation: Panel VAR Model 2

Null Hypothesis:	Regions	Chi squared Statistic	Conclusion	Signs of significant impact
For equation FDI:				
Coefficient of GDP(-1) is zero	Costal Metropolis	15.93**	GDP ==> FDI	(+ + / -)
	Northeast	5.26	GDP =\=> FDI	
	Other Coastal	33.38***	GDP ==> FDI	(+ + + + + + + / -)
	Central	31.26***	GDP ==> FDI	
	Southwest	11.08	GDP =\=> FDI	
	Northwest	30.20***	GDP ==> FDI	(+ + / - -)
	National	**127.11*** **	**GDP ==> FDI**	
Coefficient of LOANS(-1) is zero	Costal Metropolis	5.25	LOANS =\=> FDI	
	Northeast	8.62	LOANS =\=> FDI	
	Other Coastal	20.44	LOANS =\=> FDI	
	Central	10.7	LOANS ==\> FDI	
	Southwest	20.24**	LOANS ==> FDI	(+ + + / -)
	Northwest	24.13**	LOANS ==> FDI	(-)
	National	**89.39****	**LOANS ==> FDI**	
Coefficient of i (-1) is zero	Costal Metropolis	10.18	i =\=> FDI	
	Northeast	25.74***	i ==> FDI	(+)
	Other Coastal	10.19	i =\=> FDI	
	Central	14.44	i =\=> FDI	
	Southwest	19.53**	i ==> FDI	(+++ / -)
	Northwest	25.05**	i ==> FDI	(+)
	National	**105.12*** **	**i ==> FDI**	
Coefficient of π (-1) is zero	Costal Metropolis	16.72**	π ==> FDI	(++ / -)
	Northeast	4.2	π =\=> FDI	
	Other Coastal	14.31	π =\=> FDI	
	Central	14.82	π =\=> FDI	
	Southwest	4.8	π =\=> FDI	
	Northwest	40.46***	π ==> FDI	(+ / - - -)
	National	**95.32*** **	**π ==> FDI**	
Coefficient of I_D (-1) is zero	Costal Metropolis	43.69***	I_D ==> FDI	(+ / - -)
	Northeast	15.49**	I_D ==> FDI	(+ / - -)
	Other Coastal	27.11**	I_D ==> FDI	(+ / - - - - - -)
	Central	13.85	I_D =\=> FDI	
	Southwest	14.37	I_D =\=> FDI	
	Northwest	7.19	I_D =\=> FDI	
	National	**121.7*** **	**I_D ==> FDI**	

Note: =\=> means no Granger Causality
==> means there is Granger Causality
***, ** and * denotes for 1%, 5% and 10% significance
Null hypothesis of Fujian in Other Coastal is to test all coeffiecients from 1 lag to 2 lags are zeroes

Finally, Tianjin, Jiangsu, Zhejiang, Hainan and Shandong all have a negative impact in the causality from domestic investment to foreign direct investment. The result is consistent with Song, Sun, and Qiao (2001) who examined a panel data of the behavior of investment pattern in China. The long established domestic investment hinders new foreign direct investment inflows. On the reverse causality, these 4 areas have a positive impact of foreign direct investment on domestic investment. The complementary effects suggest that the benefits of foreign direct investment help them not only to adsorb foreign capital, but also to gain skills like managerial, financial, organizational and most important technological. This, in turn, encourages domestic investment to expand in these areas.

5.3.4 (d) Economic Output as Determinant Variable (GDP => FDI)

There is no Granger causality from GDP to FDI in the previous chapter's aggregate time series VARs. It is because of the neutralization effects of the aggregation of data. However, panel VARs provide significant results of this pair of causality. A rise in aggregate output raises the demand for investment as people are willing to invest in a favorite, strong economic environment. Therefore, positive impacts occur in regions like Coastal metropolis, Other Coast, Central and Northwest regional blocks. But when considering the negative impact in Shanghai and Guangdong, it is a different story. An increase in aggregate output no longer leads to an increase in foreign direct investment because of the saturation of the existing investment in these locations. Investors realize that there is no space and opportunity for further investment. They would rather invest in other regions which provide more resources and favorable conditions, such as the recent Western Exploration Project in China that aimed at targeting investment inflow to the Southwest and Northwest regions.

5.3.4 (e) Inflation Rate as Determinant Variable (Inflation => FDI)

The Granger causality from interest rate to FDI provides similar results to that from inflation rate to domestic investment. Inflation rate negatively affects foreign direct investment in the Coastal Metropolis and Northwest regions. As the confidence of the foreign investors is affected by the uncertainty of future return on investments and an increase in inflation worsens business environments, hence, there is a negative impact of inflation rate on foreign direct investment.

5.3.5 Determinants of Economic Output

5.3.5 (a) Interest Rate as a Determinant Variable (Interest Rate => GDP)

Despite the fact that interest rate shows no causality to economic output in the previous chapter's aggregate quarterly times series VARs, panel data provides significant results which are consistent with the Keynesian theory and a reduced form of monetary transmission mechanism that indicates that an increase in interest rate will in turn negatively affect Gross Domestic Product. Northeast, Other Coastal and Central regions all obtain significant results in this pair of causality and these are the attributes of the significant effects in the national panel model. It implies the Gross Domestic Product is sensitively affected by the level of interest rate in these regions.

5.3.5 (b) Bank Loans as a Determinant Variable (Bank Loans=>GDP)

It is expected that a supply of bank loans can finally generate Gross Domestic Product. This conclusion has been found in Northeast and Southwest region blocks in China. An increase in bank loans can in turn boost investment in these regions. As we have already pointed out, investment can positively affect aggregate output (c.f. Sub-section 3.3c). Therefore, bank loans can directly affect Gross Domestic Product

in a positive way. Recall that the Northeast region is the historical industrialized area which gave substantial contribution to Chinese industrialization in the early 20th century. The underlying implication is that industrial loans definitely can directly and positively affect Gross Domestic Product of the industrial sector. This implication is supported by the evidence of the Northeast in panel VAR model 4.

