Monetary Policy in Transition – Essays on Monetary Policy Transmission Mechanism in China

Tuuli Koivu

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The views expressed in this study are those of the author and do not necessarily reflect the views of the Bank of Finland.

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Abstract

China's economic development has been exceptionally robust since the end of the 1970s, and the country has already emerged as the second biggest economy in the world. In this study, we seek to illuminate the role of the monetary policy in this successful economic performance and as a part of the extensive economic reforms of the last two decades. The five empirical essays seek to discover which monetary policy tools are the most used and most effective for guiding China's economic development. In addition, we explore which monetary policy transmission channels are functioning and to what extent monetary policy impacts inflation and real economic developments in China. The results indicate that the conduct of monetary policy in China differs substantially from what is typical for an advanced market economy, where an independent central bank often aims to hit an inflation target by simply controlling the target interest rate. First, China's monetary policy toolkit is highly diverse. Besides a collection of administrated interest rates, it contains quantitative policy tools and direct guidelines. Second, China's central bank is not independent in its decision-making. For these reasons, it is exceptionally challenging to measure the monetary policy stance or to distinguish monetary policy from other macroeconomic policies in China's case. This has been taken into account in this study by using a variety of monetary-policy indicators. Our results suggest that China's monetary-policy implementation and its transmission to the real economy still rely heavily on quantitative policy tools and direct guidelines; interest rates play a much smaller role, in terms of both usage and effectiveness. Overall, our findings suggest that the direct link between monetary policy and real economic performance is weak in China. On the other hand, this study clearly shows that monetary policy has played a key role in price developments, which tells us that monetary policy has been an important factor in China's economic success.

Key words: China, monetary policy, economic growth, inflation, exchange rates

JEL classification: E50, P30

Tiivistelmä

Kiinan talouskehitys on ollut poikkeuksellisen nopeaa 1970-luvun lopulta lähtien. Nyt maa on jo maailman toiseksi suurin talous. Tutkimuksessa analysoidaan, mikä merkitys rahapolitiikalla on ollut suotuisassa kehityksessä ja laajoissa talousuudistuksissa kahden viime vuosikymmenen aikana. Tutkimuksen viisi artikkelia pyrkivät selvittämään empiirisesti rahapolitiikan välineiden käyttöä ja tehokkuutta Kiinassa. Lisäksi tutkimuksessa tarkastellaan, mitä reittejä pitkin ja missä määrin rahapolitiikan vaikutukset heijastuvat inflaatioon ja reaalitalouden kehitykseen. Tutkimus osoittaa, että Kiinan rahapolitiikan toteutus eroaa merkittävästi useimpien kehittyneiden talouksien harjoittamasta rahapolitiikasta, jossa itsenäiset keskuspankit pyrkivät inflaatiotavoitteeseensa pitkälti ohjauskorkoa säätelemällä. Ensinnäkin rahapolitiikan välineistö on Kiinassa hyvin monipuolinen. Se sisältää useiden säädeltävien korkojen lisäksi suoraan rahan määrään vaikuttavia välineitä ja hallinnollisia määräyksiä. Toiseksi erityisleimansa harjoitettuun rahapolitiikkaan tuo se, ettei Kiinan keskuspankki ole millään muotoa itsenäinen. Näiden tekijöiden vuoksi toteutetun rahapolitiikan mittaaminen ja erottaminen muusta harjoitetusta talouspolitiikasta on Kiinan tapauksessa poikkeuksellisen haasteellista. Se on tutkimuksessa otettu erityisesti huomioon käyttämällä moninaisia rahapolitiikan mittareita. Tutkimuksen perusteella on selvää, että rahapolitiikan toimeenpano keskittyy yhä määrällisten ja hallinnollisten välineiden käyttöön, kun taas korkojen käyttö ja vaikutukset talouskehitykseen ovat vähäisiä. Ylipäätään rahapolitiikalla on usein vain heikko suora vaikutus reaalitalouden kehitykseen. Sen sijaan yhteys harjoitetun rahapolitiikan ja inflaation välillä on sangen vahva, mikä kertoo siitä, että rahapolitiikka on tärkeä tekijä Kiinan talouskehityksessä.

Asiasanat: Kiina, rahapolitiikka, talouskasvu, inflaatio, valuuttakurssit

JEL-luokat: E50, P30

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Helsinki, August 2012
Tuuli Koivu

Contents

Chapter 1

Introduction

1 Introduction

1.1 Background

Study of monetary policy impacts on the real economy has been facilitated in recent years by development of theoretical frameworks and econometric tools. So far, the work has tended to concentrate on analyzing the monetary policy transmission mechanism in advanced economies rather than emerging economies. This dissertation aims to fill partly the gap by exploring the links between monetary policy and economic development in China, the world's largest emerging economy.

China's development since the start of economic reforms in 1978 has been impressive. Real GDP has increased annually by 10% on average and the country has emerged as the second biggest economy in the world. In the five essays, we seek to illuminate the role of monetary policy behind the successful economic development and deepen the knowledge on the monetary policy transmission mechanism in China. In sum, the essays try to find out which monetary policy tools are the most effective ones in guiding economic development in China. Furthermore, we explore via which channels the monetary policy does affect the real economy and finally, we aim to make some conclusions regarding the overall effectiveness of China's monetary policy. More particularly, in the first essay, we study the role of interest rate as a monetary policy tool in China. In the following three essays, we examine for the existence and impacts of a wealth channel, exchange rate channel and bank lending channel as mean for transmitting monetary policy to the real economy. Finally, we consider the usefulness of a quantity-based monetary policy rule in forecasting inflation in China.

Improving our understanding of how China's domestic policymaking influences economic development undoubtedly provides valuable perspective on the economic reforms China has been putting in place for over three decades. Furthermore, any major economic development in China today is felt in the rest of the world, so it is hardly surprising that the impacts of China's economic policies occupy centre stage in many international discussions.

This thesis is also motivated by a fact that older studies of Chinese monetary policy transmission channels may no longer be relevant as reforms may have modified those channels, but on the other hand studies of advanced economies may lack relevance to the Chinese

context. This study concentrates on analyzing the more recent period of economic reforms starting in 1994 when most of the currently existing institutions and legislation were already in place. By making this restriction, the study contributes to the existing literature by taking into account the numerous specific characteristics still prevailing in the Chinese economy but at the same time guarantees that the conclusions drawn here are relevant to current policymaking in China.

The first chapter aims to provide a framework for the following essays by introducing the targets and tools of the monetary policy in China, giving a brief description of the economic environment in which monetary policy is conducted and finally summarizing the conclusions of the essays. In particular, Section 1.2 describes China's monetary policy, including the main policy targets and the monetary policy tools in regular use by the Chinese monetary authorities. Section 1.3 provides a short overview of China's macroeconomic environment from the perspective of monetary policy, as well as the long path of economic reform and major developments in the financial sector. Section 1.4 summarizes our main findings and the five essays follow in Chapters 2, 3, 4, 5 and 6.

1.2 The targets and implementation of monetary policy in China

1.2.1 The institutional framework and targets of monetary policy in China

Like other parts of the Chinese economy, the institutions and practices of monetary policy have been reformed, although very gradually, since 1978. The law giving the People's Bank of China (PBC) power to perform central bank functions was enacted by the People's Congress in 1995, a decade after the PBC de facto became the central bank. Even so, the PBC to this day is not independent as it remains under the leadership of the State Council. In its own mission

description, the PBC notes this subordinate role but claims independence from all other institutions in the same sentence.[1]

In 1993, the State Council stated: 'The objective of the monetary policy is to maintain the stability of the value of the currency and thereby promote economic growth.'[2] While the State Council did not specify whether stable value of the currency meant low inflation or a stable exchange rate, Mehran, Quintyn, Nordman and Laurens (1996) see this as favouring monetary policy that targets inflation over targeting the external value of the currency. Liu and Zhang (2007) further note that, whatever the case, China's monetary policy must also serve implicit objectives other than those officially declared. For example, China's monetary authorities have targets related to unemployment, balance of payments and financial sector reform. This is hardly surprising, of course, given the PBC's institutional framework and close relationship with the State Council.

Already prior to definition of the main monetary policy targets by law, the PBC began to set annual intermediate targets for monetary aggregates. In the 1986−1993 period, China had targets for currency in circulation and bank loan portfolios (Laurens and Maino, 2007). This changed in 1994, when the authorities started to set targets for M1 and M2 growth. Although Geiger (2008) notes that the new targets did not seem to be based on any model or theory, such nominal anchors likely increased the transparency of monetary policy as certain monetary developments began to be tracked in official documents such as the PBC's Quarterly Monetary Policy Report. Still today, in addition to high importance achieving the main inflation and growth targets, the authorities monitor closely developments in monetary aggregates with respect to their annual targets.

1.2.2 Main monetary policy tools and their implementation in China

We will now introduce the main policy tools the Chinese officials use in order to achieve the targets set for the monetary policy. While the conduct of monetary policy in advanced economies in normal times

[1] 'Under the leadership of the State Council, the PBC implements monetary policy, performs its functions and carry out business operations independently according to laws and free from intervention by local governments, government departments at various levels, public organizations or any individuals.' From http://www.pbc.gov.cn/publish/english/968/index.html, accessed June 1, 2011.

[2] http://www.pbc.gov.cn/publish/english/970/index.html.

often concentrates on interest rates, Chinese authorities employ a broad, ever-changing set of monetary policy tools to achieve their objectives.

In the early years of reform, direct monetary policy instruments dominated the conduct of monetary policy. Conway, Herd and Chalaux (2010) observe: 'From 1984 until 1997, the PBC issued base money and implemented monetary policy under a system of central bank lending and credit controls.' Gradual progress in banking reform eventually diminished the role of direct central bank lending in the economy, allowing the monetary authorities to turn to indirect measures. One of the cornerstones in this shift was the replacement of credit quotas with 'window guidance policy' and since 1998 the PBC's monetary tool chest has emphasized indirect quantitative monetary policy tools, particularly open market operations and reserve requirements. Of course, it took years before these indirect tools functioned properly. Part of their ineffectiveness reflected soft budget constraints on state-owned enterprises who tended also to be major bank customers but were largely immune to the costs of borrowing (Mehran et al, 1996). As a result, use of the interest rate as basically the only monetary policy tool as in advanced economies was not sufficient in China's economic environment.

Geiger (2008) divides China's monetary policy tools into three categories (price-based instruments and quantitative-based instruments used by the PBC, and non-central-bank instruments). For our purposes, it is sufficient simply to list the policy tools the PBC used actively during our observation period. As will quickly become apparent, the use of administrative guidelines and quantitative-based instruments continues to dominate monetary policymaking in China, while the role of interest rates in influencing economic trends remains limited. Strikingly, how China's monetary authorities apply this array of policy tools seems quite pragmatic and flexible. Tools considered effective for a particular economic situation are generally applied appropriately. For example, it seems that whenever inflation accelerates above the targeted level, the role of administrative guidelines increases. Moreover, the authorities show remarkable creativity in modifying tools as needed. It is noteworthy that the Chinese authorities also resort regularly to non-monetary tools to influence inflation or economic growth. For example, direct price controls are often imposed when inflation flares (Geiger, 2008). However, those measure are excluded from this study as we concentrate strictly on analysing the monetary policy in China.

1.2.2.1 Commercial bank reserve requirements

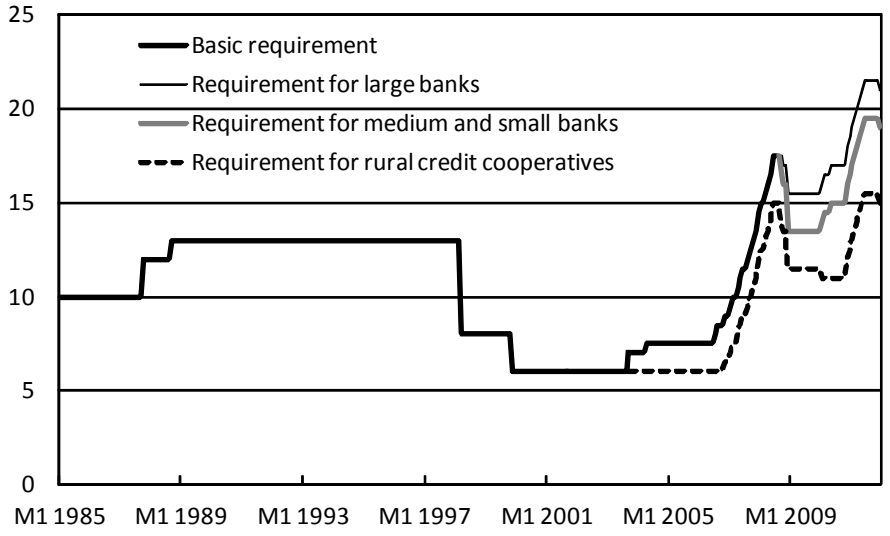
Although China introduced the minimum reserve requirement already in 1984 it was incorporated into regular use as a policy tool only in 1998 after the PBC removed the minimum requirement on bank excess reserves and allowed financial institutions to decide their own optimal levels of excess reserves based on their payment and transfer needs. Before the reform, the required reserve ratio had been 13% with an excess reserve ratio of 5–7%, meaning the effective reserve requirement approached 20%. With the reform, the 13% reserve requirement was divided into an 8% legally required portion and a 5% portion to be used for clearing and settlement among financial institutions (Xie, 2004).

Over the past decade, the reserve requirement has become a central monetary policy tool, playing a key role from 2002 onwards in efforts by the authorities to restrain money growth in the face of vast foreign exchange inflows. The shifts in the reserve requirement have been remarkable the ratio varying from 6% to more than 20% in the recent years (Figure 1.1).

In order to improve macroeconomic management, China has continued to modify the basic reserve requirement. Since 2003, the authorities have specified reserve requirements for different financial institutions. At the end of 2010, for example, the reserve requirement was 16.5% for large commercial banks with nationwide operations, 14.5% for small and medium-sized financial institutions and 11% for urban and rural co-operatives. In addition, the authorities have started to implement a new mechanism to adjust the reserve requirement on a continuous and case-by-case basis since the beginning of 2011. On top of general economic conditions, these individually defined requirements are based on eg banks' capital adequacy ratios and credit portfolios.

Both required and excess reserves bear interest in China. Geiger (2008) suggests that interest rates on reserves in the 1990s were so high they encouraged many banks to hold excess reserves rather than extend credit (Figure 1.3). In recent years, the real interest rate on excess reserves has been mostly negative and the level of excess reserves has declined substantially.

Figure 1.1 **Reserve requirements for commercial banks in China, end of period, %**



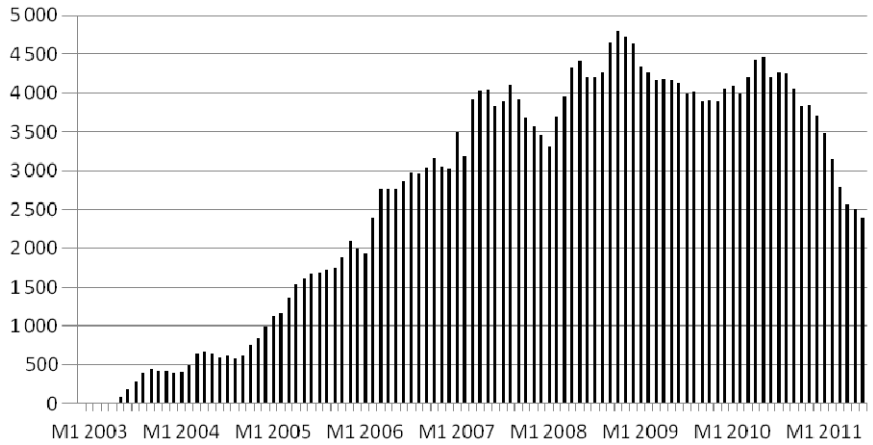
Source: People's Bank of China.

1.2.2.2 Open market operations

Open market operations (OMOs) are another important tool in China's monetary policy toolbox. Introduced in 1993, OMOs were initially limited by the lack of an interbank market and strict controls on interest rates. They were even suspended in 1997. For the re-launch in May 1998, the institutional foundation was bolstered and the PBC began trading bonds (which it later replaced with repurchase, or repo, transactions).

In June 2002, surging foreign exchange inflows forced the PBC to increase interventions in the exchange market, leading to rapid growth in the base money supply. To stabilize the situation, the PBC introduced reversed repos to soak up liquidity in the market. Of course, the PBC soon ran out of T-bonds and the outstanding repo contracts were converted into equivalent central bank bills. This creation of central bank bills provided room for the monetary authorities to continue sterilization of their intervention operations and central bank bills quickly became a major monetary policy tool.

Figure 1.2 **Stock of outstanding central bank bills, end of period, RMB bn**



Source: CEIC.

At the end of 2008, the stock of central bank bills peaked at nearly 5,000 billion RMB (Figure 1.2) and constituted a significant share of commercial bank assets. Since mid-2010, the stock has declined rapidly probably due to PBC attempts to restrain the growth of sterilization costs following China's policy to hold the value of the currency stable while trying to keep monetary growth in the domestic economy under control. Ljungwall, Xiong and Zou (2009) suggest the costs actually remained quite low for many years as interest rates on central bank bills were low compared to the interest China probably earned on its foreign reserves. The low interest rates were achieved through capital account restrictions and administrative monetary policy tools (see below) that limited the options of commercial banks to invest their excess liquidity in instruments other than central bank bills. Since autumn 2008, however, investment income on the foreign exchange reserves has likely decreased along with declining interest rates in the advanced economies. This has made sterilization operations more expensive. Thus, the recent drop in the stock of central bank bills likely reflects the desire of China's authorities to limit their sterilization costs and rely instead on the reserve requirement as the major policy tool. Of course, neither of these tools is cost-free for commercial banks.

OMOs are currently conducted twice a week and in addition to central bank bills, which carry maturity of at least 3 months, the PBC

uses repurchase operations to regulate short-term liquidity in the market. It is important to notice that central bank bills are not just used in the macroeconomic policy context; they are sometimes used as a micro-level tool to keep bank credit growth under control. This is accomplished by issuing directed bills to commercial banks considered to have excessively high lending growth. The interest paid on these bills is typically lower than the market rate, so they may be considered a form of punishment.