Nevertheless, Heilongjiang and Yuannan have a negative causality and the remaining provinces have no Granger causality from bank loans to Gross Domestic Product. It may be due to the non-performing loans (NPLs) problem (Zhao, Ma, et al, 2002). The supply of loans is not necessarily turned into an increase of Gross Domestic Product because NPLs deteriorate quality of the banking sector and financial sector which will spread risks and financial losses from economic activity. In addition, there is a failure of market discipline in the China banking system although there is an economic reform of transition from a planned economy to a market economy. Decisions of banks issuing credits are still largely governed by the administrative commands from local or central officials. The aim of bank lending is not profit-maximization oriented, but policies oriented. This situation is especially serious in the state owned enterprises (SOEs). Therefore, Gross Domestic Product conversely decreased.

5.3.5 (c) Domestic Investment as Determinant Variable (I_D => GDP)

We pointed out in the previous sub-section that bank loans can positively affect aggregate output. An increase in bank loans leads to a rise of Gross Domestic Product in the Northeast region through investment. Besides, Southwest regions have the same result. Both significant results in these two blocks make the national panel model to be significant too.

Table 5.4e Causality Test ofPanel VAR Model 2: for equation of Gross Domestic Product
Wald Test
System Estimation: Panel VAR Model 2

Null Hypothesis:	Regions	Chi squared Statistic	Conclusion	Signs of significant impact
For equation GDP:				
Coefficient of LOANS(-1) is zero	Costal Metropolis	5.74	LOANS =\=> GDP	
	Northeast	19.93**	LOANS ==> GDP	(++ / -)
	Other Coastal	4.07	LOANS =\=> GDP	
	Central	12.64	LOANS =\=> GDP	
	Southwest	23.54**	LOANS ==> GDP	(+++ / -)
	Northwest	6.56	LOANS =\=> GDP	
	National	**72.49****	**LOANS ==> GDP**	
Coefficient of i(-1) is zero	Costal Metropolis	11.26	*i* =\=> *GDP*	
	Northeast	43.53**	*i* ==>*GDP*	(+ / - -)
	Other Coastal	25.45*	*i* ==>*GDP*	(+ / - - - - - -)
	Central	38.56***	*i* ==>*GDP*	(+ / - - - - -)
	Southwest	6.54	*i* =\=> *GDP*	
	Northwest	9.79	*i* =\=> *GDP*	
	National	**135.14*****	***i* ==>*GDP***	
Coefficient of π (-1) is zero	Costal Metropolis	9.022	π =\=> GDP	
	Northeast	3.69	π =\=> GDP	
	Other Coastal	17.17	π =\=> GDP	
	Central	12.4	π =\=> GDP	
	Southwest	73.44***	π ==> GDP	(++ / - -)
	Northwest	10.25	π =\=> GDP	
	National	**125.98*****	**π ==> GDP**	
Coefficient of I_D (-1) is zero	Costal Metropolis	8.65	I_D =\=> GDP	
	Northeast	13.86*	I_D ==> GDP	(+)
	Other Coastal	19.74	I_D =\=> GDP	
	Central	9.22	I_D =\=> GDP	
	Southwest	458.6***	I_D ==> GDP	(+++ / -)
	Northwest	2.54	I_D =\=> GDP	
	National	**512.61*****	**I_D ==> GDP**	
Coefficient of FDI (-1) is zero	Costal Metropolis	18.47**	FDI ==> GDP	(+ / - -)
	Northeast	24.85***	FDI ==> GDP	(+ /- -)
	Other Coastal	22.36	FDI =/=> GDP	
	Central	4.24	FDI =/=> GDP	
	Southwest	471***	FDI ==> GDP	
	Northwest	12.48	FDI =/=> GDP	
	National	**553.34*****	**FDI ==> GDP**	

Note: =\=> means no Granger Causality
==> means there is Granger Causality
***, ** and * denotes for 1%, 5% and 10% significance
Null hypothesis of Fujian in Other Coastal is to test all coeffiecients from 1 lag to 2 lags are zeroes

5.3.5 (d) Foreign Direct Investment as Determinant Variable (FDI => GDP)

The implication behind the causality of foreign direct investment to Gross Domestic Product is similar to that of the causality from domestic investment to economic

output. Coastal Metropolis, Northeast and Southwest all have positive impact.

However, there is a negative impact in Beijing, Tianjin., Jilin and Heilongjiang. Both foreign direct investment and domestic investment have impacts on Gross Domestic Product. Due to keen competition between foreign direct investment and domestic investment, the expansion of foreign direct investment crowds out the domestic investment, which largely contributes to the increase of Gross Domestic Product in these locations. Therefore, an increase of foreign direct investment leads reductions in size of Gross Domestic Product.

5.3.5 (e) Inflation Rate as Determinant Variable (Inflation => GDP)

In the aggregate time series model of Chapter 4, an 1% increase in inflation rate led to a 0.35% decrease in Gross Domestic Product. In the panel model, only the Southwest region shows there is Granger Causality from inflation rate to Gross Domestic Product at the 1% significance level. The negative effect of inflation rate on aggregate output is also provided by the panel VARs. An increase in inflation rate deteriorates people's motivation to spend. Gross Domestic Product is hence reduced.

5.3.6 Determinants of Inflation Performance

Based on Table 5.4f, we will discuss determinants of inflation performance in the bank lending channel.

5.3.6 (a) Interest Rate as Determinant Variable (Interest Rate => Inflation)

Interest Rate has negative impact on inflation rate. As interest rate is one of the monetary policies to target the inflation rate, the aggregate time series VARs in the previous chapter only provided the result at the 10% significance level. The panel

VARs suggest that interest rate does Granger cause inflation. There are significant positive impacts in various provinces.

5.3.6 (b) Bank Loans as Determinant Variable (Bank Loans => Inflation)

From the empirical findings of panel data, it is found that bank loans have positive impact on inflation rate. In this pair of causality, 13 out of 20 provinces have positive responses. The best example is the Northeast region. This result reinforces the findings of positive impacts of bank loans on Gross Domestic Product, which in turn affect inflation rate. Aggregate output is the key factor to causing economic growth and finally accelerating the inflation rate. Therefore, the linkage is simple: an increase in bank loans increases investment and Gross Domestic Product. Then, the pace of economic growth leads to pressure for inflation.

5.3.6 (c) Domestic Investment as Determinant Variable (I_D=>inflation)

No Granger Causality is found in this pair of variables in the previous chapter's aggregate time series VARs.

From Table 5.4f, both positive and negative causalities are found in the panel VARs. Let us take Southwest and Northwest as examples. Provinces in these regions consistently show a positive causality from domestic investment to inflation rate. The reason is that investment of domestic firm can speed up the pace of economic growth, which in turn leads to an increase of inflation rate. On the other hand, negative impacts of domestic investment on inflation in other provinces may be due to an expansion of production capacity and excessive competition.