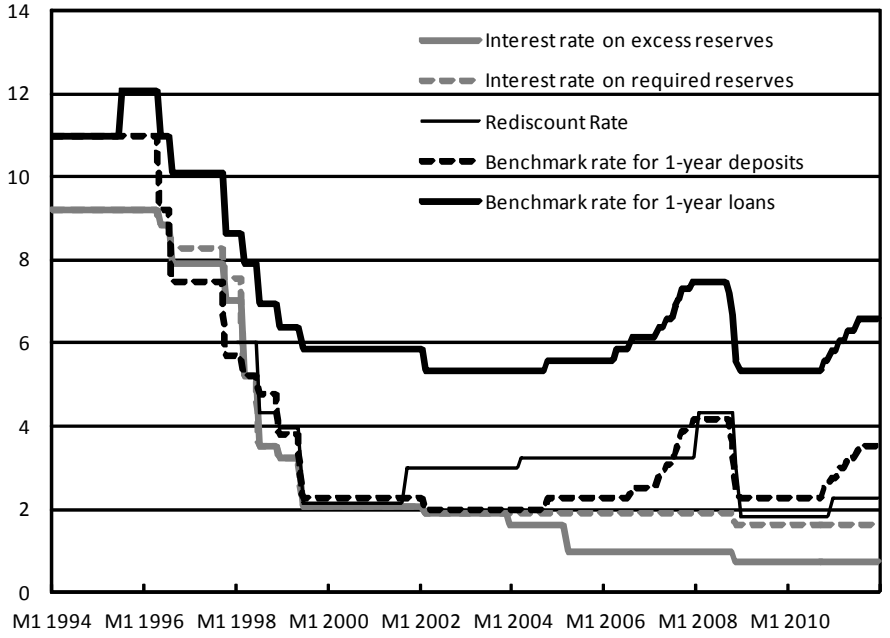
1.2.2.3 Rediscounting and central bank lending

Both rediscounting and direct central bank lending have decreased their significance in policy making in China in the recent years. As mentioned above the PBC lent directly to state-owned companies in the early 1980s, then gradually withdrew from that role. Similarly, the PBC got out of the business of providing rediscount loans as a monetary policy variable in 2002, when the amount of outstanding rediscount lending decreased dramatically (the rediscount rate was set deliberately higher than the average money-market rate). Furthermore, the recent emphasis on limiting, rather than increasing, liquidity in the market has also decreased the role of these tools in the economy. At the moment, these instruments can no longer be seen as a means to influence general monetary conditions (Conway et al, 2010). Instead, both the rediscount rate and direct central bank lending have been directed towards political objectives such as agricultural reforms and economic development of western China. Central bank lending has also been used to indirectly subsidize rural credit cooperatives and bail out financial institutions, local governments and asset management companies (Geiger, 2008).

1.2.2.4 Interest rate setting

The PBC is responsible for setting numerous interest rates. In addition to the benchmark rates on loans and deposits with various maturities, the authorities define rates for required and excess reserves, central bank lending and rediscounting. Although some rates are adjusted very infrequently and the shifts in the benchmark rates can still be considered moderate compared to fluctuations in eg inflation rates it seems that the use of interest rates as a monetary policy tool has increased over the last years (Figure 1.3).

Figure 1.3 **Selected benchmark interest rates in China, end of period, %**



Source: People's Bank of China, CEIC.

On the other hand, officials have only gradually withdrawn from interest rate regulation and let market forces influence rates (Porter and Xu, 2009). The liberalization of rates in the late 1990s began with interbank lending rates and repo rates. In 1998−1999, rates on treasury bonds and financial bonds of policy banks were deregulated. Rates in the wholesale market today are largely liberalized but progress in liberalizing bank deposit and lending rates has been plodding. The upper bound for lending rates was gradually increased after 1998 and completely removed in 2004, yet the minimum lending rate was left in place. Regarding deposit rates, modest liberalization on large deposits has taken place since 1999, but the PBC still sets a ceiling rate for most deposits.

Feyzioglu, Porter and Takáts (2009) itemize four impacts of interest-rate controls on the Chinese economy. First, the maximum deposit rate means real deposit rates are likely to be negative during periods of high inflation. As a result, the vast bank deposits of Chinese households typically yield very modest interest income. Second, the safeguarded margin between deposit and lending rates guarantees a steady profit flow to the Chinese banks. During the periods of high

credit growth, this implies an automatic increase in bank profits that may decrease the incentive for banks to increase efficiency or improve financial intermediation and risk analysis. Third, as interest rates do not fully serve the function to channel the funds to the most efficient projects, interest-rate controls together with limits on credit growth encourage banks to lend more to large companies. Finally, China's monetary authorities do not yet avail themselves of the valuable data contained in interest rates on both macroeconomic and liquidity conditions.

From the point of view of monetary policy transmission mechanism, the impact of interest rates set by the authorities on the other interest rates is critical. While it appears the PBC could have a substantial impact on interbank interest rates as the interest paid on excess reserves sets a floor to the interbank market, the upper end of the interest rates in the interbank market is defined mainly in terms of market liquidity. Even though the central bank lending rate in theory sets a ceiling for market rates, such lending has not happened since 2001. As a result, money market rates have exceeded the central bank lending rate on several occasions.

The study of Porter and Xu (2009) reveals that the benchmark lending rate does directly impact the repo rate, but the link between quantitative monetary policy tools (ie open market operations and the reserve requirement) to the repo rate is quite weak. Analysis by Conway, Herd and Chalaux (2010) shows that the correlation between the central bank bill rate (assumed to be controlled by the PBC) and the repo rate has strengthened over the years, but correlation is still low compared to OECD countries. This can probably be attributed to market segmentation and China's relatively high level of excess reserves held by banks. Although financial sector reforms have weakened these characteristics of the Chinese financial sector, we can summarize that interest-rate transmission in the financial market remains comparatively low.

1.2.2.5 'Window guidance'

While China abolished credit quotas officially in 1998, it has not stopped the authorities from issuing guidelines to commercial banks. This supportive attitude of monetary authorities towards state-owned companies is noted by Xie (2004), who lists trends in the official credit policy in 1998−2002. Guidelines for bank lending are referred to as 'window guidance' and still today constitute an important aspect of monetary policy. Although the PBC reports latest developments in

the window guidance policy in its Monetary Policy Report, the level of openness concerning the details of the use of this policy tool is low and it is impossible to quantify the impacts of this policy.

1.2.2.6 Exchange rate policy and capital controls

China's strong management of its exchange rate constitutes a cornerstone of country's economic policy and defines the framework for the use of other monetary policy tools. China had a dual exchange rate regime until the early 1990s. In 1994, the two exchange rates were unified and the renminbi basically pegged to the US dollar. This situation remained until July 2005, when the renminbi was revalued 2% against the dollar and the authorities announced that the value of renminbi would henceforth be defined based on a basket of currencies with a daily fluctuation band of 0.3%. A few weeks later, the PBC announced the basket would consist of eleven currencies (but gave no weightings).[3] In practise, the renminbi tracked the US dollar for several months, then started to appreciate gradually. At the same time, daily fluctuations around the central parity increased. When the global financial crisis hit in summer 2008 and the uncertainty in the world economy increased the dollar peg was reimposed. The peg was lifted in summer 2010, and the renminbi again began to rise slowly against the dollar (Figure 1.4).

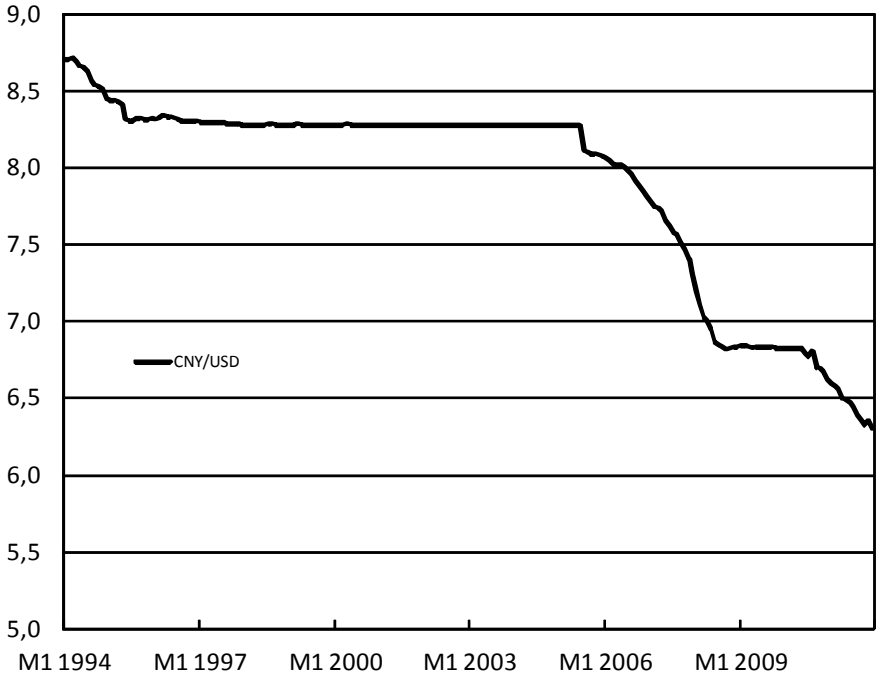
Given China's pegged exchange rate, it is clear that it could not have liberalized capital flows without losing monetary policy independence. During the research period, China has still maintained a system of strict controls on capital flows. Foreign direct investment (FDI) is the most notable exception; China has been active in encouraging foreign direct investment inflows since 1992 and more recently China has encouraged domestic companies to make direct investments abroad. On top of the FDI flows, there are small programmes launched in 2006 (QDII and QFII) and in 2011 (RQFII) that allow qualified domestic institutional investors to invest into foreign instruments and qualified foreign investors to purchase certain Chinese instruments. However, the size of these programmes has been limited and their economic significance remains minor.

Since 2005, foreign exchange inflows to China have increased considerably leading to an active discussion about a possible

[3] US dollar, euro, Japanese yen, South Korean won, Singapore dollar, British pound, Malaysian ringgit, Russian rouble, Australian dollar, Thai baht and Canadian dollar.

undervaluation of the Chinese renminbi (see, for example, Cheung, 2012). The monetary authorities' interventions to the foreign exchange market has naturally increased the money growth in the economy and caused pressure on China's monetary policy in the recent years. Although the majority of flows have been due to a growing trade surplus as well as a vast amount of foreign direct investment, there has been also discussion whether China's capital controls are still binding. During our research period, China's controls on capital flows have been considered binding which guarantees the country monetary policy independence (Ma and McCauley, 2007). This, of course, is a necessary starting point for this dissertation. However, the situation is about to change relatively quickly in the coming years along the internationalisation of the renminbi.

Figure 1.4 **Renminbi exchange rate against the US dollar, end of period**



Source: IMF.

1.3 Characteristics of the Chinese economy affecting the monetary policy transmission mechanism

Several characteristics of the Chinese economy likely have an impact on the monetary policy transmission mechanism. These factors limit to a certain extent the applicability to the Chinese context of research and theories related to advanced economies.

1.3.1 Over three decades of economic reform

China has remained steadfastly on its path of economic reform since 1978. The reform era is characterized by gradualism and pragmatism. Most importantly for our purposes, monetary policy still functions in an environment distinctly different from that of a market economy. The Chinese economy is essentially a transition economy, even though profound reforms have been implemented in some parts of its economy. Many parts of the Chinese economy are still running under central control and planning.

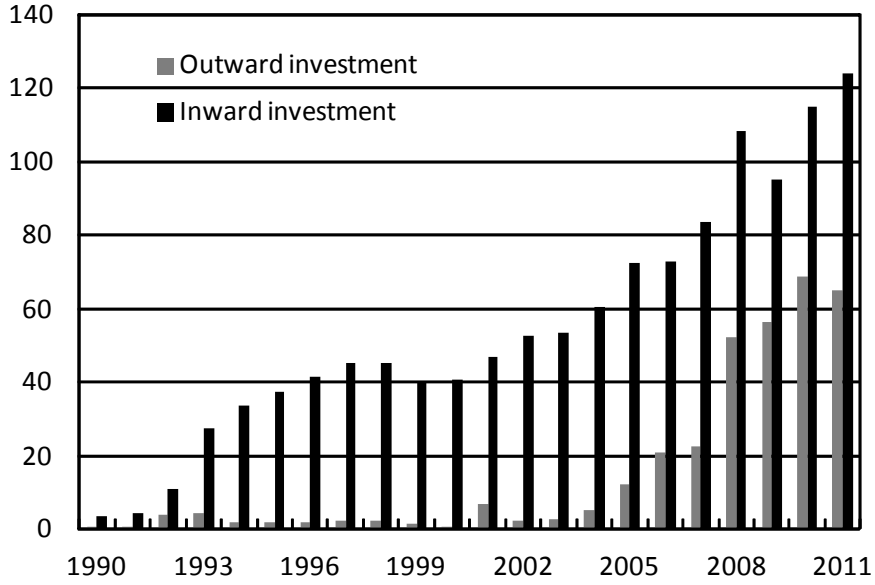
The gradual nature of reforms present a challenge for empirical economic research as the economic environment has been continuously evolving. China today is not the China that started reform over thirty years ago, not the China that prevailed in 1990s and not even the China of two years ago. Recognizing this, we concentrate our analysis on the Chinese economy since 1994, a year when many important reforms were already implemented. There is good reason for limiting our dates. Naughton (2007) designates 1993 as a watershed point in China's reforms. Initially, the emphasis (and much of the success) was in agriculture, and in Naughton's view, no 'losers' were created by economic reforms. In 1990s, however, the reform turned to the cities. Many existing institutions and practices were untouched by early reform, but later reforms affected state-owned enterprises, which meant that millions of people lost their jobs.

The early 1990s were also important with regard to institutional developments. 1994 saw key legislation, including a new company law, as well as regulation of the fiscal revenue system. In the sphere of monetary policy, the exchange rates were unified and renminbi convertibility on current account was introduced.

This watershed in reform also roughly coincides with China's economic opening to the outside world. Even though the first special

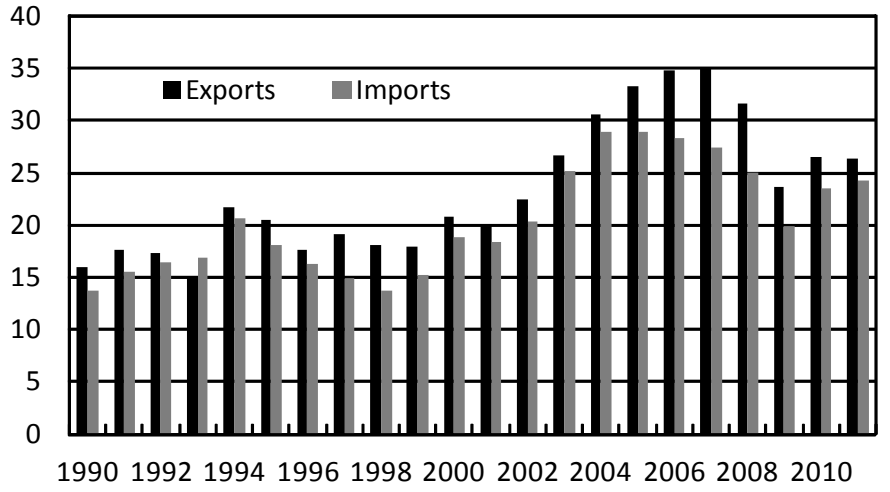
economic zones to attract foreign investment were founded in 1979, FDI inflows were modest before the 1990s. After Deng Xiaoping's famous southern trip in 1992, the opening policies were enhanced so that China began to open its domestic markets for foreign investors. FDI inflows increased sharply (Figure 1.5). China's further cemented its opening policy in December 2001 with its accession to the World Trade Organization (WTO). WTO membership boosted FDI inflows and greatly increased foreign trade. As a result, China became the world's largest exporting economy in 2009 (Figure 1.6).

Figure 1.5 **Inward and outward foreign direct investment of China, USD bn**



Source: UNCTAD.

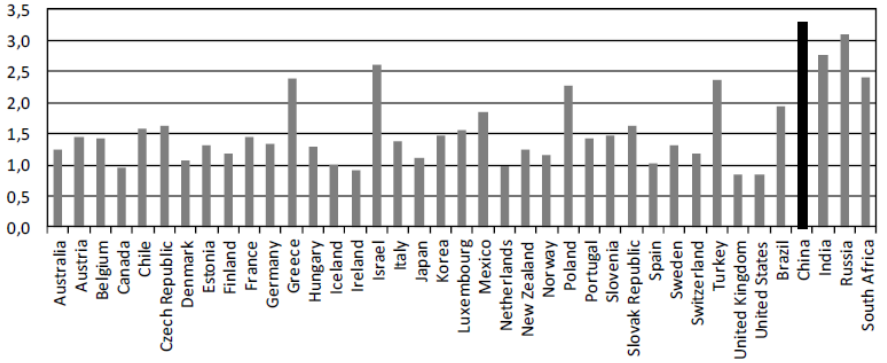
Figure 1.6 **Goods exports and imports of China, % of GDP**



Sources: CEIC and IMF.

Despite the long period of reforms, China's economic structures still differ fundamentally from those of a typical market economy. The OECD (2010) estimates, for example, that product market regulation is considerably more restrictive in China than in any OECD country, or even Brazil, India, Russia or South Africa (Figure 1.7). In terms of barriers to entrepreneurship, China continues to place inordinate administrative burdens on startups and imposes significant barriers to competition. China is also one of the world's most restrictive countries in terms of investment and trade. The Chinese economy is well-known for the large role of the public sector in e.g. China's vast industrial sector (which is clear from the OECD indicator). In particular, public sector ownership is exceptionally high in the Chinese economy. From the point of view of this study, a significant characteristic of the Chinese economy is the vast public participation in the financial sector.

Figure 1.7 **OECD indicator on product market regulation in OECD and selected non-member countries in 2008**



Source: OECD.

1.3.2 China's financial sector

As the financial sector has a specific role in intermediating the shifts in monetary policy on the real economy, we introduce shortly the basic characteristics of the Chinese financial industry.

1.3.2.1 Banking sector

China's financial system is dominated by a massive banking sector; the major source of external finance for companies and households. To give some idea of the scale, the outstanding amount of loans in banking institutions increased for example in 2009 by about 10 trillion CNY (nearly 30% of annual GDP), while the total new stock issues on the Shanghai and Shenzhen stock markets amounted to around 500 billion CNY and the amount of issued corporate bonds was even smaller. The role of China's banking sector compared to banking sectors in most emerging economies is also staggering: the outstanding amount of loans to non-financial companies and households equalled 130% of GDP at the end of 2010.

China's steps in reforming its banking sector have been particularly cautious. The PBC dominated the banking industry and provided credit to state-owned enterprises and other government units still in the beginning of 1980s (Chow, 2007). A number of key banking sector reforms took place in 1983−1984 after state-owned

companies were allowed to retain after-tax profits. The change laid the basis for banking sector development by increasing the flow of savings to the sector (Kudrna, 2007). Furthermore, the PBC was transformed to a central bank with the cessation of its urban commercial banking activities. The change led to the establishment of four large state-owned banks[4] and later on a number of smaller banks (Mehran et al, 1996).

Only in 1995, the legal framework for commercial banking was laid down and the orientation of the large four state banks was shifted away from public sector activities by establishing three policy banks specifically to finance large infrastructure projects (Kudrna, 2007). Of course, even after the change, the vast public ownership[5] in the banking sector continued to link bank activities tightly to other economic policies and the OECD (2005) observed that Chinese banks often more closely resembled governmental agencies than market-based institutions. Thus, it is not surprising that the banking sector was in poor shape. Capitalization was low and the ratio of non-performing loans to overall lending was high.

Naughton (2007) actually states that the potential magnitude of negative impacts of a weak financial sector on the real economy was not grasped by policymakers until the Asian financial crisis in 1997. Only after the crisis had caused vast damage on a number of Asian economies, China's authorities began serious efforts to strengthen the banking sector. The first round of bank recapitalization in 1998 involved injecting 270 billion CNY (3% of GDP in 1998) of capital into the large four state-owned banks. In the 1999, 1.4 trillion CNY (over 15% of GDP) in non-performing loans were transferred off bank balance sheets to asset management companies created to deal with the bad assets. In order to avoid another round of accumulation of non-performing loans (NPLs), a new loan classification with five parts was introduced and the banks were encouraged to reduce their NPL ratios (OECD, 2005).

Although these reforms enjoyed modest success, it turned out that the role of banks was not that easily changed. For example, Podpiera (2006), using data for 1997−2004, found that Chinese banks still failed to apply best practices in lending that considered company profitability or pricing of credit risk. Furthermore, Shih (2004) notes existing strong links between the central government and large banks'

[4] Bank of China, Industrial and Commercial Bank of China, Agricultural Bank of China and the People's Construction Bank of China.

[5] According to the OECD (2005), all but one of the major domestic commercial banks are controlled by central or local governments.

headquarters. As a result, data from China Banking Regulatory Commission which show the share of non-performing loans in the commercial banks still exceeded 20% in 2002 (and unofficial estimates put the ratio much higher) is hardly surprising (Table 1.1).

WTO membership also served as an impetus to accelerating reform of the banking sector. Following the negotiated transition period, China's banking sector was set to open up to international competition at the end of 2006 (Kwong, 2010). In 2002, the State Council made a plan of further reforms and established the China Banking Regulatory Commission (CBRC) to supervise banks. A second round of bank recapitalization started at the end of 2003. Thereafter, all four large state-owned banks were recapitalized and profound reforms implemented throughout the banking sector. Ma (2006) estimates the total cost of repairing bank balance sheets had already exceeded 20% of GDP by 2005.

Since this second round of recapitalization, the ratio of non-performing loans has remained low according to the official figures. As a positive signal, a share of loans becoming non-performing has become smaller although a part of the lower NPL ratios is explained by further transfers of old NPLs from the system and the rapid expansion of credit in the economy.

Table 1.1 **Non-performing loans in Chinese banking sector, end of period**

	Large state-owned banks		Joint-stock banks	
Year	**CNY bn**	**% of loans**	**CNY bn**	**% of loans**
2002	2,088	26.2	203	11.9
2003	1,917	20.4	188	7.9
2004	1,575	15.6	143	4.9
2005	1,072	10.5	147	4.2
2006	1,053	9.2	117	2.8
2007	1,115	8.1	86	2.2
2008	421	2.8	66	1.3
2009	363	1.8	64	1.0
2010	313	1.3	57	0.7
2011	300	1.1	56	0.6

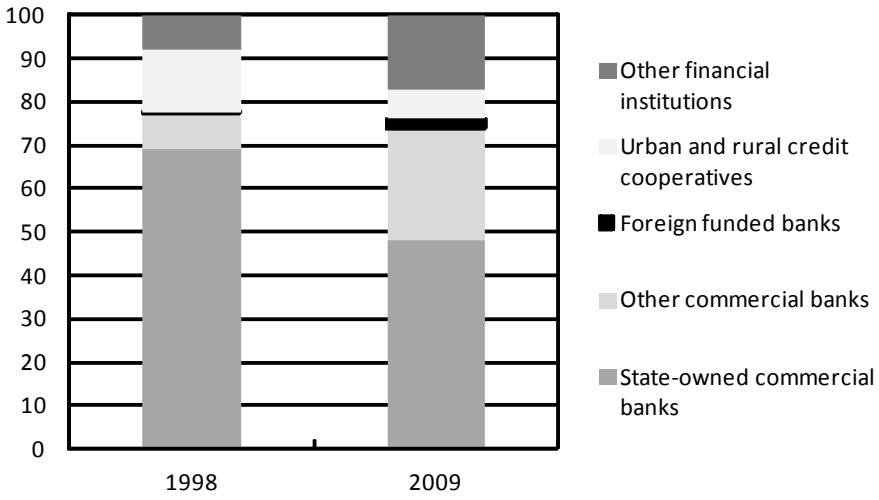
Source: 2002−2003 from Naughton (2007); 2004−2010 from CEIC database.

In addition to a declining NPL ratio, another important aspect of banking reform has been the implementation of new rules on banks' capitalisation. The rules concerning the calculation of capital adequacy ratio that took place in March 2004 are largely consistent with the Basel I standards (Kudrna, 2007). Success in hitting set

targets has been great. In 2003, only eight banks holding less than 1% of assets of the total banking system had capital adequacy ratios above the required 8%. By 2009, the entire sector met the capital adequacy criterion. The improvement in bank balance sheets has been accompanied with rapidly improving profitability (OECD, 2010). Some of the gains reflect higher productivity and reductions in staff.

Despite the successes, the Chinese banking sector faces serious challenges in for example implementing the international standards at the grass-root level (Kudrna, 2007, OECD, 2010). For our purposes, the most important characteristics of the Chinese banking sector are those that affect the monetary policy transmission mechanism. One such characteristic is the close linkage of the banking industry and local and state governments. Kudrna (2007) summarizes his analysis with the observation that 'the largest Chinese banks remain under the firm state control, thus state policy objectives dominate over the long term stability of banks'. While dominance of the central government is probably clearest among the large state-owned banks, we can assume a tight linking of local government and smaller banks as well. The major reasoning behind the links is the vast public ownership in the banking sector. The opening of the banking sector to international competition under WTO rules at the end of 2006 did almost nothing to reduce the dominance of the large four banks that still account for a nearly half the market (Figure 1.8). The share of foreign-owned banks of the market is only a couple per cent. Although the strong links between banks and public sector may enhance the monetary policy transmission mechanism in the Chinese economy, a question rises whether the monetary policy tools can be genuinely market based in this kind of economic environment where banks' profitability is overlooked by political purposes.

Figure 1.8 **The structure of China's banking sector in 1998 and 2009, end of period, % of total assets**



Source: People's Bank of China.

On the other hand, the transmission mechanism is probably affected by a fact that some parts of the Chinese economy are relatively independent from external financing. For example, Chinese households have traditionally had little access to bank financing. At the end of 2010, the share of bank credit channelled to households amounted to less than a quarter of all lending, and corresponded to a mere 28% of GDP which is small compared to advanced economies or the relative size of the Chinese banking sector. At the same time, numerous survey have noted that the lack of external financing is one of the major obstacles facing small and medium-sized companies. Thus, despite the large size of China's banking sector, the dependency of economic sectors on the banking sector development varies tremendously.

Finally, the effectiveness of the monetary policy is affected by the fact that China has a vast informal financial sector that operates outside the formal regulatory frameworks. Some estimates put the size of the informal financial sector to around 10% of GDP (OECD, 2010). The recent phenomenon of informal securitization of bank loans is also likely to change the dynamics between monetary policy and real economy in China in coming years. Fitch Ratings has paid particular attention to the trends in securitization. Since 2010, an increasing

amount of credit has shifted off bank balance sheets and beyond the control of banking authorities.[6]

1.3.2.2 Capital markets

When stock markets were first established in the early 1990s, they suffered from serious institutional weaknesses. Green (2003) notes that China's stock markets were mainly developed to support often poorly-performing state-owned companies. At the same time, the rights of the minority shareholders were weakened by the fact that listed firms remained under the state control; only some shares were even tradable (OECD, 2005). As a result, minority shareholders had little influence on corporate decision-making. Small investors also were constantly exposed to the risk of share dilution, so any speculation about the sell out of the state-owned shares tended to spark jitters about oversupply in the markets. In addition to the capital controls that originally forbid all foreign investment in A-shares,[7] the lack of domestic institutional investors has been mentioned as an early weakness of Chinese stock markets (OECD, 2005).

In the mid-2000s, the Chinese authorities took several important steps to improve the functioning of stock markets. First, a growing, but still strictly limited, amount of foreign investment was allowed into the A-shares through the Foreign Qualified Institutional Investor programme (QFII). Rules preventing investment of domestic institutional investors in the stock markets were loosened. More importantly, listing rules were made more transparent to create a considerably more objective procedure than earlier. The new rules and restructuring of the Shenzhen stock exchange also encouraged small privately owned companies to list. Divestment of state-owned shares is now more openly scheduled to decrease the amount of uncertainty in the markets with regard to share price dilution.

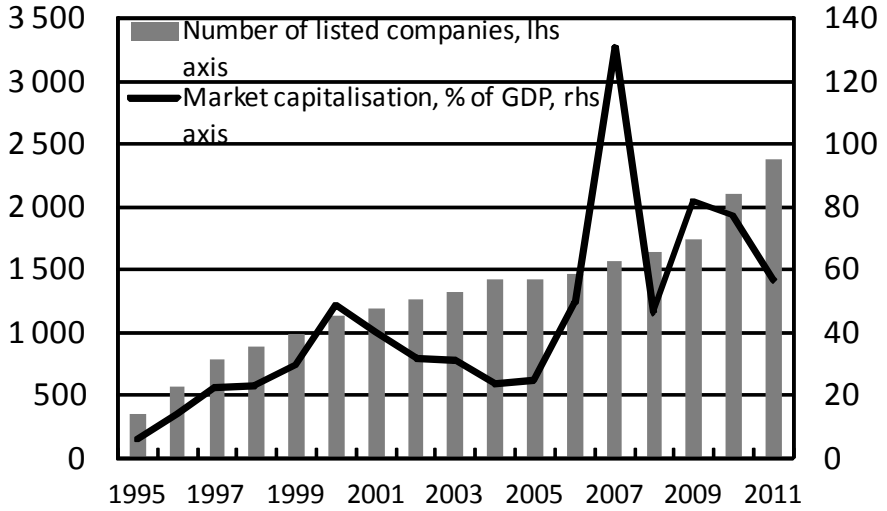
The new rules have increased the number of listed companies in the stock markets so that at the end of 2011, around 2400 companies were listed in the stock exchange and the level of capitalisation was around 50% of GDP (Figure 1.9). Overall, however, China's stock

[6] See eg Fitch Ratings report 'Chinese Banks', published December 2, 2010.

[7] When launching its stock markets, a small portion of shares were marked as B-shares denominated in US dollars. These could be bought and sold by foreign investors. A-shares, which constitute the lion's share of tradable shares, are denominated in renminbi.

markets still play a rather small role as a source of external finance and as a format of saving.

Figure 1.9 **Number of listed companies and the level of capitalisation of China's stock markets, end of period**



Source: CEIC.

The role of the bond markets is also limited in China. The OECD (2010) put the size of the bond market at the equivalent of 44.5% of GDP in August 2009, but noted that the market was dominated by bonds issued by the central bank, the treasury and development banks. Largely because of institutional reasons, the bond market only offers access to external finance for a few companies. The OECD (2010) estimates that the National Development and Reform Commission (NDRC), which is responsible for approving the bond issues of non-listed companies, needs to relax its approval practices considerably before the bond market can become a meaningful channel for external finance for small and medium-sized companies.

1.3.2.3 Money markets

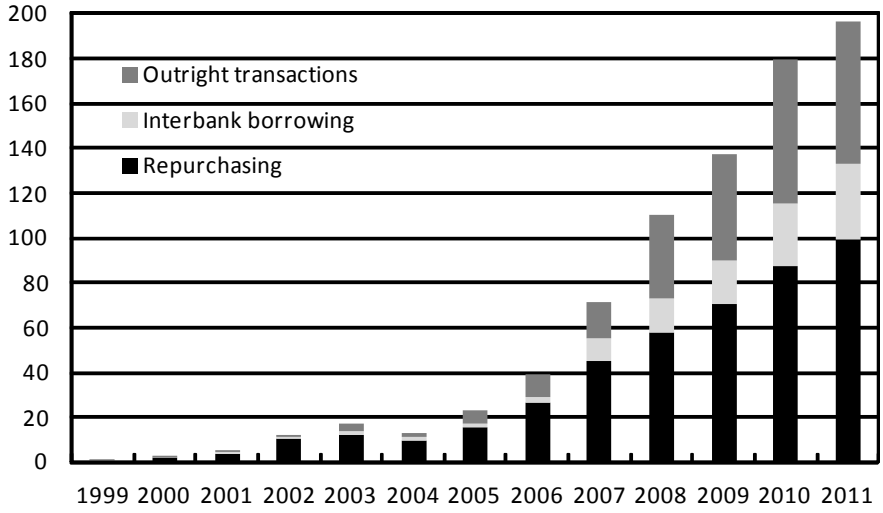
Money markets were originally slow to develop in China, even if the main component of the market, the interbank market, was established in 1981. In the early years, market conditions were partially

unregulated which led to market abuses such as short-term borrowing to fund long-term lending (Mehran et al, 1996). The first unified national interbank market was established in 1996.

The interbank market for bonds launched in 1997. It allowed commercial banks, which had limited access to the stock exchanges, to participate in bond trading. The interbank market has been dominated by repo transactions as the amount of uncollateralized transactions is very small. The volume in the interbank market has increased rapidly since the mid-2000s (Figure 1.10). The rapid growth reflects the decline in banks' excessive reserves, which has especially increased the dependence of small banks on market financing. At the same time, both the central bank and the State Administration of Foreign Exchange have tightened their liquidity providing policies. Overall, liquidity appears unevenly distributed among the banks: the four large state-owned banks are the main suppliers of liquidity in the repo market, while other banks (foreign banks, in particular) are net recipients (Porter and Xu, 2009). In addition, the new rules concerning the interbank market, revised in 1997, have strengthened the market and coverage of interbank market participants has been expanded. Foreign participants in the market are also more active.

With the establishment of the national market in 1996, the PBC began publishing CHIBOR interest rates based on the actual transactions in the market. The formation of a yield curve was initially difficult due to a fact that very few transactions involving longer maturities were made. To improve the situation, the PBC started to publish SHIBOR rates in the beginning of 2007. SHIBOR rates are based on daily average quotes of 16 banks and functionally similar to LIBOR rates. This increase in available data on market conditions is obviously very important from the point of view of Chinese monetary authorities.

Figure 1.10 **Transaction volume in China's interbank market, 1000 bn CNY**



Source: People's Bank of China.

1.4 Summary of article findings

The theoretical and empirical literature describes several channels through which monetary policy affects the real economy. In the following essays, we concentrate on four monetary policy transmission channels in the Chinese economy: the interest rate channel, the wealth channel, the exchange rate channel and the bank lending channel. Studying of these channels should hopefully deepen our understanding of the monetary policy transmission mechanism in China and allow us to specify the most efficient policy tools available to the Chinese authorities. We end by asking whether the PBC follows a quantity-based rule when conducting monetary policy. The essays concentrate on analyzing the more recent period of China's economic reforms starting in 1994.

1.4.1 The interest rate channel

In advanced economies, central banks often use short-term interest rate as their main (or even sole) operational target. In China, the foundations of monetary policy are much more diverse. If anything,

the role of the interest rates as a part of monetary policy has been modest and earlier studies have noted only a weak linkage of the interest rate and the real economy in China. More surprisingly perhaps, the linkage that did exist functioned in a very unexpected way as recently as in the 1990s, ie interest rate hikes tended to increase economic activity rather than decrease it (Dickinson and Liu, 2007, Qin et al, 2005). Studies using more recent data have shown that the bizarre positive linkage of the interest rate to the real economy waned in the past decade, although at the same time the negative impact of the interest rate on the real economy remained weak (Laurens and Maino, 2007, Mehrotra, 2007). However, China's reforms appear to be increasing the role of the interest rates in the economy. Banking reform, interest rate liberalization and reforms in the enterprise sector have made banks and their customers more sensitive to interest rate changes than earlier.

Our first essay contributes to the earlier literature by examining the emerging influence of the interest rate channel in affecting economic development in China. The empirical part of the essay closely follows the work of Calza, Gartner and Sousa (2003) on euro area, and concentrates on analyzing the impacts of interest rates in a framework of credit demand where credit demand is assumed to be affected by real economic output and the real lending rate. As causality may run both ways between variables, a vector error correction model is used in the estimations. Based on the literature on the interest rate channel, we assume the link from interest rate to credit growth and economic output is negative, although it has been suggested that credit demand may also include a counter-cyclical component (Bernanke and Gertler, 1995).

Using monthly data for 1998M1−2007M5, we identify a break point in the system in September 2001. Accordingly, we split the sample into two parts and run a separate estimation for each sub-period. Our finding of a positive, albeit statistically insignificant, link from interest rate to credit stock both in the long and short run in the first sub-period supports the findings of earlier studies on China's monetary policy. In the latter sub-period, the link turns negative indicating that the behaviour in the Chinese financial sector is moving towards practices of advanced economies. However, even in the latter sub-period, the link from interest rate to economic output remains insignificant. Our results are confirmed by the paper by Girardin and Liu (2006), who also find a weak link between the short-term interest rate (CHIBOR) and economic output in 1999M1−2005M8.

1.4.2 The wealth channel

Our second essay considers the existence of a wealth channel in China. The logic behind the channel is that a loosening of monetary policy drives up asset prices and increases household wealth (Boivin, Kiley and Mishkin, 2011). Following the life-cycle hypothesis (Ando and Modigliani, 1963), households consume their lifetime income and wealth, so any increase in wealth increases consumption. Although the wealth channel is an integral part of many large macroeconomic models used by central banks, empirical studies of the entire chain of events from monetary policy to consumption are scarce. Most empirical studies concentrate on either the link from monetary policy to asset prices or the link from asset prices to consumption without combining the two parts. An exception is the paper by Ludvigson, Steindal and Lettau (2002), which estimates the size of the wealth channel in the US to be relatively small. We are not aware of any previous studies on the wealth channel in China.

We determine the existence of a wealth channel in China using a structural VAR model with five variables: household income, household consumption, consumer price inflation, monetary policy indicator and asset prices. We estimate separate models for two categories of asset prices: stock and housing prices. Due to data availability, our quarterly data starts in 1998 and runs through 2008.