Table 5.4f Causality Test of Panel VAR Model 2: for equation of Inflation Rate
Wald Test
System Estimation: Panel VAR Model 2

Null Hypothesis:	Regions	Chi squared Statistic	Conclusion	Signs of significant impact
For equation π :				
Coefficient of GDP(-1) is zero	Costal Metropolis	16.93**	GDP ==> π	(+ + / -)
	Northeast	3.16	GDP =\=> π	
	Other Coastal	76.86***	GDP ==> π	(+ + + + + / - -)
	Central	325.10***	GDP ==> π	(+ / - - - - -)
	Southwest	9.15	GDP =\=> π	
	Northwest	460.58***	GDP ==> π	(+ + / - -)
	National	**891.78*** **	**GDP ==> π**	
Coefficient of LOANS(-1) is zero	Costal Metropolis	10.2	LOANS =\=> π	
	Northeast	12.92*	LOANS ==> π	(+)
	Other Coastal	55.61***	LOANS ==> π	(+ + + + + / - -)
	Central	74.17***	LOANS ==> π	(+ + + / - - -)
	Southwest	6.74	LOANS =\=> π	
	Northwest	461.97***	LOANS ==> π	(+ + / - -)
	National	**621.6*** **	**LOANS ==> π**	
Coefficient of i (-1) is zero	Costal Metropolis	12.42	i =\=> π	
	Northeast	23.13***	i ==> π	(+)
	Other Coastal	42.24***	i ==> π	(+ + + + / - - -)
	Central	482.35***	i ==> π	(+)
	Southwest	23.10***	i ==> π	(+ + + / -)
	Northwest	464.87***	i ==> π	(+)
	National	**1048.11*** **	**i ==> π**	
Coefficient of I_D (-1) is zero	Costal Metropolis	2.33	I_D =\=> π	
	Northeast	9.04	I_D =\=> π	
	Other Coastal	72.19***	I_D ==> π	(+ + + + / - - -)
	Central	169.69***	I_D ==> π	(+ + + / - - -)
	Southwest	11.56***	I_D ==> π	(+)
	Northwest	460.24***	I_D ==> π	(+)
	National	**725.03*** **	**I_D ==> π**	
Coefficient of FDI (-1) is zero	Costal Metropolis	22.79***	FDI ==> π	(+ + / -)
	Northeast	7.52	FDI =\=> π	
	Other Coastal	86.05***	FDI ==> π	(+ + / - - - - -)
	Central	11.08	FDI =\=> π	
	Southwest	7.68	FDI ==> π	
	Northwest	459.06***	FDI ==> π	(+ + / - -)
	National	**594.19*** **	**FDI ==> π**	

Note: =\=> means no Granger Causality
==> means there is Granger Causality
***, ** and * denotes for 1%, 5% and 10% significance
Null hypothesis of Fujian in Other Coastal is to test all coeffiecients from 1 lag to 2 lags are zeroes

5.3.6 (d) Foreign Direct Investment as Determinant Variable (FDI=>inflation)

Similarly, no Granger Causality is found in the impact of foreign direct investment

on inflation rate in the aggregate time series model of Chapter 4.

From Table 5.4f, both positive and negative causalities are found in panel VARs. There are two possibilities associated with the result of causality. First, the amount of foreign direct investment is large enough in certain provinces so that it can stimulate economic growth. Therefore, an increase in foreign direct investment leads to a rise of inflation rate. Second, negative causality can be explained as the foreign direct investment increases production capacity and creates excessive competition in the domestic market (Ma, 2001a).

5.3.6 (e) Economic Output as Determinant Variable (GDP=>inflation)

The aggregate time series VARs in Chapter 4 found that the aggregate output has no impact on inflation rate.

However, it is found that there are two possibilities generated from the panel data. First, the positive effects in various provinces indicate that fast economic growth can accelerate inflation from the demand side, and thus an increase of Gross Domestic Product leads to a rise of inflation rate. Second, the growth rate of economic output in some provinces creates excess supply which in turn decreases the inflation rate.

5.3.7 Sensitivity Analysis of Institutional Changes

Similar to section 4.3.4, we employ the dummy variable, $DUMMY_{GOV}$, into the Panel VAR Model 2 to test the sensitivity of the panel model. The results are listed as the following Table 5.4 (g). In the empirical findings without dummy variable of Granger causality from loans to GDP and its reverse causality, it was found that although there is two-way Granger causality at the national level, yet only some of

the regions (Northeast regions, for example) have shown the significance result for existence of Granger causality.

On the other hand, the estimation of Panel VAR Model 2 with dummy variable has shown a change of the result. The $DUMMY_{GOV}$ has significant impacts on the bank lending channel. Overall, the dummy variable increases the significance of the national level from 5% to 1%. Specifically, in Other Coastal region, it is found that there is a Granger causality from GDP to loans initially; however, after adding the dummy variable, the Granger causality is no longer existed. There is evidence to show that the government interventions aimed at controlling overheated economy do affect the lending and borrowing behaviors of the credits. Although considerable economic growth should enhance the investment activity, the institutional factor to prohibit the overheated economy with a symptom of a bubble can effectively halt the availability and accessibility of bank loans. Conversely, regions like Central and Northwest have insignificant results without dummy variable. Yet, the factor of institutional change allows these regions have Granger causality. The negative signs of some specific provinces suggest that there are severe non-performing loan (NPL) problems associate with the lending activity. It is crystal clear that government interventions affect the operation of bank lending channel. The consolidation of the PBOC provincial offices and the AMCs may have helped to solve the problem of NPLs in the banking sector. However, it is only established to become effective from 1998. Therefore, the negative signs can still be expected in these regions.