Like other studies we find role of interest rate in the Chinese economy to be quite small, so we use the monetary aggregate M2 as our monetary policy indicator. The use of M2 is justified by its central role in communicating the PBC's monetary stance: the PBC sets annual targets for M2 growth and closely tracks M2 in its reporting. A number of studies suggest that an increase in M2 accelerates inflation (Gerlach and Kong, 2005, Mehrotra, 2008). Furthermore, the broad monetary aggregate can contain information about monetary policy tools otherwise impossible to quantify such as the window guidance policy. On the other hand, the wisdom of relying on M2 for guiding monetary policy is questionable given that M2 is difficult to control, especially over the short run.

The estimations show that over the short run, there is a link from monetary policy to both stock and housing prices so that a monetary policy loosening causes prices to rise. This expected finding is stronger and more rapid in the case of stock than housing prices. However, the second phase of the channel, the affect of the stock prices on consumption, is rather weak although residential prices do influence household consumption in a statistically significant way. However, when we study explicitly those changes in residential prices

that are caused by monetary policy, we find little impact on household consumption. Thus, the existence of a wealth channel in China is questionable.

The results reflect many characteristics of the Chinese economy. First and most important, income from investment typically represents tiny share of total household income. In addition, few families in China are in a position to sell their apartment even if prices go up. The contrary seems more likely for most families; higher prices mean they have to save more to afford an apartment. Thus, it is not surprising to find that household consumption is not much affected by fluctuations in asset prices.

Our results suggest that the overall reaction of household consumption to shocks in monetary policy is weak. This result confirms the earlier findings of Zhang and Wan (2002) and probably reflects the fact that for most of our research period, the access of households to bank credit was limited. Regarding the use of M2 as a monetary policy indicator, the results are encouraging. Confirming earlier results, M2 merits a closer look by authorities as a shock in M2 accelerates inflation.

1.4.3 The exchange rate channel

The raging international discussion on China's exchange rate regime in recent years has helped produce an extensive body of academic literature attempting to pin down just how undervalued the renminbi actually is. Much less literature has been generated on the impacts of the renminbi exchange rate on the real economy in China or elsewhere. Our third essay studies the implications of exchange rate fluctuations on China's foreign trade and asks whether a revaluation of the exchange rate be sufficient to balance country's current account. This approach also illuminates the trade linkages between Asia and the rest of the world.

The earlier studies on the exchange rate elasticity of China's foreign trade have used data mainly prior to China's WTO membership and the possible changes in trade dynamics that accompanied it (see Bénassy-Quére and Lahrèche-Révil, 2003, Cerra and Dayal-Gulati, 1999, Cerra and Saxena, 2003, Dees, 2001, Eckaus, 2004, Kamada and Takagawa, 2005, Lau et al, 2004, Marquez and Schindler, 2006, Shu and Yip, 2006, Thorbecke, 2006, Voon et al, 2006, Yue and Hua, 2002). Here, we contribute to the earlier literature in several ways. First, we concentrate on analyzing China's trade after the WTO membership. Second, by studying both exports and imports,

we can provide a rough estimate on the impact of real effective exchange rate fluctuations on China's current account surplus. Third, we analyze China's bilateral trade with its major trading partners to explore possible differences among the trade relationships and find the main reasons for exchange rate elasticities in trade. Fourth, we estimate how China's exchange rate fluctuations affect exports from other emerging Asian countries.

Using the division suggested by Marquez and Schindler (2006), we study the impacts of exchange rate separately on Chinese ordinary and processed exports and imports. As expected, a renminbi appreciation leads to a decline in Chinese exports. The exchange rate elasticity is slightly higher among ordinary exports than among goods originating from China's processing industry. The elasticities are close to the values estimated earlier for both China and the US and the UK (Hooper et al, 1998). However, also imports decline in a case of renminbi appreciation which means that from the point of view of trade balance, the decline in China's exports is partly offset by a simultaneous drop in imports. As a result, a decline in the current account surplus due to an exchange rate appreciation remains relatively modest. A more recent study by Cheung, Chinn and Fujii (2009) came to the same conclusion.

Interestingly, renminbi appreciation leads to a drop in both ordinary imports and imports for processing. The estimations based on bilateral trade equations reveal that renminbi appreciation decreases imports both from Southeast Asian economies and from advanced economies. Naturally, the Asian supplies to China's exporting industry decline when the renminbi appreciates but the result suggest that also a large share of imported investment goods goes to the exporting sector, so demand declines when the exporting sector weakens.

Finally, our study suggests that total exports of Southeast Asian economies could decline with an appreciation of China's exchange rate. In other words, goods from these countries seem to be more complementary than substitutes for Chinese goods. The role of the East Asian supply chains is also emphasized in a micro-level study by Zhang (2008), who finds that for most goods produced in the region the final consumer is still in the US, even if the Chinese market has become more important over the years.

1.4.4 The bank lending channel

In the fourth essay, we examine whether the monetary policy can affect bank lending independently from credit demand. The traditional *bank lending channel* is based on the assumption that monetary policy can affect the loanable funds of banks by influencing reserves and deposits (Bernanke and Blinder, 1988). Disyatat (2010) adds that monetary policy can also impact on bank balance sheets via asset prices. A decrease in asset prices can reduce a bank's capitalization, which forces the bank to look for new sources of external finance or decrease lending. In both models, monetary tightening leads to a reduction in bank credit in excess of the reaction of credit demand. This obviously implies curtailed spending by customers dependent on bank financing.

We are aware of only one earlier study on the bank lending channel in China, and that study's results are inconclusive (Gunji and Yuan, 2010). Our aim then is to deepen the picture on the links between the monetary policy and bank behaviour in China. In principle, the channel could be functioning in China for two reasons. First, monetary authorities can have a direct impact on banks' loanable funds as monetary policy is often conducted using quantity-based monetary policy tools. Second, many agents in the economy are dependent on bank financing due to the small size of capital markets.

We study the bank lending channel by using quarterly data for six bank groups. The research period is constrained by the data availability to start in 2002. We follow the earlier empirical literature on the bank lending channel and assume that if the channel exists, different type of banks would react to a monetary policy tightening in different ways. For example, lending of a highly capitalised bank would be less affected by a tightening that lending of banks with low level of capitalisation. We use both TSLS and GMM estimation methods. We only find weak evidence on the bank lending channel in China. Apparently, banks with higher levels of capitalisation are somewhat less affected by shifts in the monetary policy stance than banks with lower levels of capitalisation. However, the result can only be considered preliminary due to data limitations. Overall, our earlier result on the weak role of interest rate as a monetary policy tool in China is confirmed, while the quantity-based monetary policy tools seem to have their expected effects on credit growth.

1.4.5 Indentifying a monetary policy rule for China

The PBC's unclear communication about its use of monetary policy tools and targets has triggered a growing body of speculation as to which policy rules are followed. The empirical essays of this thesis strongly indicate the authorities focus on quantity-based monetary policy rules rather than an interest rate rule. This has led researchers to study whether the Chinese authorities apply a quantity-based monetary policy rule proposed by McCallum (1988, 2003). Under the McCallum rule, monetary growth is depends on its lagged growth, changes in money velocity and the deviation of GDP growth from its target rate. However, Burdekin and Siklos (2008) and Liu and Zhang (2007) point out the fit of this particular rule in its original format on China's monetary policy is rather poor. In order to improve the fit, Liu and Zhang (2007) estimate a rule in which M2 growth depends on the size of output gap and the deviation of inflation from its target rate. Mehrotra and Sanchez-Fung (2010) model China's monetary policy by using a hybrid McCallum-Taylor reaction function in which the monetary base reacts to the output gap, deviation of inflation from the target and the deviation of the nominal trade-weighted exchange rate from a long-run path.

We aim to contribute to the existing literature by studying whether deviations from the McCallum rule can be used to forecast inflation and whether the same deviations can be treated as shocks in monetary policy. By comparing the actual growth rates of the reserve money and M2 in China to the growth rates implied by the McCallum rule in 1994−2007, we see that in the early years of the period, monetary policy was contractive, ie money growth was lower than suggested by the McCallum rule. In the middle of the period, money growth seems rather neutral. At the end of the period, money growth is expansive with both reserve money and M2 growth exceeding the pace suggested by the rule.

A quick visual inspection of the data shows that the contractionary monetary policy coincided with falling inflation and GDP growth. At the end of the period, both inflation and GDP growth rates accelerated in line with the excessive monetary expansion. Studying the links more formally, we find that deviations from the McCallum rule are useful in forecasting inflation developments in China. Faster monetary growth than suggested by the rule implies higher corporate goods inflation in coming quarters. The reaction of consumer prices and asset prices (specifically, stock and land prices) are less robust. Finally, deviations of the monetary base from the rule are used as monetary policy shocks in a VAR framework. The findings are

encouraging in the sense that a positive shock in money growth leads to higher GDP growth in China.

This essay gives further support to the earlier analysis that the quantitative monetary aggregates do play an important role in the Chinese economy and their use as monetary policy tools should not be underestimated. This result is similar to found by Zhang (2009) who argues that a positive shock in a quantitative-based monetary policy rule leads to an increase in inflation and output. However, Zhang's DSGE simulations suggest the potential effectiveness of an interest-rate-based price rule might actually be higher.

1.4.6 Assessment of the effectiveness of monetary policy in China

This dissertation studies the links between monetary policy and macroeconomic development in China during the most recent period of economic reforms. With regard to the achievement of the monetary policy targets, China's monetary policy looks very successful. If we ignore the Asian crisis years in the late 1990s, real GDP growth has largely exceeded the targeted level (Table 1.2). In addition, inflation rates, which ran in the double digits in 1994−1995, have been tamed successfully. While China has recently experienced episodes of higher inflation, they have been mainly due to increased food prices. The economy has largely avoided second-round effects of such price hikes, and inflation quickly returned to the target level.

From the point of view of the Chinese monetary authorities, it would be flattering to credit these achievements to successful implementation of monetary policy. However, it is clear that a number of factors have contributed to China's economic success. Indeed, our findings back up the existing literature on China's monetary policy in showing a rather weak link between monetary policy and the real economy. Thus, the role of the monetary policy in creating high economic growth should not be overestimated. On the other hand, this study shows that the role of monetary policy behind price developments has been essential. These essays note that an unnecessarily loose monetary policy stance leads to a significant acceleration in inflation. Without low, fairly stable inflation figures, China would not have achieved such impressive growth.

Table 1.2 **Targeted and actual values of selected monetary aggregates and China's economic performance, 1994–2010**

	M1 growth, %		M2 growht, %		RMB loan growth (trn)		CPI inflation		Real GDPgrowth	
	Target	Actual value	Target	Actual value	Target	Actual value	Target	Actual value	Target	Actual value
1994	21.0	26.2	24.0	34.5			10.0	24.1	9.0	13.1
1995	21–23	16.8	23–25	29.5			15.0	17.1	8–9	10.9
1996	18.0	18.9	25.0	25.3			10.0	8.3	8.0	10.0
1997	18.0	16.5	23.0	17.3			6.0	2.8	8.0	9.3
1998	17.0	11.9	16–18	15.3	0.9	1.2	5.0	–0.8	8.0	7.8
1999	14.0	17.7	14–15	14.7	1.0	0.7	2.0	–1.4	8.0	7.6
2000	15–17	16.0	14–15	14.0	1.0	0.6	1.0	0.4	8.0	8.4
2001	13–14	12.7	15–16	14.4	1.3	1.3	1–2	0.7	7.0	8.3
2002	13.0	16.8	13.0	16.8	1.3	1.9	1–2	–0.8	7.0	9.1
2003	16.0	18.7	16.0	19.6	1.8	2.8	1.0	1.2	7.0	10.0
2004	17.0	13.6	17.0	14.6	2.6	1.8	3.0	3.9	7.0	10.1
2005	15.0	11.8	15.0	17.6	2.5	1.7	4.0	1.8	8.0	10.4
2006	14.0	17.5	16.0	16.9	2.5	3.1	3.0	1.5	8.0	11.6
2007			16.0	16.7	2.9	3.6	3.0	4.8	8.0	13.0
2008			16.0	17.8	3.6	4.2	4.8	5.9	8.0	9.6
2009			17.0	27.7	>5.0	9.6	3–4.8	–0.7	8.0	9.1
2010			17.0	19.7	7.5	8.0	3.0	3.3	8.0	10.3

Source: PBC, Liu and Zhang (2007), Conway et al (2010).

The results also show that the implementation of monetary policy in China differs substantially from what is typical for advanced market economies. First, the role of the interest rates as a monetary policy tool remains small. Even though the essays and other recent studies suggest the impact of interest rates on the main targets of monetary policy (inflation and GDP growth) has increased, they are still limited. Accordingly, contrary to the normal practice in the advanced economies, China's implementation of monetary policy and its transmission to the real economy relies strongly on the quantitative policy tools and direct guidelines. Out of the quantifiable monetary policy tools, monetary aggregates are found to have the closest links to macroeconomic, particularly inflation development.

Due to the diverse package of monetary policy tools, it is challenging to measure China's monetary policy stance. In general, judging the success of monetary policy with respect to macroeconomic developments is complicated by the fact that isolating the impacts of the monetary policy from other factors in the economy is a non-trivial task. In China's case, this is made all the more

challenging by the country's political structure − monetary policy is not an area of independent decision-making. China aspires to political decision-making that is centrally orchestrated and generally aimed in the same direction. In such an institutional framework, a goal set for monetary policy such as annual growth targets for monetary aggregates must inevitably be subordinated to the overarching economic target such as economic growth. This might partly explain why China consistently misses its annual targets growth of monetary aggregates, yet, as Geiger (2008) points out, manages to achieve consistently high economic growth and low inflation.

The weak link between the monetary policy and the real economy is partly due to a fact that some segments of the economy, particularly households, are largely outside the influence of monetary policy in China. This finding probably reflects the fact that households have traditionally had limited access to financial markets in any role other than bank depositors. However, this seems to be changing as households become increasingly active as investors and debtors. Following similar reasoning, the previously overlooked monetary policy transmission channels, ie the wealth channel and the bank lending channel, have yet to play a significant role in the monetary policy transmission mechanism in China, but should be tracked as they now play significant roles in most advanced economies.

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Chapter 2

Has the Chinese economy become more sensitive to interest rates? Studying credit demand in China

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Has the Chinese economy become more sensitive to interest rates? Studying credit demand in China ☆

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ABSTRACT

Chinese authorities have traditionally relied mainly on administrative and quantitative measures in conducting monetary policy, with interest rates playing a less prominent role. Additional support for this view resides in a number of earlier studies that have found that the impact of interest rates on the real economy has been miniscule. However, taking into account numerous reforms in the financial sector and more widely in the Chinese economy, interest rates may have gained some influence in the last few years. It is important to study the effectiveness of interest rates also in light of future reforms of the monetary policy tools in China. Whereas administrative policy measures were effective in guiding the behaviour of state-owned enterprises, the authorities may need to increase the use of more market-oriented monetary policy tools as the share of the economy in private and foreign ownership grows. We use a vector error correction model to study, within a credit demand framework, whether the impact of interest rates in China has become stronger over the last decade. Our results suggest that loan demand has indeed become more dependent on interest rates, albeit the channel from interest rates to the real economy is still weak.

1. Introduction

Central banks in the developed economies often use an interest rate as the main operating target. In China, the foundations of monetary policy have been a fixed exchange rate, strict controls on capital flows, and a wide selection of administrative and quantitative policy tools. The role of interest rates has been moderate in pursuing the objective of monetary policy "to maintain stability of the value of the currency and thereby promote economic growth".[1] Overall, according to several studies, the effectiveness of interest rates as a policy tool has been modest (see e.g. Laurens & Maino, 2007; Mehrotra, 2007).

However, many features of the Chinese economy have changed in recent years, and thus the role of interest rates may have increased. For example, the influence of interest rates has been boosted by decisions to allow lending and deposit rates to move more freely around benchmark rates. Overall, the financial structure is seen to have become more price-sensitive, as commercial banks' ownership structures change from the original state-ownership model, and as other parts of the financial sector are further developed. Besides the financial reforms, some administrative measures such as price controls have been reduced and the enterprise sector is undergoing significant alteration. The majority of state-owned enterprises has been reorganised and, even

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[1] Announced by the People's Bank of China (PBC) at www.pbc.gov.cn/English/huobizhengce/objective.asp (24 May 2007).

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more importantly, the focus of the economy has gradually shifted from state-owned enterprises towards a private ownership economy. Foreign-owned companies have played a significant role in this development.

In this study, we will examine whether the reforms have increased the room for effective use of interest rates as a monetary policy tool by analysing interest-rate effects on the Chinese economy in 1998–2007. Besides being an interesting topic as such the question of the role of interest rates is crucial also because the People's Bank of China (PBC) will be forced to update its toolbox to retain the effectiveness of its policy actions as a consequence of changing economic environment. Already in 2006–2007, the authorities increased the use of interest rates when trying to keep accelerating inflation under control. Furthermore, China's long-term goals, flexible exchange rate and liberalisation of capital flows, will undermine the influence of the administrative policy tools over the economy.

We will analyse the effectiveness of interest rates in the credit demand framework. While several studies have been done on the dynamics of Chinese money demand, we are not aware of any that use fresh data to examine the links between interest rates, credit stock and economic output in China. While in advanced economies, an interest rate hike may only force the enterprises to shift from bank credit to the other forms of financing keeping the level of economic activity constant (Kashyap, Stein, & Wilcox, 1993), this may not have happened in China where the other modes of financing have been underdeveloped.

The paper is organised as follows. We first review earlier studies on the transmission mechanism of China's monetary policy and find that the impact of interest rates on the real economy has often been found small. We then run through the specific features of the Chinese economy that could explain the small influence of interest rates. While many of those features have been altered by the reforms of the last decade, we will finally study whether the effectiveness of interest rate policy in China has increased. To answer that question, we study China's credit demand with the aid of a vector error correction model and impulse response analysis in Sections 4 and 5. Section 6 concludes.

2. Literature review

There are already a number of empirical studies on the transmission channels of monetary policy in China. While many earlier studies have focused on the links between the money supply and the real economy[2], those that examine the role of the interest rates in the economy are more relevant for our purposes here.

Zhang and Wan (2002) study the impacts of interest rates on household consumption using annual data for 1966–1998. They find that households have since 1985 been reacting as expected to financial variables and uncertainty, but a constraining financial system has made intertemporal allocation of resources difficult.

Qin, Quising, He and Liu (2005) first estimate equations for monetary aggregates M1, M2 and base money using an error-correction model and quarterly data starting from 1992. Interest rates and the required reserve ratio are both treated as exogenous because of their scant usage in the conduct of monetary policy. Although this treatment is understandable in light of the discreteness of both time series, we cannot fully agree that neither the policy interest rate nor the reserve requirement would react to changes in money stock or production. In the second part of the paper, the authors investigate the effectiveness of monetary policy in China by using the results from the first part. They conclude that while the effects of the interest rate, reserve requirement, and a direct quantity control rule for the base money supply on the real sector are small, their impacts on the price level and monetary base are considerably larger. Surprisingly, the link between the interest rate and the real economy was actually found to be perverse: a rise in the interest rate leads to a temporary increase in capital formation after about a 1 year lag. Unfortunately, the authors do not report the confidence intervals on their results.

Mehrotra (2007) compares the exchange rate and interest rate channels in Japan, Hong Kong and China. For China (1996–2004), the results from a structural VAR indicate that a rise in the interest rate leads to lower output. However, the effect lasts for only seven months and so cannot be considered very robust. The negative effect of interest rate on price level is only weakly significant. The results are reported to be stable for the period studied.

Laurens and Maino (2007) estimate a VAR model for China by using quarterly data for 1994–2005 on five variables: real GDP, consumer prices, exchange rate, short-term interest rate and money supply. In line with earlier studies, the link from interest rate to GDP is found to be weak. Their results on the impact of an increase in the broad money supply (M2) are similar to those from the other studies on China's money supply, so that an increase in money supply accelerates inflation but the impact on output is practically nil.

Finally, Dickinson and Liu (2007) study the effectiveness of monetary policy in China in 1984–1997 to avoid the more recent regime shifts. However, by doing this, their study cannot really describe the functioning of the monetary policy transmission channel nowadays. The authors divide the research period into two subperiods and, employing a VAR approach, study whether the monetary policy tools have gained more power during the research period. In the first subperiod, interest rates did not have any significant effect on the economy. For the later subperiod, the authors could not identify any link between the interest rates and the state-owned sector but they found weak evidence that an increase in the interest rates actually boosted economic activity in the collective and private sectors. The authors argue that the somewhat surprising result is due to the fact that during the research period, privately and collectively owned enterprises were still credit constraint in China. Higher interest rates encouraged saving and thus increased banks' capability to lend out more. Higher rates boosted also banks' willingness to lend to the collective and private sectors which were considered to be riskier than the state-owned sector. The results of Dickinson and Liu (2007) thus

[2] See e.g. Sun and Ma (2004), Xie (2004) and Mehrotra (2008).

confirm the positive link from interest rates to economic activity that was found earlier by Qin et al. (2005). The paper's interesting results should, however, be treated cautiously because of the very small number of lags in the paper compared to the results from earlier studies on the length of delay of monetary transmission mechanisms.

As we have seen, earlier papers have not found convincing evidence of an effective transmission channel from interest rates to the real economy in China. It seems that still in the 1990s the causal link might have been the reverse of what one might expect, so that a rise in the interest rate actually led to an increase in economic activity. However, statistical significance of this result has not been clarified and it should be treated with prudence. In the next chapter we will go through some of the specific features of the Chinese economy that could explain the small influence of interest rates. We will concentrate on studying whether the recent reforms may have removed at least some of these features.

3. Reasons behind the ineffectiveness of interest rate policy — has anything changed?

As we have seen above, Chinese economy has earlier been relatively immune to interest rate policy. While one can cite many reasons for this, we are interested in knowing whether the numerous reforms in the banking sector and the whole economic system over the recent years have altered the situation. For example, there are already signs in the banking sector of a shift to greater market orientation (Podpiera, 2006). While the financial sector reforms have been well documented e.g. by Geiger (2006), Green (2005) and Laurens and Maino (2007), we will concentrate on those impacting directly the interest rate channel.

Most importantly, the role of the interest rates has been reduced by the fact that commercial banks' activities in China were until recently under strict guidance of the central authorities. For example, the credit plans, which essentially determined the amounts of credit banks would extend and to which customers, were disbanded only at the start of 1998. Until then, banking sector mainly served state-owned companies, while private companies and households had very limited access to bank credit. The credit rationing basically hindered the price mechanism from working in China as the borrowing was quantitatively restricted.

Even since 1998 the authorities have continued to issue strict guidelines on bank lending (Fung et al., 2000). The so-called window guidance policy – which contains pure quantitative restrictions on bank lending and hence considerably reduces the price sensitivity of banks' activities – is still actively used by the PBC. Actually, both in 2004 and again in 2007 when inflation has accelerated, the role of window guidance has increased. Thus we would conclude that administrative tools, although diminished during the last decade, are still actively employed by the Chinese authorities.

Another important reason for the weak response of the Chinese economy to interest rate setting has been the slow pace of liberalisation of lending and deposit rates. The interest rate liberalisation began in 1996 and since then the fluctuation bands around the benchmark lending and deposit rates have gradually been enlarged. The latest step in the liberalisation was taken in October 2004, when commercial banks' lending rates could start moving freely upwards from a level of 90% of the benchmark rate and the lower limit for deposit rates was removed. Despite the expanded possibilities for setting interest rates vis-à-vis benchmark rates, the high level of liquidity in the market in recent years has restricted commercial banks' ability to raise lending rates above the benchmark rate. In the second quarter of 2007, the share of floating-rate loans having interest rates above the benchmark rate dropped to 44% although at the same time the level of real interest rate dropped time significantly (PBC, 2007). Thus the deviations from benchmark, although increasingly possible, are still quite modest and raise a question about the capability of the Chinese banks to price their credit.

Obviously, the close links between commercial banks and their majority owner – the state – have given rise to a mixture of interests and probably decreased the profit-orientation in the banking sector. However, the banking reform seems to have progressed considerably in this respect. Three of the four big, and previously fully state-owned, banks have sold minority stakes to foreign strategic investors and have listed on stock exchanges. Thus, even though the state still owns majority shares in all four of the big banks, the links between banks and the administration are assumed to have weakened to some extent. Among the smaller banks, reforms have advanced at widely varying speeds. In addition, the introduction of the new main target for the banks – meeting the capital adequacy requirement – by the supervisory authorities should have led to more sustainable developments in the sector in the recent years. In light of these reforms, the incentives of the banking sector have experienced a dramatic change in the last years and there could indeed be more room for interest rates to function as a monetary policy tool via increased price sensitivity of the commercial banks.

Progress has also taken place in the banking sector from the institutional point of view. The domination of the four big state-owned banks in the market, which may also have hindered the effectiveness of market-oriented monetary policy instruments, has diminished as the role of smaller and foreign banks has increased. Also the possibilities of the commercial banks to operate more widely in the financial sector have been increased. Laurens and Maino (2007) point out that segmentation of the banking sector and money market has hindered the conduct of monetary policy in China. If financial institutions operating in the interbank market were allowed to operate more actively also in the other segments of the financial markets, the PBC policies directed at the interbank market would also affect other parts of the financial sector. Due to limitations on Chinese banks' operations, this did not earlier happen. These problems have been tackled in recent years via further development of the financial market by launching new instruments and by encouraging the development of e.g. interbank market.

Besides the banks themselves, one must blame their customers for the weak transmission mechanism of interest rate policy. Many state-owned companies (SOEs) used to enjoy soft budget constraints and unlimited financing from the banks. As the SOEs often neglected to repay debts, interest rates hardly played any role in their investment decisions. Thus, from the banking sector point of view, the profound SOE reform that started in the mid-1990s has been crucial. Besides the resulting increase in the profit-

orientation of the SOEs, the role of the private sector has expanded rapidly.[3] There have also been legislative changes that have encouraged private entrepreneurship in China.[4] In addition to changes in the ownership structure, higher rates of return on equity and continuous improvement in total factor productivity are signs that the business sector is becoming more market-oriented (OECD, 2005).

As we have seen, one can find many reasons for the weak response of the Chinese economy to the interest rate setting. However, we have also noticed that many of the causes have been either partly or wholly removed along the economic reforms during the last decade. As a result there could now be more room for the interest rates to work as an efficient policy tool in China. It is important to study whether this has actually happened also from the point of view of the future reforms. Further liberalisation of the economy will probably reduce the effectiveness of administrative policy tools in China, so that the PBC will have to increase the emphasis of the more price-oriented measures in its policy conduct in order to retain its control over economic developments in the coming years. In addition, the gradual liberalisation of capital flows will finally lead into a situation, where interest rates in China will affect financial flows not only inside the country but more widely in the international market.

4. Modelling credit demand

We now turn to describe how interest rates may affect the Chinese economy within the credit demand framework. After estimating the long-run credit demand function for China, we examine whether the link from interest rates to financial sector and real economy has strengthened in recent years.

4.1. Theoretical considerations

The earlier literature is not unanimous on how to model credit demand. While there is already an extensive literature on credit supply, there is considerably less theory concerning credit demand. In our paper, we follow closely Calza, Gartner and Sousa (2003), who found credit demand in the euro area to be a function of total output and the lending rate.[5]

The major argument for having output in the equation is that a pick-up in economic activity improves firms' and households' prospects for future profits and income and thus allows them to increase their indebtedness. In addition, an increase in economic output might raise the expected returns on investment projects and thus encourage firms to invest and borrow more. Some authors do argue, however, that an increase in economic activity could actually reduce credit demand by increasing households' and firms' ability to repay debts and reduce their indebtedness. Moreover, a willingness on the part of households to smooth out consumption over time would make borrowing a countercyclical factor, while a drop in demand that leads to diminished cash flows might induce companies to do more short-term borrowing and not adjust their production levels immediately. (Bernanke & Gertler, 1995) Thus, there is not clear consensus among economists in which way output growth affects borrowing.

The interest rate is assumed to affect credit demand negatively. When lending rates rise, borrowing becomes more expensive and demand for credit declines (so-called price effect). A rise in the interest rate may render an investment project unprofitable and so discourage an enterprise from borrowing to finance the project. Interest rates might also have indirect effects on credit demand. Bernanke and Gertler (1995) pay particular attention to the effects of interest rates on households' and companies' balance sheets. The impact of an interest rate hike on balance sheets could come via either an increase in interest expenses or a decline in asset prices. Another negative impact on balance sheet could stem from worsening situation of firms' customers or, as regards households, the employers. The worsening of balance sheets could then lead to an increase in the so-called external finance premium, which would mean that interest rates paid on loans would actually rise by more than the policy rate hike would suggest. The increase in the premium could thus increase the impact of monetary tightening on borrowing.

In China, as we have already seen, interest rates used to be strictly determined by the authorities, and an increase in the external finance premium following monetary tightening was almost impossible until 2004. Even now with the possibility of interest rates fluctuating around benchmark rates, there are no signs of the balance sheet effect. While the benchmark rates have been raised a number of times, the share of loans carrying above-benchmark interest rate has actually declined since the start of 2005. We would thus expect that the impact of higher interest rates on credit demand in China would come mainly from the price effect or via delay or abandonment of investment plans.

Gertler and Gilchrist (1994) found that the way an enterprise reacts to a monetary policy tightening and the following decrease in cash flows depends on it size. By using US data, they found that whereas larger firms are likely to increase their borrowing, small firms seem unable to increase short-term borrowing in the wake of monetary tightening. From this perspective, one could expect that the impact of interest rate policy may have gained efficacy in China in the last decade along with the increasing role of small and medium size enterprises.

One can of course argue that it is not the level of the interest rates as such but the cost of bank loans relative to other forms of financing that we should take into account in our model for credit demand (Kashyap et al., 1993). In China, however, the other

[3] According to OECD (2005), the private-sector share in the non-farming business sector increased from 43% in 1998 to 57% in 2003.
[4] Most recently, the property law was approved by the People's Congress in March 2007.
[5] They found that credit stock reacts positively to output and negatively to interest rates in the euro area.

channels of external financing have been limited. According to the PBC[6] and the OECD (2005), on average more than three-quarters of domestically raised external funds by non-financial corporations was covered by bank loans in 1998–2007. Until the last few years, stock-exchange listing or issuing corporate bonds was basically possible for only a few large state-owned companies and the role of these ways of financing has remained small. The share of domestic financing raised by stock market listings rose close to 9% in the first three quarters of 2007 but the share of corporate bonds remained small. Thus, although Kashyap et al. (1993), using US data, find that firms shift from bank loans to commercial paper issuance in the wake of monetary tightening, we would not expect the same type of behaviour in China, simply due to the lack of other financing possibilities. From this standpoint, the impact of interest rate policy on the real economy could have even been more powerful in China than in countries with highly developed financial markets.

In our model for credit demand, the causality may of course run also to the opposite direction — from credit stock to industrial output and interest rate. Looser lending policies might encourage industrial companies to increase production. That could accelerate inflation and encourage the central bank to tighten monetary policy. We thus turn to an econometric method that allows causality to run both ways and also among the explanatory variables (output and interest rate).

Although the starting point for our analysis is the credit demand equation, we cannot rule out the possibility that supply-side factors also have affected credit developments in China. As mentioned above, the credit plans essentially determined the banks' lending until the end of 1997, and for this reason we do our estimation for period starting from 1998 when the credit demand is assumed to have played a more important role. Furthermore, while a tightening of monetary policy, particularly the hikes in reserve requirement or the window guidance, may have weakened the liquidity of certain banks temporarily, at the aggregate level the existence of excess reserves shows that the lending seems not to have been constrained by supply side effects during 1998–2007.

4.2. Data

We now turn to the empirical part of the paper and based on the discussion above, we define credit demand as a function of economic output and the lending rate:

$$credit_t = \beta_1 y_t + \beta_2 int_t + ec_t. \tag{4.1}$$

We use monthly data for 1998 M1-2007 M5. As you can see from Table A1, all data is in real terms, and the data on the credit stock and economic output is in logarithms and seasonally adjusted (by using Census X-12) by the author. Due to data limitations, we are unable to analyse separately the credit demands of households and enterprises, as our data cover total bank credit to non-financial institutions (credit). In practice, our analysis focuses heavily on enterprise borrowing because the share of loans to households in China used to be very small and, although it has increased rapidly over the last decade, it still amounted to less than 18% of all loans at the end of March 2007.

For economic output (y), we use the value-added of industry. GDP would of course be a broader measure of economic output, but the statistical authorities have yet to publish quarterly GDP statistics for 1994–2005 since the major statistical reform in 2005.[7] In addition, the quality of GDP data has often been questioned (see e.g., Holz, 2008).

As the interest rate (int), we use the benchmark one-year lending rate, which is one of the main interest rate policy variables in China. Although as we saw above the market lending rate can nowadays fluctuate around the benchmark rate, the actual differentiation from the benchmark rate has been moderate and the benchmark rate seems to capture rather well the prevailing level of lending rate in the market. We use the *ex post* real lending rate, so that we deflate the lending rate by contemporaneous inflation measured by annual percentage change in the CPI. We thus assume agents to expect the level of inflation of the previous 12 months to prevail in the future. Obviously, we have to take into account when interpreting the results that the PBC can directly control only the nominal and not the real lending rate. However, in the credit demand framework, the use of a nominal rate would be problematic as it may not be informative with respect to the real financial costs of the borrowers.

Fig. A1 in the Appendix A illustrates the dynamics of the variables in the model. As we can see from Figs. A2–A4, the authorities were keen to revive economic growth after the slowdown at the end-1990s and the benchmark lending rate was lowered considerably in the first years of our research period. The interest rate cuts were supported by very low, even negative, inflation figures. In 2004, a negative supply shock induced by small grain crops boosted inflation, but only temporarily. At the end-2006 consumer price inflation started to accelerate again. Although some difficulties in food supply were again the initial reason for the inflation, it seems that also the more general inflationary pressures are on rise in the Chinese economy (Kaaresvirta & Koivu, 2008). While in 2004 the benchmark lending rate was raised only once, during the current boom interest rates have been used much more actively to keep inflation under control. However, as we can see from Fig. A4, the interest rate hikes in 2007 were offset by higher inflation. Movements in the real lending rate and in credit stock growth are surprisingly parallel during the late 1990s. However, in recent years the expected negative link between interest rate and credit growth seems to appear. Growth of industrial value added accelerated after a period of slow growth in the aftermath of the Asian crisis at the end of 1990s and remained rapid until the end of the research period. Real industry value-added has thus increased faster than the real credit stock for most of the period studied.

[6] PBC: China Monetary Policy Report, various issues, China Financial Publishing House.

[7] After an economic census in 2004, the authorities raised the level of China's GDP in 2004 by 17 % but updated only the annual data for 1995–2004. The quarterly series have not been updated after the revision.

To be able to proceed with our estimation, we first test our time series by the Augmented Dickey–Fuller (ADF) test to discover the order of integration. We use the Akaike, Hannan–Quinn and Schwarz information criteria to determine lag length. We introduced a trend to each of the tests in levels based on graphical observation. As we can see from the results reported in Table A2 in the Appendix A, all our variables are stationary in first differences.

Now that we have found our variables to be integrated of order one we will study whether there is a cointegrating vector in our system. We test the rank of cointegration using the Johansen cointegration test (the results are reported in Table A5 in the Appendix A). Graphical observation suggests the inclusion of a deterministic trend in the cointegration testing, so we conduct the tests with and without a trend. Our results are fairly dependent on the use of a trend in the test. Without a trend, we often find more than one cointegration vector among our variables while introducing a trend into the test reduces the number of vectors. However, having a constant and a trend in the test, we can find one cointegration relation in all but one system that contain the credit stock. We thus proceed to estimate a long-run credit demand equation in the vector error correction model.

4.3. Estimation of reduced form VEC models

We use a vector error correction model, written in matrix form (Lütkepohl, 2004) as

$$\Delta x_t = \Pi x_{t-1} + \Gamma_1 \Delta x_{t-1} + \ldots + \Gamma_{p-1} \Delta x_{t-p+1} + CD_t + u_t \tag{4.2}$$

where $x_t = (\text{credit}_t, y_t, \text{int}_t)'$. CD is a vector of deterministic terms, i.e. constant and trend; u is the error term; Πx_{t-1} contains the cointegration relations; the Γ matrices contain the short-run parameters; and p is the order of the model. Π can be written $\Pi = \alpha\beta$ where α and β are $(K \times p)$ matrices that contain the so-called loading coefficients and cointegration coefficients. K is the number of variables.

We estimate our model with lag order 8 on the basis of misspecification tests and a desire to include a sufficient number of lags to enable study of the monetary transmission mechanism. We define an impulse dummy for January 2001[8] because of exceptionally slow credit growth. Our estimation from the Johansen maximum likelihood method yields the following long-run relationship:

$$\underset{}{credit_t} = \underset{(.071)}{0.207 y_t} - \underset{(.006)}{0.016 int_t} + \underset{(.001).}{0.005 t} + ec_t \tag{4.3}$$

We normalised the coefficients of the credit stock so that our formulation could be a credit demand equation. Standard errors are in parentheses. The coefficients of output, interest rate and trend are all statistically significant. Higher economic output is linked to higher credit demand while an increase in the real lending rate reduces credit demand. Illustrating the expanding banking industry and rising level of indebtedness (particularly for households) over the period studied, the trend has a positive coefficient.