Table 5.4(g) Sensitivity Analysis of Banking Institutional Changes in Panel Model

	Without dummy		With Dummy			
Null Hypothesis:	$LOANS \rightarrow Y_{GDP}$	$Y_{GDP} \rightarrow LOANS$	$LOANS \rightarrow Y_{GDP}$	$Y_{GDP} \rightarrow LOANS$	$DUMMY_{GOV} \rightarrow Y_{GDP}$	$DUMMY_{GOV} \rightarrow LOANS$
	p-values of χ^2	p-values of χ^2	p-values of χ^2	p-values of χ^2	p-values of χ^2	p-values of χ^2
METROPOLIS						
$VAR_{Beijing}$	0.361291	0.00017	0.376531	8.62489E-09	0.178156	0.05644
$VAR_{Tianjin}$	0.182484	0.712829	0.245414	0.63483	0.586105	0.559473
$VAR_{Shanghai}$	0.858601	0.594905	0.934816	0.894003	0.53624	0.147502
Result of Fisher Test:	5.74	19.08***	4.763127193	38.04602316***	4.518704065	6.910674324
NORTHEAST						
$VAR_{Liaoning}$	0.933248	0.01129	0.900337	0.000512	0.725902	0.000001
VAR_{Jilin}	0.932118	0.055721	0.440277	0.065794	0.096695	0.4662
$VAR_{Heilongjiang}$	0.000054	0.830068	0.000001	0.719428	0.154561	0.361114
Result of Fisher Test:	19.93**	15.12**	29.48169581***	21.25542278***	9.047400564	31.19442538***
OTHER COASTAL						
$VAR_{Guangdong}$	0.577579	0.548004	0.789044	0.505998	0.318146	0.379018
VAR_{Fujian}	0.764597	3.91E-14	0.235188	0.091985	0.655107	0.537467
$VAR_{Jiangsu}$	0.840142	0.96832	0.220122	0.395322	0.626497	0.692895
$VAR_{Zhejiang}$	0.963075	0.449916	0.835935	0.53057	0.507857	0.635703
VAR_{Hainan}	0.725409	0.329407	0.844005	0.348856	0.512188	0.460596
$VAR_{Shandong}$	0.758904	0.858243	0.20565	0.416745	0.189877	0.15129
VAR_{Hebei}	0.664122	0.82532	0.964477	0.80986	0.319345	0.068283
Result of Fisher Test:	4.07	67.52***	10.32885355	13.53696209	12.37058763	15.51769057
CENTRAL						
VAR_{Henan}	0.067471	0.708851	0.052749	0.78201	0.343947	0.052388
VAR_{Hubei}	0.618074	0.774985	0.618082	0.43212	0.775018	0.788644
VAR_{Hunan}	0.097675	0.406684	0.000203	0.3318419	0.00804	0.126426
VAR_{Anhui}	0.633554	0.204209	0.932946	0.006566	0.592761	0.000994
$VAR_{Jiangxi}$	0.75268	0.084707	0.218203	0.009384	0.180857	0.145549
VAR_{Shanxi}	0.925325	0.967969	0.989856	0.369787	0.980577	0.103373
Result of Fisher Test:	12.64	11.18	27.05516481**	25.75492815**	16.79617928	32.73008682***

SOUTHWEST						
$VAR_{Guangxi}$	0.013023	0.009821	0.109825	5.69911E-12	0.478369	4.95985E-08
$VAR_{Sichuan}$	0.001461	0.010862	0.000229	0.100007	0.220613	0.691306
$VAR_{Guizhou}$	0.608382	0.105258	0.762462	0.322549	0.977129	0.190488
$VAR_{Yuannan}$	0.66823	0.347748	0.817094	0.27162	0.834495	0.713838
Result of Fisher Test:	23.54***	24.91***	22.12771877***	61.25615606***	4.905566496	38.36748651***
NORTHWEST						
$VAR_{Shannxi}$	0.94854	0.351504	0.841553	0.324038	0.030332	0.535705
VAR_{Gansu}	0.56988	0.330579	0.000161	0.027607	1.33227E-15	1.12865E-08
$VAR_{Qinghai}$	0.391991	0.867454	0.950207	0.305491	0.437687	0.048609
$VAR_{Xingjiang}$	0.177598	0.427618	0.168291	0.478301	0.001036	0.630166
Result of Fisher Test:	6.56	6.29	21.47949711**	13.2798608*	90.89217062***	44.81909039***
NATIONAL						
Result of Fisher Test:	72.49**	144.08***	115.2360572***	173.129353***	138.5306087***	169.539454***

Note: ***, ** and * denotes for 1%, 5% and 10% significance

Null Hypothesis of VAR_{FUJIAN} is to test all coefficients from 1 lag to 2 lags are zeroes

Fisher test statistic: $-2 \sum \log p_j \sim \chi 2$, with 2N degrees of freedom, N is the number of provinces in panel VAR, p_j is the p-value of provice j

Denotes at the 1%,5%, and 10% significance level to reject the null hypothesis of no Granger causality

5.3.8 Comparison of Time Series and Panel Model

The unsatisfactory results of the aggregate time series model have put the motivation of doing the panel model forwards. The results of panel model are relatively more fruitful. Yet, this does not imply that the panel estimation is superior to the time series estimation. Because, for example, the panel model cannot provide the aggregate impact of the Granger causality whilst it can be estimated in the aggregate time series model easily. Besides, it should be cautious that these two models are not strictly comparable. The reason is that different time periods were chosen for conducting the time series analysis (from 1994Q1 to 2003Q3) and the unbalanced panel analysis (the longest data available from 1978 to 2003). Due to the constraints of data availability, the time series can merely commence from 1994Q1. Despite panel data provide longer time periods for estimation, it should be feasible to choose the same time period for the panel approach to make these two models more comparable. However, the shorter estimation period for the panel model would deteriorate the power of the Fisher test. Therefore, the final estimation of two models are in different time periods.

5.4 Conclusion

Notwithstanding the unsatisfactory results obtained from the aggregate time series model in Chapter 4, empirical results of panel VARs in this chapter provide affluent and comprehensible findings for the bank lending channel in China.

The unbalanced panel VAR model in this chapter is estimated by formulating the individual time series VARs in every province or metropolis. The Granger causality test is conducted by adopting the Fisher Equation reviewed by Maddala and Wu (1999).

The panel models provide supportive empirical results to explain the bank lending channel of China in Section 5.3. This research not only has examined the effects at the national level of China, but also has investigated the origins of the effects attributed to each province. The results have successfully explained the transmission mechanism underlying the bank lending channel. Moreover, comparisons of similarities and differences of the results of Granger causalities between the aggregate time series model and panel model, as well as models of individual regions, are useful to explain the latest economic conditions in China.

In addition, sensitivity analysis of institutional change: cross-provincial office of the PBOC and those 4 AMCs under the supervision of the PBOC, provide alternative explanations of the bank lending channel of China; such changes have impact on China's banking system to prohibit the overheated economy and to tackle the NPLs problems. Similarly, the institutional change affects only some of the regions, but overall, it does have impacts on the whole banking sector in the national level.