The error-correction coefficient (−0.038) is low but indicates a stable model. Due to the fact that our system has many insignificant short-run coefficients and that the number of observations is limited due to the shortness of the period studied, we switch to a subset model that allows us to keep a sufficient number of lags in the system and still have an adequate number of degrees of freedom. To end up with that model, we used a procedure whereby at each step the parameter with the lowest t-value for the short-run coefficients was checked and possibly eliminated from the model. We determined the threshold value to be 1.0, so that only variables with lower t-values were eliminated.

Our subset model for credit demand was submitted to a number of misspecification tests, reported in Table A8. The tests include Portmanteau and LM tests for autocorrelation, ARCH-LM test for heteroscedasticity as well as Jarque–Bera test for non-normality of residuals. The model easily passes all other tests despite the one on residuals' normality. We cannot reject the non-normality for credit and output in the Jarque–Bera test, but the fact that the residuals seem to display more curtosis than skewness should make the problem of non-normality less serious (Juselius, 2006). Overall, it appears that the model is adequate for our analysis, and we proceed to the stability tests.

Due to the numerous reforms in the Chinese economy during the period studied, we are particularly interested in the stability of the model. To study the stability, we ran Chow sample split test, where the null hypothesis is that parameters are invariant over time. We used bootstrapped p-values based on 500 replications because the approximate χ^2 and F distributions of the Chow test statistics often lead to very high rejection rates and are, according to Candelon and Lütkepohl (2001), rather poor approximations. We searched for a break in the maximum available sample, as we could not specify any date that could have caused a break in our model.

The results from the test can be found in Fig. A5 in the Appendix A. The Chow sample split test points to a break in our model at 95% significance level in the latter half of 2001 confirming our hypothesis of changing dynamics in the Chinese financial system. We thus continue by splitting our model into two subsamples with the break at September 2001.

4.3.1. Credit demand equation for 1998 M1-2001 M9

For the first subperiod, obvious weakness is that we have slightly less than 4 years of observations, which is a very short period of time to estimate a long-run relationship. However, as we want to form an equation for China's credit demand for the two

[8] The dummy has the value 1 at the below-specified months and 0 otherwise.

subsamples we will continue running VEC models for both subperiods. In addition, our data support estimation of the long-run relationship, as we find that the variables are stationary only in differences (Table A3), and we obtain evidence of at least one cointegration vector among our variables (Table A6). Unfortunately, we had to reduce the number of lags in the system to 4 in order to have sufficient degrees of freedom. Like above, we introduced a dummy for January 2001.

Our estimation via the Johansen maximum likelihood method yields the following long-run relationship for the first subperiod, 1998 M1-2001 M9:

$$\underset{}{credit_t} = \underset{(.112)}{-0.231y_t} + \underset{(.008)}{0.004int_t} + \underset{(.001)}{0.011t} + ec_t \tag{4.4}$$

We again introduce the trend variable into our model as it is statistically significant. The positive trend probably captures the impacts from the gradual structural changes, which are not explicitly accounted for in the model, on the lending in the Chinese economy. For example, the increase in households' possibilities of borrowing from commercial banks increased steadily over the period[9]. Our variable for economic activity – industrial value-added – is not broad enough to capture this structural change in the economy. Besides the households, the credit market was opening up also to private enterprises. Although their increased activities are partly captured by industry value-added, this kind of monetarisation of the private sector is not explicitly modelled in our equation and may thus be reflected in the trend variable. The coefficient of industrial value-added is now negative and statistically significant. The result thus confirms the hypothesis by Bernanke and Gertler (1995) that higher level of economic activities actually leads to lower level of debt.

The positive link from interest rate to credit stock is not statistically significant and thus reflects the small role of interest rates in the credit demand. Although one has to treat these results with extreme care due to the shortness of the time period, we could at least argue that during the first subperiod, the credit stock could not be controlled by the interest rate setting.

As with the model for the whole period we again shifted to a subset model by eliminating short-run coefficients with t-values less than 1.0. The model passes misspecification tests, although again there appears to be some non-normality in the residuals of the industry value-added (Table A9). Obviously, the time frame is too short for any sort of stability tests. When taking into account also the short-run coefficients in the subset model, we end up with the following equation for credit stock in 1998 M1-2001 M9:

$$\begin{aligned}\Delta credit_t = & \underset{(.073)}{-0.383}[credit_{t-1} + \underset{(.112)}{0.231}y_{t-1} - \underset{(.008)}{0.004}int_{t-1} - \underset{(.001)}{0.011}t_{t-1}] + \underset{(.104)}{0.176}\Delta credit_{t-1} \\ & - \underset{(.002)}{0.003}\Delta int_{t-1} + \underset{(.046)}{0.163}\Delta y_{t-2} - \underset{(.002)}{0.004}\Delta int_{t-2} + \underset{(.091)}{0.205}\Delta credit_{t-3} - \underset{(.045)}{0.107}\Delta y_{t-3} \\ & - \underset{(.001)}{0.002}\Delta int_{t-3} + \underset{(.006)}{0.029}dummy0101 + \underset{(.900)}{4.759} + u_{1t.}\end{aligned} \tag{4.5}$$

The error-correction coefficient was found to be −0.383 and statistically significant, indicating that the model converges to the long-run equilibrium.

4.3.2. Credit demand equation for 2001 M10-2007 M5

Looking now at the later subperiod, we again find all data series to be I(1) and we also find a cointegration vector in the system when a trend and a constant are included (Tables A4 and A7). We are again able to introduce 8 lags into the model and our estimation based on the Johansen maximum likelihood method yields the following long-run relationship:

$$\underset{}{credit_t} = \underset{(.082)}{0.787y_t} - \underset{(.001)}{0.017int_t} - \underset{(.002)}{0.006t} + ec_t. \tag{4.6}$$

The coefficient of the lending rate is now negative as expected. Illustrating the more important role of the interest rate in the credit demand equation during the later subperiod, the t-value for the coefficient of the lending rate is very high (15.1). If interpreting the coefficient correctly, a 10% rise in the real lending rate decreases the credit stock by 17%. We thus can infer that the role of interest rates has increased in the Chinese economy during the period studied.

It seems that during the second subperiod, lending became more dependent on the level of economic activity. The link from economic activity to credit stock is now positive and the size of the coefficient is much higher than in the first subperiod. A 10% rise in industrial value-added led to a nearly 8% rise in the credit stock. While the coefficient on euro area found by Calza, Gartner and Sousa was even higher, China's lower coefficient can be explained by the fact that the size of the credit stock compared to the GDP is already exceptionally high in China. The trend variable is again statistically significant but turns negative. We would assume the negative trend to result from the substantial write-offs of non-performing loans of the banks' balance sheets during the recent years. Overall, our results seem to confirm our hypothesis that the lending in China has become more market-oriented during the last decade.

We again shift to a subsample model by eliminating the short-run coefficients with t-values lower than 1.0 and run the above-mentioned misspecification tests (see Table A10 in the Appendix A). Again the only test that we have problems in passing with is

[9] According to the OECD (2005), the share of consumer loans as a share of total commercial bank assets rose from less than 0.5% to almost 5% in 1998–2001.

the non-normality test as the residuals of the real interest rate are not normally distributed. Otherwise, the test results are rather encouraging. Finally, we end up with the following equation for the credit stock in 2001 M10-2007 M5:

$$\begin{aligned}\Delta credit_t = & -0.083[credit_{t-1} - 0.787y_{t-1} + 0.017int_{t-1} + 0.006t_{t-1}] + 0.220\Delta credit_{t-1} \\ & (.050) \quad (.082) \quad (.001) \quad (.002) \quad (.163) \\ & -0.089\Delta y_{t-1} + 0.004\Delta int_{t-1} + 0.200\Delta credit_{t-2} - 0.173\Delta y_{t-2} + 0.622\Delta credit_{t-3} \\ & (.061) \quad (.002) \quad (.160) \quad (.060) \quad (.142) \\ & -0.201\Delta y_{t-3} - 0.121\Delta y_{t-4} + 0.123\Delta y_{t-5} - 0.103\Delta y_{t-6} + 0.127\Delta credit_{t-7} \\ & (.060) \quad (.045) \quad (.056) \quad (.049) \quad (.117) \\ & + 0.482\Delta credit_{t-8} + 0.635 + u_{1t.} \\ & (.106)(.439).\end{aligned} \tag{4.7}$$

The ec-term for credit stock (−0.083) is again negative indicating a slow convergence to the long-run equilibrium. Not only the credit stock but also the real lending rate seems to be defined endogenously in our model, as its error correction term is statistically significant. With excess credit in the economy, the model moves to the long-run steady state by lowering the lending rate. The ec-term for industrial value-added is positive so that excess credit would lead to an increase in the economic activity, just as one would expect, but the ec-term is not statistically significant.

4.3.3. Robustness checks

Due to the shortness of our subperiods, it is particularly essential to check the robustness of the results. We have done this by moving the timing of the subperiods around the original ones and by introducing different number of lags into our system. In general, our results seem to be fairly robust. The results from the robustness checking are reported in Table A11.

For the first subperiod, we have tested the robustness of our results first by shifting the timeframe around the initial one and afterwards by lengthening the time period to cover a six year period so that we were able to introduce more lags into the system. The positive link between the interest rate and credit stock is retained in most cases but it is not always statistically significant. The link turns negative only when we drop the whole year 1998 from our sample and lengthen the time period to cover the entire 2004.

For the results on the second subperiod, our results seem to be even more robust. Neither shifting the timing of the sample around the original one nor introducing different number of lags into the system removes the negative and significant link between the interest rate and the credit stock. The positive link between industrial value-added and credit stock is also robust.

5. Impulse response analysis

So far, we have said little about the dynamics of our system. Although we wrote the short-run coefficients in Eqs. (4.5) and (4.7), the dynamics are hard to obtain with the large number of coefficients. Thus we next illuminate the dynamics of our model with the help of impulse response analysis.

We compare the dynamics of credit stock, output and the lending rate as between the two subperiods using contemporaneous restrictions by means of a recursive identification scheme. The cointegration relations for the two systems were written in Eqs. (4.3) and (4.4). This approach is well suited to a reduced VAR model when the errors are orthogonalized via a Cholesky decomposition. With variables in the order $credit_t$, y_t and int_t, the restrictions on the B matrix are

$$\begin{bmatrix} * & 0 & 0 \\ * & * & 0 \\ * & * & * \end{bmatrix}$$

where the asterisks denote unrestricted elements. This means that a shock to credit can have an instantaneous impact on both of the other variables, i.e. economic output and lending rate. A shock to output, however, cannot have an immediate impact on credit stock, whereas the lending rate could react immediately to a shock in output. The lending rate can have an impact on credit stock or industrial output only after one month lag.

We used the maximum likelihood method to estimate the contemporaneous impact matrix and Hall bootstrapped percentile confidence intervals at the 95% significance level to control for parameter uncertainty. The number of bootstrap replications was set at 1000. We present system responses to a shock of one standard deviation in Figs. 1 and 2 for the periods 1998 M1-2001 M9 and 2001 M10-2007 M5 respectively.

As we see from Fig. 1, the responses to shocks in the first period are hardly statistically significant. This might be partly due to the small number of lags in the system. As observed already in the long-term equation, an increase in the lending rate actually leads to a rise in the credit stock but the response is not statistically significant. Neither is the negative response of output to an interest rate hike. The short-run analysis confirms also our earlier result on the negative link between output and credit stock. Somewhat surprising is the result according to which a positive shock to credit stock leads to a decrease in output.

For the latter subperiod (Fig. 2), the impulse responses are more often statistically significant than for the first subperiod. Mirroring the long-term cointegration vector, a rise in the lending rate now leads to a decline in the credit stock. The decline takes place a few months after an interest rate rise and lasts statistically significant for about 2 years. Despite the decline in the credit stock, the impact of an interest rate hike on economic output is very weak. The industry value-added actually increases temporarily with a rise in the interest rate, which could reflect the expectations content of interest rate policy: the boom is still in progress for some time after the interest rate hike. In a longer-term, not significant link seems to exist between the dynamics of interest rates and output.

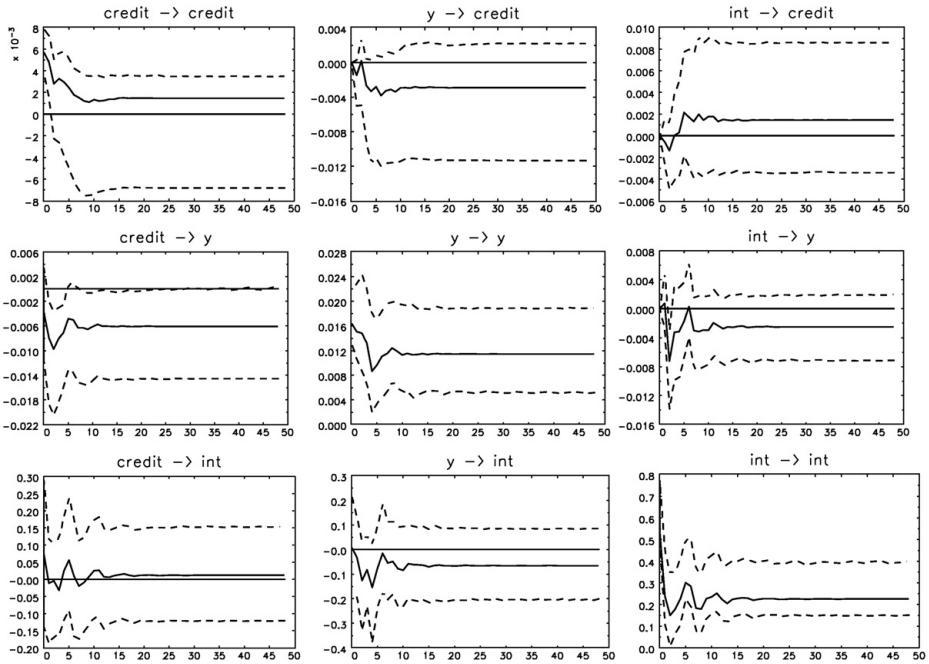

Fig. 1. Impulse responses for 1998 M1-2001 M9.

In contrast to the first subperiod, a positive shock to the credit stock now boosts economic output as expected. The change in the link from credit stock to the output could be due to the improved quality of the lending in the latter period. Although we did find a long-run positive link between the economic output and credit stock, it seems that in the short-run, an output shock actually leads to a drop in the credit stock. However, this impact lasts statistically significant less than 1 year.

While in the first subperiod we could not find any statistically significant response from the interest rate to shocks in credit stock or in output, in the latter subperiod, the interest rate seems to follow the other variables in the model more closely. A positive output shock raises the real lending rate. The impact increases over time and is robust. Also looser lending activities of the commercial banks are immediately accompanied by higher real interest rate. This positive impact, however, vanishes after about half a year and turns negative. The negative impact could actually be due to a rise in inflation rate that may follow with a lag the loosening in the credit market.

The impulse response analysis with only short-run restrictions based on the ordering of the variables obviously has its weaknesses. For example, from the perspective of the theoretical literature, the restriction that a rise in industrial output cannot have an instantaneous impact on the credit stock may be questionable. We would assume that the credit stock could react immediately to a shock in the real economy, as the demand for e.g. short-term loans should react quickly. We would also expect that the credit stock may react with hardly any delay to changes in the interest rate, whereas the above analysis does not allow for any contemporary impact of interest rate on credit stock. In the future work, it would thus be useful to analyse the dynamics of the system also by using a structural vector error correction model whereby one would be able to remove some of the short-run restrictions and introduce long-term restrictions.

To briefly sum up our results from the cointegration and impulse responses analyses, it seems that the role of interest rates has indeed strengthened in the Chinese financial system. The credit stock has become more dependent on the level of interest rates during the last decade. However, the real economy responses very weakly to interest sate settings — a familiar result in earlier studies of China and some other countries. It thus seems that, even though the credit stock reacts to an interest rate hike, the effectiveness of the interest rate as a monetary policy tool is still rather low.

6. Conclusions

In the earlier studies on monetary policy transmission channels in China, the link from interest rate to the real economy has been found weak. While one can readily list a number of features of the Chinese economy that used to reduce the role of interest

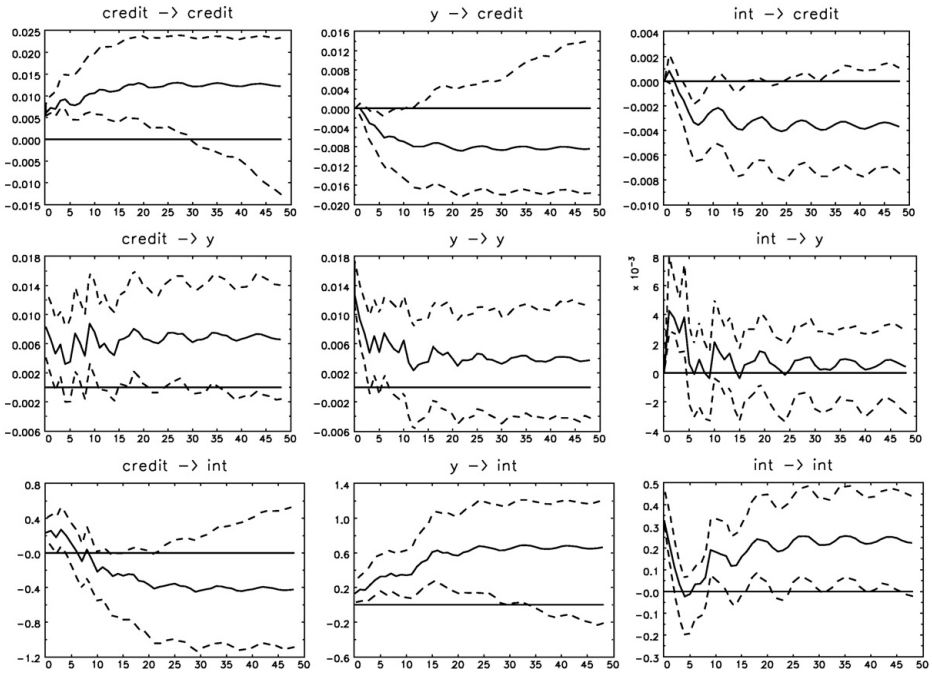

Fig. 2. Impulse responses for 2001 M10-2007 M5.

rate, there has been a constant stream of reforms that may have increased the impact of interest rate on the real economy during the last decade. The reforms have been profound not only in the financial sector but also in the other parts of the economy.