Last but not lest, the different time periods in respective time series and unbalance panel analysis lead the results from the two models less comparable. It is due to the constraints of the data availability.

Statistical Appendix:

Results of VAR of Beijing ($VAR_{Beijing}$) in the Panel VAR Model 2

Table 5.5 Vector Autoregressive Model of Beijing with 1 lag: all variables below refer to the variables of Beijing

Vector Autogression Estimates $VAR_{Beijing}$ with 1 lag
Sample(adjusted): 1986 2002
Included observations: 17 after adjusting endpoints
t-statistics in [ ]

	Dependent Variables					
	GDP	LOANS	*i*	π	I_D	FDI
Independent variables						
GDP(-1)	1.034197	2.884484	6.897528	-1.931891	9.420255	4.834729
	[3.13827]	[2.64215]	[0.42145]	[-0.73817]	[5.27582]	[0.63311]
LOANS(-1)	-0.08179	0.334789	0.628174	0.183203	-0.094535	-1.186829
	[-1.48911]	[1.83993]	[0.23029]	[0.42000]	[-0.31766]	[-0.93248]
i(-1)	-0.001818	-0.020016	0.232842	0.014141	0.061499	0.068914
	[-0.27125]	[-0.90163]	[0.69965]	[0.26572]	[1.69379]	[0.44379]
π(-1)	-0.004592	-0.335512	3.722259	0.242148	-0.724171	0.081619
	[-0.08090]	[-1.78436]	[1.32052]	[0.53721]	[-2.35480]	[0.06206]
I_D(-1)	-0.006239	-0.045513	-3.780709	-0.060104	-0.283238	-0.120062
	[-0.14199]	[-0.31266]	[-1.73252]	[-0.17224]	[-1.18968]	[-0.11791]
FDI(-1)	-0.027439	-0.096238	1.599336	0.069895	-0.076844	0.074602
	[-1.72331]	[-1.82450]	[2.02256]	[0.55275]	[-0.89073]	[0.20219]
C	0.149955	-6.979916	-3.711979	5.913569	-26.78519	-13.729
	[0.15373]	[-2.15996]	[-0.07662]	[0.76337]	[-5.06791]	[-0.60737]
TIME	0.015965	-0.154421	-0.827416	0.14513	-0.730703	-0.10585
	[0.59058]	[-1.72436]	[-0.61633]	[0.67603]	[-4.98887]	[-0.16898]

R-squared	0.999046	0.995897	0.873559	0.424433	0.982932	0.889598
Adj. R-squared	0.998303	0.992705	0.775216	-0.02323	0.969657	0.803729
Sum sq. resids	0.003743	0.041078	9.231704	0.236068	0.109884	2.009893
S.E. equation	0.020393	0.067559	1.012791	0.161956	0.110496	0.472569
F-statistic	1345.947	312.055	8.882772	0.948108	74.04376	10.36002
Log likelihood	47.45727	27.09469	-18.93211	12.23124	18.73114	-5.973332
Akaike AIC	-4.642032	-2.246434	3.168484	-0.497793	-1.262486	1.643921
Schwarz SC	-4.249931	-1.854334	3.560584	-0.105693	-0.870386	2.036022
Mean dependent	4.820175	5.113696	8.517647	0.210422	3.987653	1.690321
S.D. dependent	0.495106	0.791011	2.136175	0.160107	0.634334	1.066688

Determinant Residual Covariance	4.91E-13
Log Likelihood (d.f. adjusted)	96.17442
Akaike Information Criteria	-5.667579
Schwarz Criteria	**-3.314976**

Table 5.6 System Estimation of VAR of Beijing ($VAR_{Beijing}$) in the Panel VAR Model 2

System: $VAR_{Beijing}$ in Panel Model 2
Estimation Method: Least Squares (Marquardt)
(all variables below refer to the variables of Beijing)
Sample: 1987 2002
Included observations: 16
Total system (balanced) observations 96

Equation: GDP = C(1)*GDP(-1) + C(2)*GDP(-2) + C(3)
*LOANS(-1) + C(4)*LOANS(-2) + C(5)
i(-1) + C(6)i(-2) + C(7)
π(-1) + C(8)π(-2) + C(9)
I_D(-1) + C(10)I_D(-2) + C(11)*FDI(-1)
+ C(12)*FDI(-2) + C(13) + C(14)*TIME

Observations: 16			
R-squared	0.999908	Mean dependent var	4.866938
Adjusted R-squared	0.999307	S.D. dependent var	0.470975
S.E. of regression	0.012395	Sum squared resid	0.000307
Durbin-Watson stat	2.328679		

	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	1.816612	0.857355	2.118856	0.0556
GDP(-2)	-0.410902	1.251645	-0.32829	0.7484
LOANS(-1)	-0.116437	0.127545	-0.912908	0.3793
LOANS(-2)	0.060063	0.058605	1.024891	0.3256
i(-1)	0.007794	0.009178	0.849253	0.4124
i(-2)	0.008196	0.008998	0.910828	0.3803
π(-1)	-0.093998	0.119057	-0.789525	0.4451
π(-2)	-0.116981	0.068527	-1.707083	0.1135
I_D(-1)	-0.008622	0.066653	-0.129358	0.8992
I_D(-2)	-0.042165	0.046201	-0.912627	0.3794
FDI(-1)	-0.046741	0.014286	-3.271874	0.0067
FDI(-2)	-0.0061	0.037305	-0.163516	0.8728
Constant Term	-1.159809	2.038018	-0.569087	0.5798
TIME	-0.013689	0.057071	-0.239865	0.8145

Equation: LOANS = C(15)*GDP(-1) + C(16)*GDP(-2) + C(17)
*LOANS(-1) + C(18)*LOANS(-2) + C(19)
i(-1) + C(20)i(-2) + C(21)
π(-1) + C(22)π(-2) + C(23)
I_D(-1) + C(24)I_D(-2) + C(25)*FDI(-1)
+ C(26)*FDI(-2) + C(27) + C(28)*TIME

Observations: 16

R-squared	0.999686	Mean dependent var	5.172976
Adjusted R-squared	0.997642	S.D. dependent var	0.776974
S.E. of regression	0.037725	Sum squared resid	0.002846
Durbin-Watson stat	2.437439		