In this paper, we studied whether the Chinese economy has become more sensitive to interest rate policy along the reforms in the framework of credit demand. To our knowledge, this is the first attempt to estimate a long-term credit demand equation for China. We used the vector error correction model and data starting from 1998 in our model.

Reflecting the ongoing reforms and structural breaks during our research period in China, we could not find a stable credit demand equation for the whole research period. The stability tests identified a break at autumn 2001. By comparing the monetary policy transmission for the two subsamples, we found that interest rates have indeed become a more important factor in the credit demand equation in the latter subperiod. In addition to the continuous steps taken in liberalising interest rates in China, the break can be associated with the decline of the big four state-owned banks' share of total bank lending to non-financial institutes. While their share remained almost constant at above 75% from the beginning of 1998 until spring 2001, it started to decline in the mid- 2001 and has dropped to 60% by summer 2007. If we assume the smaller banks to serve more private and small and medium size enterprises, a decline in the role of the big banks could reflect the rise of the role of more price-oriented borrowers in the economy.

In the first subperiod, our results found support for the earlier studies so that the link from the lending rate to credit stock was found positive but very weak. Overall, however, we need to be very cautious when interpreting our results for the first subperiod because of its shortness. In the second subperiod, we found a negative and strongly significant link from lending rate to credit stock. The strengthening of the link was obvious from both cointegration and impulse response analyses. Thus we could infer that interest rate policy has gained at least some power along with the reforms in the financial sector.

However, our results also supported the findings from the earlier studies that the link from interest rates to real economy is still weak in China. While the weak impact of interest rates on economic output via bank credit in e.g. the US has been explained by other well-functioning parts of the financial sector, in China, the reasons for the weak channel might be somewhat different due to the underdeveloped state of the other parts of the official financial sector. A possible explanation is that because the share of self-finance is high in China enterprises shift from bank credit to self-finance after a hike in interest rates.[10] Moreover, since the black credit market

[10] Of total fixed investment, more than 60% was self-financed in 2006.

in China is also a vital part of the financial sector, a hike in the lending rate might encourage that kind of borrowing as well, assuming that interest rates in the black market do not move in accord with central bank interest rate settings.[11]

Overall, our results still raise the question of the effectiveness of the interest rates as a monetary policy tool in the Chinese economy. While the authorities still use administrative tools actively, the continuous liberalisation of the economy will probably decrease the influence of these measures and the authorities will have to rely on more market-oriented tools, such as interest rate setting, in the coming years.

Appendix A

Table A1
Data sources.

Variable	Source	Explanations
Credit stock	IFS	Row 22d: Banking institutions' claims on other sectors, deflated by the CPI, in logs and seasonally adjusted
Industrial value-added	CEIC	Until 11/2006, data on industrial value-added in renminbi deflated by the cpi. For 12/2006-5/2007, we used real growth rates of industrial value-added. In logs and seasonally adjusted
Lending rate	CEIC	One-year benchmark lending rate deflated by the 12-month consumer price inflation
CPI	PBC, CEIC	Own calculations. Based on data on m-o-m and y-o-y consumer price inflation

Table A2
Results from augmented Dickey–Fuller tests, 1998 M1-2007 M5.

Series	Det. term	Lagged differences	Test. stat.
Y	Constant, trend	0 (AIC, HQ, SC)	−2.04
Dy	Constant	0 (AIC, HQ, SC)	−10.42***
Credit	Constant, trend	0 (AIC, HQ, SC)	−1.42
Dcredit	Constant	0 (AIC, HQ, SC)	−10.13***
Int	Constant, trend	0 (AIC, HQ, SC)	−2.70
Dint	Constant	0 (AIC, HQ, SC)	−13.22***

*Indicates significance at 10%, ** at 5% and *** at 1% level. The order specification in parentheses: AIC = Akaike, HQ = Hannan–Quinn, SC = Schwarz-criteria. Maximum number of lags 12.

Table A3
Results from augmented Dickey–Fuller tests, 1998 M1-2001 M9.

Series	Det. term	Lagged differences	Test. stat.
y	Constant, trend	0 (AIC, HQ, SC)	−2.30
dy	Constant	0 (AIC, HQ, SC)	−6.25***
credit	Constant, trend	0 (AIC, HQ, SC)	−1.93
dcredit	Constant	0 (AIC, HQ, SC)	−8.06***
int	Constant, trend	0 (AIC, HQ, SC)	−4.94***
int	Constant	0 (AIC, HQ, SC)	−1.95
dint	Constant	0 (AIC, HQ, SC)	−9.77***

*Indicates significance at 10%, ** at 5% and *** at 1% level. The order specification in parentheses: AIC = Akaike, HQ = Hannan–Quinn, SC = Schwarz-criteria. Maximum number of lags 12.

Table A4
Results from augmented Dickey–Fuller tests, 2001 M10-2007 M5.

Series	Det. term	Lagged differences	Test. stat.
y	Constant, trend	2 (AIC)	−0.16
y	Constant, trend	1 (HQ, SC)	−0.089
dy	Constant	0 (AIC, HQ)	−7.71***
dy	Constant	0 (SC)	−6.03***
credit	Constant, trend	8 (AIC)	−3.09
credit	Constant, trend	1 (HQ, SC)	−2.03
dcredit	Constant	8 (AIC)	−1.64
dcredit	Constant	0 (HQ, SC)	−5.87***
int	Constant, trend	12 (AIC)	−2.21
int	Constant, trend	0 (HQ, SC)	−1.64
int	Constant	0 (AIC, HQ, SC)	−1.63
dint	Constant	0 (AIC, HQ, SC)	−8.45***

(continued on next page)

[11] Unfortunately we could not find any time series data on prevailing level of interest rate in the black market. However, perhaps reflecting the weak link from the official rates to the black market rates, according to data from the PBC, the margin between lending rates in the official and black market is very large. At end-2004, the official benchmark rate for a one-year credit was 5.6% while the prevailing black market lending rate was 12%.

Table A5
Results from Johansen cointegration tests, 1998 M1-2007 M5.

Series	Det. term	Number of lags	Coint. Rank	Test stat.
y, credit, int	Constant	1 (AIC, HQ, SC)	0	157.45***
			1	26.49***
			2	10.27**
y, credit, int	Constant, trend	1 (AIC, HQ, SC)	0	44.67**
			1	17.75
			2	3.93
y, credit	Constant	1 (AIC, HQ, SC)	0	120.85***
			1	13.41**
y, credit	Constant, trend	1 (AIC, HQ, SC)	0	17.25
			1	3.47
y, int	Constant	1 (AIC, HQ, SC)	0	66.03***
			1	7.06
y, int	Constant, trend	1 (AIC, HQ, SC)	0	19.11
			1	7.69
credit, int	Constant	1 (AIC, HQ, SC)	0	123.35***
			1	8.09*
credit, int	Constant, trend	1 (AIC, HQ, SC)	0	28.86**
			1	3.51

*Indicates significance at 10%, ** at 5% and *** at 1% level. The order specification in parentheses: AIC = Akaike, HQ = Hannan–Quinn, SC = Schwarz-criteria. Maximum number of lags: 12.

Table A6
Results from Johansen cointegration tests, 1998 M1-2001 M9.

Series	Det. term	Number of lags	Coint. rank	Test stat.	Test stat. for small samples[1]
Y, credit, int	Constant	10 (AIC, HQ, SC)	0	197.80***	39.44***
			1	83.99***	16.80
			2	21.79***	4.39
Y, credit, int	Constant, trend	10 (AIC, HQ, SC)	0	447.13***	89.43***
			1	120.47***	24.09*
			2	56.74***	11.35*

*Indicates significance at 10%, ** at 5% and *** at 1% level. The order specification in parentheses: AIC = Akaike, HQ = Hannan–Quinn, SC = Schwarz-criteria. Maximum number of lags 12.

[1]Due to the small sample for the first subperiod, we used the following small sample adjusted trace statistics: $[(T-\mathrm{kp})/T]$(trace statistics) suggested by Ahn and Reinsel (1990).

Table A7
Results from Johansen cointegration tests, 2001 M10-2007 M5.

Series	Det. term	Number of lags	Coint. rank	Test stat.
Y, credit, int	Constant	12 (AIC)	0	119.73***
			1	26.76***
			2	9.66
Y, credit, int	Constant	1 (HQ, SC)	0	125.24***
			1	22.46**
			2	9.35**
Y, credit, int	Constant, trend	12 (AIC)	0	145.53***
			1	48.79***
			2	8.65
Y, credit, int	Constant, trend	1 (HQ, SC)	0	57.44***
			1	25.69*
			2	8.29

*Indicates significance at 10%, ** at 5% and *** at 1% level. The order specification in parentheses: AIC = Akaike, HQ = Hannan–Quinn, SC = Schwarz-criteria. Maximum number of lags 12.

Table A8
Misspecification tests, 1998 M1-2007 M5.

$Q^*(16)$	101.70 [0.52]
LM_5, LM_4, LM_1	39.29 [0.71], 35.57 [0.49], 8.16 [0.52]
JB (Eqs. (1),(2),(3))	16.38 [0.00], 82.28 [0.00], 0.45 [0.80]
ARCH-LM(16)(Eqs. (1),(2),(3))	8.43 [0.94], 17.23 [0.37], 15.89 [0.46]

Table A9
Misspecification tests, 1998 M1-9/01 M9.

$Q^*(16)$	100.97 [0.92]
LM_5, LM_4, LM_1	32.70 [0.91], 31.34 [0.69], 9.34 [0.41]
JB (Eqs. (1–3))	1.60 [0.45], 28.19 [0.00], 0.94 [0.63]
ARCH-LM(16)(Eqs. (1),(2),(3))	8.12 [0.95], 14.74 [0.54], 16.51 [0.42]

Table A10
Misspecification tests, 2001 M10-2007 M5.

$Q^*(16)$	116.35 [0.14]
LM_5, LM_4, LM_1	39.92 [0.69], 35.77 [0.48], 6.45 [0.69]
JB (Eqs. (1),(2),(3))	1.74 [0.42], 27.02 [0.00], 0.48 [0.79]
ARCH-LM(16)(Eqs. (1),(2),(3))	20.22 [0.21], 23.25 [0.11], 8.32 [0.94]

Note: *p*-values in brackets.
Q^* denotes adjusted Portmanteau test statistic for autocorrelation (conducted only for models without exogenous variables).
LM is the Lagrange multiplier test statistic for autocorrelation.
JB is the Jarque–Bera test for non-normality.
ARCH-LM is a Lagrange multiplier test for autoregressive conditional heteroscedasticity.
16 lags used for the Portmanteau and ARCH-LM tests. 5, 4 and 1 lags for the LM test.

Table A11
Results from the robustness tests.

Time period	Number of lags	Dummies	Long-run equation with the ec-term $\Delta credit_t$ =
1/98–9/01	4	1/01	$-0.383[credit_{t-1}+0.230y_{t-1}-(0.004)int_{t-1}-0.011t_{t-1}]$
1/98–3/02	4	1/01	$-0.356[credit_{t-1}+(0.134)y_{t-1}-0.013int_{t-1}-0.011t_{t-1}]$
7/98–9/02	4	1/01	$0.002[credit_{t-1}-0.641y_{t-1}+(0.002)int_{t-1}]$
1/98–12/03	8	1/01	$-0.124[credit_{t-1}-1.148y_{t-1}-0.048int_{t-1}]$
7/98–6/04	8	1/01	$-0.230[credit_{t-1}-0.521y_{t-1}-0.008int_{t-1}-0.004t_{t-1}]$
1/99–12/04	8	1/01	$-0.088[credit_{t-1}+1.162y_{t-1}+0.049int_{t-1}-0.023t_{t-1}]$
10/01–5/07	8		$-0.234[credit_{t-1}-0.787y_{t-1}+0.017int_{t-1}+0.006t_{t-1}]$
4/01–5/07	8		$(0.004)[credit_{t-1}-0.945y_{t-1}+0.010int_{t-1}+0.009t_{t-1}]$
4/01–11/06	8		$-0.146[credit_{t-1}-0.759y_{t-1}+0.013int_{t-1}+0.005t_{t-1}]$
10/01–5/07	4		$(0.107)[credit_{t-1}-1.252y_{t-1}+0.017int_{t-1}+0.015t_{t-1}]$
10/01–5/07	12		$-0.176[credit_{t-1}-0.695y_{t-1}+0.058int_{t-1}-0.005t_{t-1}]$

Note: *t* is the trend which is introduced to the model when significant.
Numbers in parentheses () are statistically insignificant.

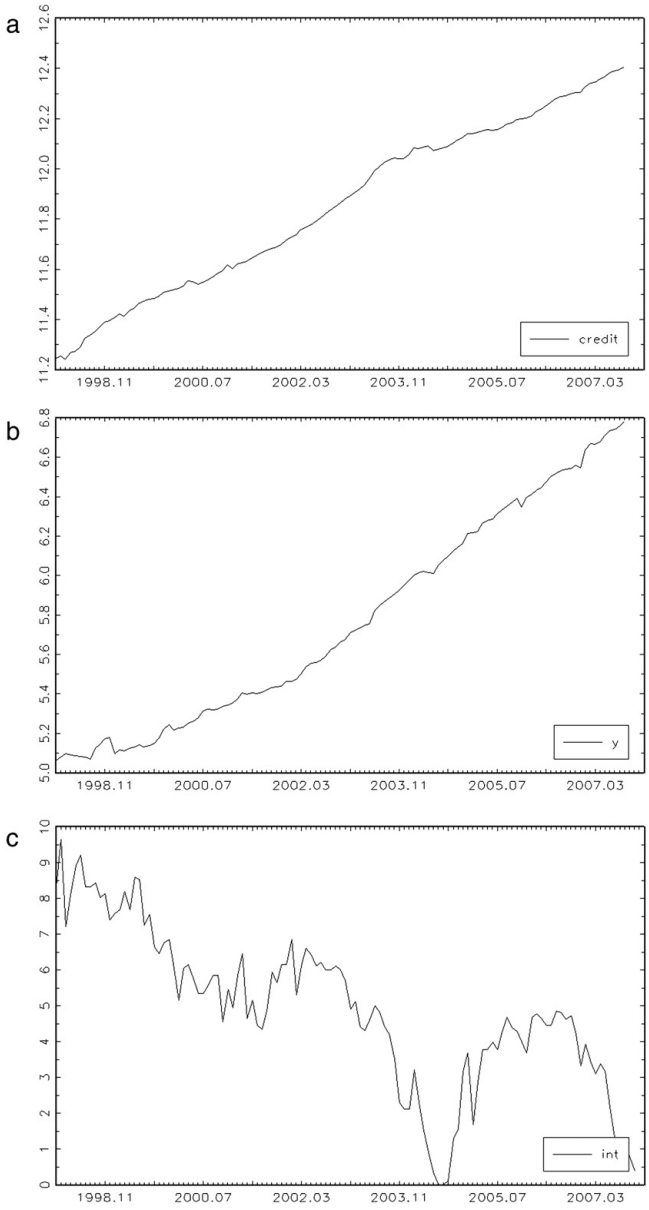

Fig. A1. Series used in structural VAR estimations.

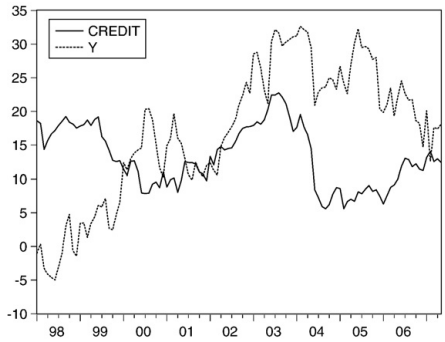

Fig. A2. Annual changes in real credit stock and industry value added, 1998 M1-2007 M5, %.

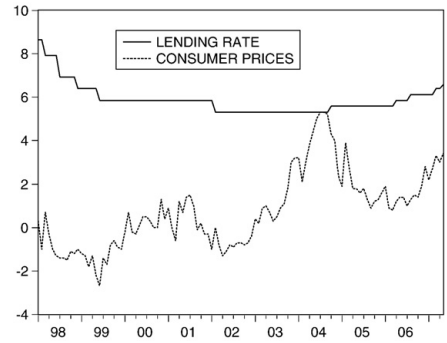

Fig. A3. Annual changes in consumer price index and nominal benchmark one-year lending rate at end of period, 1998 M1-2007 M5, %.

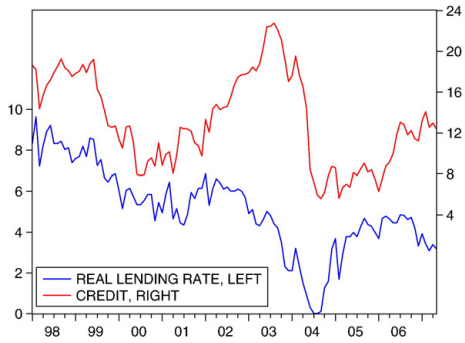

Fig. A4. Real lending rate and annual changes in real credit stock, 1998 M1-2007 M5, %.

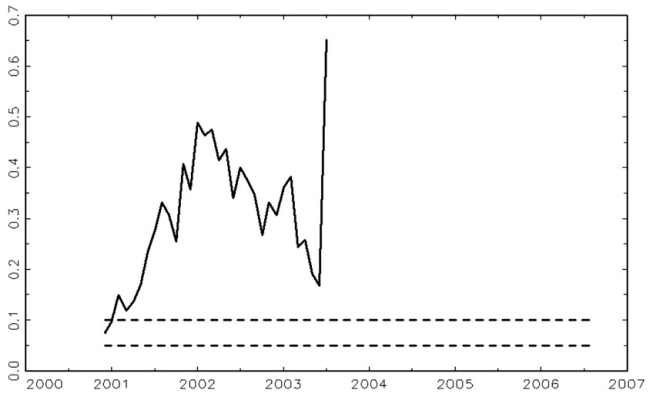

Fig. A5. Results from the Chow sample split test.

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Chapter 3

Monetary policy, asset prices and consumption in China

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Monetary policy, asset prices and consumption in China

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ABSTRACT

This paper studies the wealth channel in China. Although the wealth channel has been found to be functioning in many advanced countries, its existence is yet to be explored in most emerging economies, also in China. In order to illuminate dynamics between monetary policy, asset prices and consumption, we use the structural vector autoregression method. The findings support the view that a loosening of China's monetary policy does indeed lead to higher asset prices. Furthermore, a positive shock to residential prices increases household consumption, while the role of stock prices seems to be small from the households' point of view. Finally, we test the existence of the wealth channel more formally to find out whether those changes in asset prices that are caused by monetary policy are significant enough to increase consumption. In summary, the wealth channel remains weak but there are some signs of it via residential prices. The results are not that different from those attained for the advanced economies, where the size of the wealth channel has been found to be limited.