	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	9.81041	2.609357	3.759703	0.0027
GDP(-2)	-11.15183	3.809376	-2.927469	0.0127
LOANS(-1)	0.934771	0.388183	2.408071	0.033
LOANS(-2)	0.783303	0.178363	4.391635	0.0009
i(-1)	0.010746	0.027933	0.384714	0.7072
i(-2)	0.033252	0.027386	1.214191	0.248
π(-1)	-1.316171	0.362349	-3.632329	0.0034
π(-2)	0.411579	0.208561	1.973421	0.0719
I_D(-1)	-0.151669	0.202859	-0.747655	0.4691
I_D(-2)	0.151032	0.140614	1.074086	0.3039
FDI(-1)	-0.092161	0.043479	-2.119673	0.0556
FDI(-2)	0.332943	0.113538	2.932447	0.0125
Constant Term	2.042442	6.202699	0.329283	0.7476
TIME	-0.030697	0.173696	-0.176726	0.8627

Equation: i = C(29)*GDP(-1) + C(30)*GDP(-2) + C(31)
*LOANS(-1) + C(32)*LOANS(-2) + C(33)
i(-1) + C(34)i(-2) + C(35)
π(-1) + C(36)π(-2) + C(37)
I_D(-1) + C(38)I_D(-2) + C(39)*FDI(-1)
+ C(40)*FDI(-2) + C(41) + C(42)*TIME

Observations: 16

R-squared	0.961659	Mean dependent var	8.555
Adjusted R-squared	0.712445	S.D. dependent var	2.200491
S.E. of regression	1.179995	Sum squared resid	2.784777

Durbin-Watson stat	2.806697			

	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	80.31474	81.61703	0.984044	0.3445
GDP(-2)	-110.2365	119.1519	-0.925176	0.3731
LOANS(-1)	4.736033	12.14181	0.39006	0.7033
LOANS(-2)	6.104649	5.578931	1.094233	0.2953
i(-1)	0.63331	0.87371	0.724852	0.4824
i(-2)	0.331642	0.856609	0.387157	0.7054
π(-1)	-5.928956	11.33377	-0.523123	0.6104
π(-2)	2.168758	6.523494	0.332453	0.7453
I_D(-1)	-2.494198	6.345156	-0.393087	0.7011
I_D(-2)	-0.240222	4.398208	-0.054618	0.9573
FDI(-1)	0.967434	1.359951	0.711374	0.4905
FDI(-2)	2.172031	3.551295	0.611617	0.5522
Constant Term	73.54223	194.0117	0.379061	0.7113
TIME	0.691016	5.432969	0.127189	0.9009

Equation: π = C(43)*GDP(-1) + C(44)*GDP(-2) +
C(45)*BANKLOANS(-1) + C(46)*BANKLOANS(-2) + C(47)
i*(-1) + C(48)i*(-2) + C(49)
*π(-1) + C(50)*π(-2) + C(51)
I_D(-1) + C(52)I_D(-2) + C(53)*FDI(-1)
+ C(54)*FDI(-2) + C(55) + C(56)*TIME

Observations: 16

R-squared	0.966213	Mean dependent var	0.219274
Adjusted R-squared	0.746597	S.D. dependent var	0.161005
S.E. of regression	0.081048	Sum squared resid	0.013138
Durbin-Watson stat	2.799526		

	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	16.3811	5.605901	2.922118	0.0128
GDP(-2)	-24.2903	8.184001	-2.968022	0.0117
LOANS(-1)	1.462749	0.833965	1.753969	0.1049
LOANS(-2)	1.444771	0.383191	3.770364	0.0027
i(-1)	0.147995	0.060011	2.466126	0.0297
i(-2)	0.129556	0.058837	2.201962	0.048
π(-1)	-2.247484	0.778465	-2.887073	0.0137

$\pi(-2)$	-0.010599	0.448069	-0.023654	0.9815
$I_D(-1)$	-0.223874	0.43582	-0.513684	0.6168
$I_D(-2)$	0.015781	0.302093	0.052241	0.9592
FDI(-1)	-0.077139	0.093409	-0.825823	0.425
FDI(-2)	0.512	0.243922	2.09903	0.0576
Constant Term	15.1905	13.32578	1.139933	0.2766
TIME	0.247832	0.373166	0.664135	0.5192

Equation: I_D = C(57)*GDP(-1) + C(58)*GDP(-2) + C(59)
*LOANS(-1) + C(60)*LOANS(-2) + C(61)
i(-1) + C(62)i(-2) + C(63)
π(-1) + C(64)π(-2) + C(65)
I_D(-1) + C(66)I_D(-2) + C(67)*FDI(-1)
+ C(68)*FDI(-2) + C(69) + C(70)*TIME

Observations: 16

R-squared	0.996202	Mean dependent var	4.033349
Adjusted R-squared	0.971517	S.D. dependent var	0.625573
S.E. of regression	0.105578	Sum squared resid	0.022293
Durbin-Watson stat	2.15511		

	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	17.34159	7.302531	2.374737	0.0351
GDP(-2)	-1.027542	10.6609	-0.096384	0.9248
LOANS(-1)	0.339342	1.086365	0.312364	0.7601
LOANS(-2)	0.775463	0.499164	1.553522	0.1463
i(-1)	0.004194	0.078174	0.053654	0.9581
i(-2)	0.130133	0.076643	1.697899	0.1153
π(-1)	-0.983495	1.014068	-0.969852	0.3513
π(-2)	-0.398943	0.583677	-0.683499	0.5073
I_D(-1)	-0.948155	0.567721	-1.670108	0.1208
I_D(-2)	-0.811879	0.393521	-2.063112	0.0614
FDI(-1)	-0.137547	0.121679	-1.130408	0.2804
FDI(-2)	0.309214	0.317745	0.973151	0.3497
Constant Term	-47.8862	17.35883	-2.758607	0.0173
TIME	-1.472147	0.486105	-3.028456	0.0105

Equation: FDI = C(71)*GDP(-1) + C(72)*GDP(-2) + C(73)
*LOANS(-1) + C(74)*LOANS(-2) + C(75)

i(-1) + C(76)(-2) + C(77)i
*π(-1) + C(78)*π(-2) + C(79)
I_D(-1) + C(80)I_D(-2) + C(81)*FDI(-1)
+ C(82)*FDI(-2) + C(83) + C(84)*TIME

Observations: 16

R-squared	0.967995	Mean dependent var	1.812696
Adjusted R-squared	0.75996	S.D. dependent var	0.970628
S.E. of regression	0.475548	Sum squared resid	0.452292
Durbin-Watson stat	2.322724		

	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	2.604063	32.89238	0.079169	0.9382
GDP(-2)	23.23707	48.01927	0.483911	0.6372
LOANS(-1)	-5.586872	4.893255	-1.14175	0.2758
LOANS(-2)	-0.494515	2.248358	-0.219945	0.8296
i(-1)	0.340959	0.352113	0.968323	0.352
i(-2)	-0.091208	0.345221	-0.264202	0.7961
π(-1)	0.604907	4.567608	0.132434	0.8968
π(-2)	-4.571271	2.629025	-1.73877	0.1076
I_D(-1)	-0.217213	2.557154	-0.084943	0.9337
I_D(-2)	-0.005122	1.772517	-0.00289	0.9977
FDI(-1)	-0.485551	0.548072	-0.885925	0.3931
FDI(-2)	-0.971518	1.431203	-0.678812	0.5101
Constant Term	-68.13837	78.18842	-0.871464	0.4006
TIME	-1.076868	2.189534	-0.491825	0.6317

Table 5.7 Results of Panel VAR Model 2: Example of equation for LOANS

Null Hypothesis:	Coefficient of $Y_{GDP}(-1)$ is zero	Coefficient of $i(-1)$ is zero	Coefficient of $\pi(-1)$ is zero	Coefficient of $I_D(-1)$ is zero	Coefficient of FDI (-1) is zero
	p-values of χ^2	p-values of χ^2	p-values of χ^2	p-values of χ^2	p-values of χ^2
METROPOLIS					
$VAR_{Beijing}$	0.00017	0.70045	0.000281	0.454669	0.034034
$VAR_{Tianjin}$	0.712829	0.953989	0.484865	0.938533	0.210868
$VAR_{Shanghai}$	0.594905	0.718309	0.580774	0.714498	0.83444
Result of Fisher Test:	19.08***	1.47	18.89***	2.38	10.23
NORTHEAST					
$VAR_{Liaoning}$	0.01129	0.137659	0.436438	0.147425	0.650527
VAR_{Jilin}	0.055721	0.186699	0.177506	0.014705	0.478774
$VAR_{Heilongjiang}$	0.830068	0.071532	0.983981	0.045652	0.969907
Result of Fisher Test:	15.12**	12.6	5.15	18.44**	2.39
OTHER COASTAL					
$VAR_{Guangdong}$	0.548004	0.646997	0.706033	0.585041	0.398345
VAR_{Fujian}	3.91E-14	0.000005	1.00E-99	1.00E-99	1.11E-16
$VAR_{Jiangsu}$	0.96832	0.008273	0.400376	0.944421	0.491144
$VAR_{Zhejiang}$	0.449916	0.112704	0.3968	0.435645	0.469595
VAR_{Hainan}	0.329407	0.661208	0.408747	0.405257	0.487043
$VAR_{Shandong}$	0.858243	0.347878	0.800651	0.795462	0.495863
VAR_{Hebei}	0.82532	0.115593	0.924565	0.134457	0.400307
Result of Fisher Test:	67.52***	46.49***	462.68***	465.04***	89.92***

CENTRAL					
VAR_{Henan}	0.708851	0.88709	14.19	0.224581	0.518204
VAR_{Hubei}	0.774985	0.93962	0.564473	0.825179	0.595107
VAR_{Hunan}	0.406684	0.493938	0.526055	0.590917	0.571097
VAR_{Anhui}	0.204209	0.460593	0.227291	0.439087	0.851677
$VAR_{Jiangxi}$	0.084707	0.06727	0.907558	0.693988	0.952207
VAR_{Shanxi}	0.967969	0.697337	0.104449	0.246112	0.623541
Result of Fisher Test:	11.18	9.44	14.19	9.6	4.84
SOUTHWEST					
$VAR_{Guangxi}$	0.009821	0.512415	0.000284	0.277985	0.524705
$VAR_{Sichuan}$	0.010862	0.000815	0.138698	0.007876	0.247473
$VAR_{Guizhou}$	0.105258	0.406704	0.133634	0.959136	0.62623
$VAR_{Yuannan}$	0.347748	0.714731	0.875778	0.758035	0.632868
Result of Fisher Test:	24.91***	18.03**	24.57***	12.89	5.93
NORTHWEST					
$VAR_{Shannxi}$	0.351504	0.466078	0.275025	0.769077	0.557932
VAR_{Gansu}	0.330579	0.772636	0.244998	0.617976	0.890364
$VAR_{Qinghai}$	0.867454	0.685684	0.864589	0.884914	0.751182
$VAR_{Xingjinag}$	0.427618	0.808042	0.818009	0.732542	0.44839
Result of Fisher Test:	6.29	3.22	6.09	2.35	3.58

NATIONAL					
Result of Fisher Test:	144.08***	91.26**	531.57***	510.7***	109.9***

Note: ***, ** and * denotes for 1%, 5% and 10% significance

Null Hypothesis of VAR_{FUJIAN} is to test all coefficients from 1 lag to 2 lags are zeroes

Fisher test statistic: $-2 \Sigma \log p_j \sim \chi 2$, with 2N degrees of freedom, N is the number of provinces in panel VAR, p_j is the p-value of province j.

Data Annex

Variable	Explanation
FDI	Natural logarithm of Foreign Direct Investment deflated by GDP deflator
FDI2	Natural logarithm of Foreign Direct Investment deflated by iGDP deflator
GDP	Real national Gross Domestic Product in natural logarithm
I_D	Natural logarithm in Domestic Investment deflated by GDP deflator
I_{D2}	Natural logarithm in Domestic Investment deflated by iGDP deflator
iGDP	Real Industrial value-added in natural logarithm
iLOANS	Industrial Loans of National Banking System deflated by iGDP deflator
LOANS	Total Loans of National Banking System deflated by GDP deflator
$\boldsymbol{i}$	Lending rate is the bank rate that meets the short and medium term financial needs of the private sector
π	Inflation rate calculated as: $\triangle p*4$, where p is the GDP deflator
π_2	Inflation rate calculated as: $\triangle p*4$, where p is the iGDP deflator
TIME	Time Trend

Note: Domestic investment equals to gross capital formation minus respective foreign direct investment.

Chapter 6 Conclusions and Policy Implications

6.1 Conclusions

Monetarism is at the heart of economics which aims at stabilizing the economy through conducting monetary policies to maintain a stable economic growth. The fundamental underlying assumptions of the bank lending channel is that a reduction or an increase of bank loans are actually the responses to monetary policies, and bank loans eventually affect output though the lending channel. There are already considerable amounts of empirical work that have examined the bank lending channel in developed economies such as the U.S., the U.K., Germany and Japan. The evidence for the importance of a bank lending channel is relatively little in China.

In this research, we extended the traditional bank lending channel into a multi-directional causality cycle to examine the pattern of the credit channel in China. The background information of China, motivations, limitations and structure of this research are given in the first chapter. The second chapter reviews the literatures related to the bank lending channel. It also describes the investment issues on whether there is a crowding-out, or a crowding-in, relationship between domestic investment and foreign direct investment.

The core of this research is the proposed framework of investigating the bank lending channel of China in Chapter 3. By expanding the traditional framework of Keynesians' structural model and the monetarist's reduced-form approach, a multi-directional causality cycle is developed to explain the bank lending channel of China. The analytical paradigm is composed of two parts – the times series model

and the unbalanced panel model. The empirical results of these two models are shown in Chapter 4 and Chapter 5 respectively.

In Chapter 4, the time series model provides a quarterly aggregate analysis for the period of 1994Q1 to 2002Q3. The results are unsatisfactory in that only direct but weak causality from Gross Domestic Product to bank loans was found but no reverse causality. However, there are indirect links from banks loans to Gross Domestic Product. Surprisingly, we find that there is a crowding-out effect of domestic investments on foreign direct investment which is opposite to the findings from countries in the Ivory Coasts. A sensitivity analysis of institutional change, have been conducted for the VAR5. The results are that interventions from Chinese Government did have impact on the lending behavior of investors. Given the fact that the power of the aggregate times series model test is low, therefore it is believed that the panel data can provide more information that can be a complement to the time series model of China.

In Chapter 5, the unbalanced panel VAR model comprises the annual data from 27 provinces and 3 metropolises, for the period of 1978 to 2002. The results are far more satisfactory than those of the aggregate times series. Strong and direct causalities and reverse causalities are found in the bank lending channel, which strongly support the new analytical framework laid out in Chapter 3. Moreover, the panel data model gives different significance levels for Granger causality tests in various regions. The advantage of the regional blocks comparison is to avoid the problems of neutralization effect in the aggregate time series model. There is also a sensitivity analysis by adding a dummy variable in Panel VAR Model 2 to compare the findings with and without the dummy, $DUMMY_{GOV}$. It is found that there are

drastic variations of the significances of Granger causality across different regions. Furthermore, the policies of consolidation of cross-provincial office of the PBOC and the setup of four AMCs aimed at targeting NPLs problem and controling the overheated economy have positive effects on the Chinese banking sector. Though the findings of panel approach provide lots of information, the two models are not strictly comparable. It is because the different time periods are adopted in the time series and unbalance panel models.

The empirical findings are that: first, the unexpected negative sign in the causality from Gross Domestic Product to bank loans and its reverse causality indicate that the overheated economy in China is shading the confidence of people as they fear that there may be a bubble economy like the Southeast Asian Countries' pre-financial crisis. It also may be related to the problem of the non-performing loans (NPLs) that hinder economic growth in some provinces. The more loans issued, the more NPLs may accumulate. Therefore, GDP growth may go down instead of up.

Second, the decomposition of investment into domestic investment and foreign direct investment enables us to investigate their relationships in each region. There is evidence to show that both crowding out and complementary effects are occurring for these two types of investment activities in different provinces of China. Government should beware of these effects and implement appropriate measures to encourage investment.

Third, various associated in different regions imply that mechanisms of transmission channel are different across regions. The reasons are government intervention (administrative commands), different paces of economic development (i.e. Coastal

regions developed first), lack of financial infrastructure in some areas and non-market discipline in the banking sector.

6.2 Policy implications

The reforms in the banking system, such as the decentralization of credit control and the development of financial institutions, help to channel the financial resources towards a broad range of sectors in the Chinese economy across different regions. However, according to the empirical results presented by this research, it is found, similar to the findings of Samolyk (1993), that the inequalities of regions in banking sectors result in differences in the transmission mechanisms of the monetary policy and have different distributional effects to provinces and metropolises.

Harrison and McMillan (2002) claim that foreign firms can simply be more profitable and have access to more collateral and thus be a better investment for lending institutions. For domestic firms, there may be problems associated with asymmetric information for bank credits to the local firms. The state-owned commercial banks (SOCBs) are not well-equipped to deal with these problems They simply do not have the experience and expertise to select profitable firms. The administrative commands of issuing loans to the state owned enterprises (SOEs) in China have been rooted in the financial system for over a half century. Even after the economic reforms implemented after 1978, there are still lots of problems associated with the SOEs to the banking sector. There is lack of disciplinary control to both staff in both the SOEs and the banking sector to eliminate the non-performance loans (NPLs) problem. The state-owned commercial banks (SOCBs) have over 70% of the business in the banking sector and they are the main source of the NPLs.

Foreign direct investment remains an important channel for China's economic growth. The spillover effects of these foreign investments should not be overlooked. The positive spillover effects are that foreign direct investment can contribute technology transfer and bring in advanced skills such as managerial, organizational and technological skills to China. Up to this point, we welcome the crowding-in effect of foreign enterprise to China through co-operative measures with local enterprises. However, there is a crowding-out effect as negative externalities. Foreign firms may crowd out local firms in local credit markets. Therefore, officials of both central and local governments should be concerned about the survival of domestic firms in the face of foreign firms' competition. It is necessary to provide financial and infrastructure support for local investors within the frameworks of the WTO.

Finally, it is important to further liberalize the banking sector to introduce market discipline in the financial sector in China. Meanwhile, the enforcement of supervision of the banking sector and abolishment of policy loans through the administrative commands can be a starting point to prohibit NPLs and to strengthen the banking system of China.

6.3 Limitations of the Research

The times series and panel model enable us to explore the bank lending channel on the macro level. Further investigation should be done on the micro level (i.e. firm level). Moreover, our analytical paradigm has no control variables such as government regulation, foreign direct investment quota, market restriction, and shares of ownership of firm. The results may be varied when considering these factors. This could be a future direction of the research. Data of bank loans include only national banking systems but not those of non-banking financial institutions,

which are increasingly play a significant role in bank lending channel of China.

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