1. Introduction

One of the monetary policy transmission channels is the so-called wealth channel. It implies that monetary policy can affect the real economy via its impact on asset prices. For example, a loosening of monetary policy is often linked with an increase in asset prices which can then have a positive impact on firms' investment behaviour or household consumption. In the advanced economies, the wealth channel has frequently been introduced to macroeconomic models analysing the impacts of monetary

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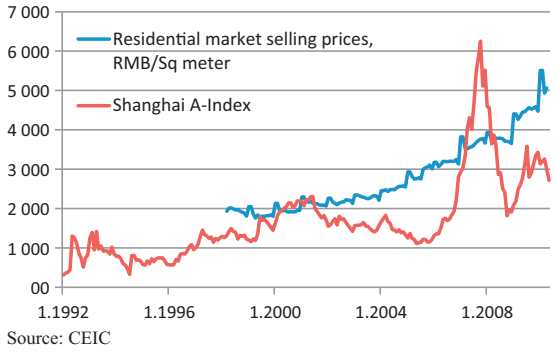

Fig. 1. Shanghai A-Index and residential prices.

policy on the real economy. However, the evidence of the wealth channel in emerging markets is still questionable, mainly due to underdeveloped asset markets in these economies.

In this paper, we study whether the wealth channel exists in China. In particular, we explore whether monetary policy can have an impact either on housing or stock prices, and if so, whether these price developments are capable of influencing household consumption. In addition to the fact that the wealth channel in China has not been studied before, this paper is motivated by the growing importance of the stock and residential markets in the Chinese economy. For decision makers it is essential to know whether the asset markets provide another monetary policy transmission channel in the country. Furthermore, taking into account China's rapidly increasing role in the world economy, the knowledge of the dynamics of the Chinese economy is essential for other economies as well.

Interestingly, developments in the two asset markets – stock and residential markets – have been rather uneven in China. In particular, the stock markets have had a bumpy ride, as share prices experienced several booms and busts right after the opening of the Shanghai Stock Exchange in 1992 (see Fig. 1). During the first years of the 2000s, market performance remained weak – especially compared to the strong performance of the economy. The weakness of the stock market was thought to be mainly due to institutional problems such as lack of transparency, low quality of listed companies, weak minority shareholder rights, limited role of institutional investors, and the unclear plan to sell state-owned shares.[1] Efforts were made to revive investors' interest in the stock markets through institutional reforms touching on some of these problems, which in part led to another stock market bubble in 2006–2007, as share prices rose fivefold in less than two years before the market crashed again. The sharpest monthly drop in the Shanghai A-Index amounted to almost 25% in October 2008. Since the beginning of 2009, stock markets have recovered to some extent.

Compared to the high volatility of stock markets, developments in Chinese housing prices have been consistently positive, even though extensive reforms have also targeted this sector (see Fig. 1). Liang and Cao (2007) divide the reforms into three subperiods. The last of the three began in 1998, after which most of the apartments were privatised and the market mechanism was allowed to function. Nowadays 80% of urban residents own their apartment in China.[2] However, the public sector has maintained its role as a moderator in the real estate market, not least because of its monopoly in supplying land. Moreover, minor regulatory changes, e.g., in respect of minimum down payments and land usage, are still common. Housing prices have performed favourably for many years since the start of the data series in 1998. The strong uptrend ended only in 2008 and even then the period of declining prices was short-lived; since the spring of 2009, prices have been on the rise again.

In the past, asset prices had virtually no impact on the Chinese economy. The size of the stock markets compared to the economy was small, and until the second half of the 1990s, apartments were owned by the public sector. Profound economic reforms have gradually increased the importance of

[1] An overview of stock market developments in China can be found for example in Chen and Shih (2002).

[2] Financial Times, 22nd September 2009: http://blogs.ft.com/dragonbeat//2009/09/22/whats-behind-chinas-skyrocketing-residential-property-market-subsidies-subsidies-subsidies/?catid=152&SID=google.

asset markets in the economy. During the stock market boom in 2007, the number of stock accounts rose to 139 million (Leung and Yim, 2008).[3] In addition, more and more companies are obtaining external finance by listing on stock markets. The total capitalisation of the Shanghai and Shenzhen Stock Exchanges, which amounted to just 5% of GDP in the mid-1990s, peaked at 120% of GDP at the end of 2007. At the same time, the real estate sector has become one of the key segments of the Chinese economy along with the fast increase in household wealth and the vast migration from rural areas to cities. The volume of investment in the sector amounts to 10% of GDP on average. From the point of view of the wealth channel, however, the relevance of asset market development for household behaviour is still questionable as only 2.3% of total household income was classified as property income in 2008 (see Fig. A1 in Appendix A).

We study the wealth channel in China by using a structural VAR model. According to our results, a loosening of monetary policy does indeed lead to higher asset prices in China. When money supply increases, both residential and stock prices rise. In addition, positive asset price developments are linked to higher household consumption as a rise in residential prices leads to an increase in household consumption after about a year. Also, an increase in stock prices boosts household consumption, but the positive impact is less robust than from the residential prices. Even if our findings support the role of property prices in the Chinese economy, we still had to test the existence of the wealth channel more formally to find out whether those changes in asset prices that are caused by monetary policy are significant enough to increase consumption. In this regard, we can conclude that the wealth channel remains rather weak, but there are weak signs of the channel via the residential prices. This result actually follows rather closely the papers studying the wealth channel in the advanced economies, which conclude the size of the wealth channel to be relatively small.

The paper is organised as follows. We first present a short overview of the earlier vast theoretical and empirical literature on the wealth channel. As mentioned earlier, we are not aware of any papers that examine whether monetary policy affects household consumption in China via its impacts on asset prices. After the literature review, we describe the data and methodology for estimating the links between monetary policy, asset prices and household consumption in China. The fourth section contains a summary of the results, and in the fifth section we conclude and draw some policy implications.

2. Short overview of the earlier literature

Besides the other monetary policy transmission channels, monetary policy can also affect the real economy via the 'wealth channel', which can be divided into two parts. For the wealth channel to function, monetary policy must first be capable of affecting the value of wealth, and secondly, those changes in wealth must influence consumption. The existing literature on the wealth channel is vast and has a long history. Already in 1933, in the aftermath of the economic crisis, Fisher (1933) noted that a fall in security prices could be a phase of an economic depression. Later on, a theoretical framework was set out for the channel (de Leeuw and Gramlich, 1969).

In the theoretical literature on the first part of the wealth channel, monetary policy can impact stock prices in many ways. Monetary policy, which is assumed to have an impact on long-term interest rates and on the level of economic activity, can influence stock prices by affecting companies' future earnings and dividend payments. Interest rates also affect the discounted stream of dividends, and monetary policy has thus been linked to expected stock returns. Furthermore, lower interest rates are assumed to render shares more attractive than bonds as an outlet for savings and thus to boost share demand and prices. Expansionary monetary policy should also encourage households to reduce their money balances, not merely in order to increase their consumption but also to increase their equity holdings (Mishkin, 1996).

The recent empirical papers confirm these theoretical considerations and find a negative link from a monetary tightening to stock prices. For example, Bernanke and Kuttner (2005) and Rigobon and Sack (2004) find that a 25 basis point rise in a short-run interest rate decreases stock prices 1.0–2.4% in

[3] Obviously, a single person or legal entity can hold more than one account. Unfortunately, data on the share of population holding a stock account in China is not available.

the US market. Bernanke and Kuttner (2005) find that most of the decline in stock prices is due to the negative impact of tight monetary policy on expected future dividends and expected future excess returns. In this respect, the role of risk becomes important as a tightening of monetary policy can increase either the riskiness of stocks or investors' risk adversity, thus raising the expected equity premium. More evidence on the link from monetary policy to stock prices has been found by Bordo and Wheelock (2004) and Alessi and Detken (2009), who conclude that an increase in liquidity boosts asset prices in developed economies.

The link from monetary policy to residential prices can be described using the concept of user cost of capital (Mishkin, 2007). An interest rate hike raises the user cost of capital, causing a decline in housing demand and prices. As a result, housing construction and thus aggregate demand in the economy decrease. Expectations of a rise in interest rates may quickly push up the user cost of capital by lowering the expected real rate of appreciation of residential prices. There is also empirical evidence on the link from monetary policy to residential prices. Using the structural VAR methodology, Iacoviello (2000) finds that monetary policy has an impact on housing prices in Europe. Ahearne et al. (2005) study housing prices in 18 advanced economies and also get results that confirm the link from monetary policy to housing prices. In particular, booms in housing prices are often preceded by a period of monetary policy loosening.

Recently, monetary policy credibility has been linked to the wealth channel (Bordo and Wheelock, 2004). Successful monetary policy that keeps inflation low can increase the probability of an asset price bubble.

The theoretical models dealing with the second part of the wealth channel – the link between asset prices and consumption – normally rely on the life cycle model by Ando and Modigliani (1963), which gives aggregate consumption as a function of aggregate expected income and net worth.[4] Modigliani (1971) provides the framework for a large macro model in which monetary policy can affect asset prices and hence also consumption. Consumers maximise utility subject to a lifetime resource constraint, and consumption is defined as

$$C = mpc[A + H(Y)] \tag{1}$$

where C is consumption, mpc is the marginal propensity to consume, A is real non-human wealth and $H(Y)$ is the present value of the expected income stream. As can be seen from (1), the importance of the wealth effect on consumption depends largely on the marginal propensity to consume. Furthermore, the shorter the household's planning horizon, the stronger the effect from wealth to consumption (Poterba, 2000).

In the wide selection of empirical papers, the majority conclude that asset prices do influence consumption.[5] However, estimates of the size of the effect vary considerably. While Modigliani (1971) suggested that a one dollar increase in wealth boosts consumption by 5 cents, more recent studies estimate the impact to be smaller (Lettau and Ludvigson, 2004). There are many reasons for the variation in estimates of the size of the impact (Poterba, 2000; Altissimo et al., 2005). The wealth effect depends on the liquidity of the asset market and the predictability of prices. In addition, stock and residential prices influence consumption differently due to the difference in ownership distributions. While households' equity wealth is highly concentrated, real estate wealth has been more equally distributed among households. As a result, stock prices probably affect a fairly small share of households, while real estate prices are relevant for most households' behaviour. In addition, if shareholdings are concentrated in pension funds, the marginal propensity to consume is probably lower than if the equities are owned directly by households. Interestingly, the nature of the price increases or decreases is also relevant: Lettau and Ludvigson (2004) found that, while permanent shocks to wealth seem to have a statistically significant effect on household consumption, most shocks in asset prices are only temporary and do not affect consumption.

All of the above mentioned papers study only a single part of the wealth channel. Either they look at the link from monetary policy to asset prices or they estimate the impact from asset prices to

[4] Literature surveys on theoretical and empirical work on the impacts of asset prices on the real economy can for example be found in Altissimo et al. (2005) and Poterba (2000).

[5] In the empirical literature, household wealth is often measured by asset prices due to data availability.

consumption. They do not explore whether changes in asset prices due to monetary policy have any impact on consumption. There are few studies that deal with both parts of the wealth channel. Ludvigson et al. (2002) summarise the results for the wealth channel from the large macro models of the US economy. Although the link from monetary policy to the real economy via asset prices is found to be significant, the importance of the wealth channel in the economy seems to be moderate. The authors apply a structural VAR to US data and conclude that an increase in household wealth due to a loosening of monetary policy has a positive, but small and hardly significant, impact on household consumption.

From the viewpoint of this paper, studies on the wealth channel in emerging economies – and China in particular – are of course the most relevant ones. However, this literature is very limited. Liang and Cao (2007) study the impacts of monetary policy on residential prices in China. According to their long-run results, output growth is the dominating force behind property prices while the influence of bank credit on asset prices is not statistically significant. Funke (2004) studied the wealth effects from stock prices to private consumption with a panel of 16 emerging countries. According to his results, a 10% decline in stock prices could cause a 0.2–0.4% decline in private consumption. The panel data used by Peltonen et al. (2008) included 14 emerging economies, including China. Confirming the results by Funke, the authors found a significant link from stock prices to consumption. They also found that higher housing prices tend to increase consumption. In China's case, stock prices were found to boost consumption, although the wealth effect was the smallest among the countries: a 10% rise in stock prices increased consumption by 0.12%. Residential prices did not have a significant impact on consumption in China.

3. Data and methodology

As mentioned above, this study is the first attempt to highlight the dynamics of the relationship between monetary policy, asset prices and consumption in China. For this purpose, we employ a structural VAR model with five variables: household income, household consumption, consumer price inflation, an indicator for monetary policy, and asset prices. The research period runs to the end of 2008 but is restrictive in starting as late as 1998 due to the availability of data. Our data source is the CEIC database (data details are in Table A1 in Appendix A). All variables except consumer price inflation are in real terms and in logs. Furthermore, all the time series except stock prices are seasonally adjusted using Tramo Seats. The time series are graphed in Fig. A2.

Household income and consumption are measured as disposable income and living expenditure per capita, respectively.[6] The household data are based on urban household surveys. Although we are restricted to studying the urban areas because of data availability, we assume that the importance of the wealth channel is very limited in the rural areas, due to the presumably very modest shareholdings. Furthermore, the residential market in the countryside is still fairly inactive. Inflation is measured by quarterly changes in the consumer price index.

The selection of a monetary policy indicator is complicated by the fact that there is no consensus on how to measure China's monetary policy stance, mainly because of a plethora of policy tools (see, e.g., Geiger, 2008). While the studies on the advanced economies typically use a policy interest rate as the monetary policy indicator, the role of interest rates in the Chinese economy is known to be very modest (see, e.g., Koivu, 2008; Laurens and Maino, 2007; Mehrotra, 2007).

Even if we decide on a quantitative measure for China's monetary policy we are left with a number of different monetary aggregates. Using base money, which in China's case includes currency in circulation and commercial bank reserves held at the central bank, could obviously be justified by the fact that it is under the direct control of the authorities. However, the frequent changes in commercial banks' reserve requirements have made it difficult to interpret changes in base money. While an increase in base money would otherwise be interpreted as monetary easing, in China's case a rise may simply reflect a hike in the reserve requirement and thus a tightening in the monetary policy stance.

[6] A number of earlier studies on the wealth channel concentrate on the consumption of nondurable goods and services. Unfortunately, we are not able to follow this course since quarterly data on the different consumption categories in China start only from 2002.

M2 seems to capture much of the decision makers' attention. They set annual growth targets for M2 and the People's Bank of China (PBC) closely monitors movements in M2 for its quarterly reports. Furthermore, bank reserves, for which the movements are difficult to interpret, as mentioned above, are excluded from M2.[7] It is of course somewhat questionable to use such a broad monetary aggregate as a monetary policy indicator in light of the possible problems related to the controllability of the aggregate. However, contrary to many advanced economies, we argue that the Chinese officials actually do control M2 because the public sector still holds a majority ownership in all the major banks in China.[8] Moreover, even though the credit quotas were abolished in 1998, the authorities still actively issue direct guidelines regarding banks' operations under the so-called window guidance. The use of a broad monetary aggregate can be justified by the fact that it may comprehensively capture the impacts of these various policy tools on the economy.

We study the behaviour of two different asset markets – housing and stocks. Like many earlier studies, we do not have time series data on household wealth in China and therefore must use asset prices as a proxy for household wealth. As a first proxy, we use the Shanghai A-share Stock Index.[9] Another proxy that we use for household wealth is the residential property price index.

To study the impacts of monetary policy on asset prices and finally on consumption, we estimate a structural vector autoregression (SVAR) model.[10] The VAR model is preferable in our case, where the variables endogenously influence each other. A basic reduced form VAR process is presented as:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t, \tag{2}$$

where $y_t=(y_{1t},\ldots,y_{Kt})$ contains K endogenous variables. The A_i are $K\times K$ coefficient matrices and $u_t=(u_{1t},\ldots,u_{Kt})$ is a K-dimensional process. Errors (u_t) are assumed to be serially uncorrelated. The basic VAR model explains the endogenous variables solely by their history. If we want to model possible contemporaneous relations between the variables, we need a structural form of the VAR:

$$Ay_t = A_1^* y_{t-1} + \ldots + A_p^* y_{t-p} + B\varepsilon_t. \tag{3}$$

The structural errors, ε_t, are assumed to be serially and cross-sectionally uncorrelated. The A_i^* $(i=1,\ldots,p)$ are $K\times K$ coefficient matrices. The relationship between error terms in the reduced and structural forms is the following:

$$u_t = A^{-1}B\varepsilon_t \tag{4}$$

If we write $Au_t=B\varepsilon_t$, we essentially decompose the structural errors (ε_t) into components caused by the unexplained contemporary reduced-form shocks (u_t). Since we want to highlight contemporary relations, we must impose $2K^2-K(K+1)/2$ restrictions on the A and B matrices to be able to exactly identify the system. In our case, where $K=5$, the number of necessary restrictions is 35. We impose the following restrictions (y indicating household income, c household consumption, π inflation, m monetary policy and ap asset prices):

$$\begin{bmatrix} 1 & 0 & * & 0 & 0 \\ * & 1 & * & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ * & * & * & 1 & * \\ * & 0 & * & * & 1 \end{bmatrix} \begin{bmatrix} u_t^y \\ u_t^c \\ u_t^\pi \\ u_t^m \\ u_t^{ap} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix} \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^c \\ \varepsilon_t^\pi \\ \varepsilon_t^m \\ \varepsilon_t^{ap} \end{bmatrix}$$

[7] According to China's national data definition, M0 comprises currency issued by the PBC less the amount held by banking institutions. M1 comprises M0 and demand deposits. M2 comprises M1 and time and savings deposits.

[8] The most important exceptions being the foreign-owned banks and the Minsheng Bank.

[9] In Mainland China, there are two stock markets. The Shanghai Stock Exchange commenced operations at the end of 1990 and the Shenzhen Stock exchange in the following year. The use of data from the Shanghai A-Index is explained by the fact that the Shanghai Stock Exchange has always been the leading market by size. As of end-2008, the capitalisation of the Shanghai Stock Exchange corresponded to 32% and that of Shenzhen to 8% of GDP. Furthermore, the A-shares cover 99% of the capitalisation in the Shanghai Stock Exchange while the B-shares, originally directed at foreign investors, play only a minor role in the market.

[10] A detailed description of the method is available in, e.g., Lütkepohl (2004) and Breitung et al. (2004).

where * indicates a parameter that is freely estimated in the system. Following the earlier literature on wage rigidities (see, e.g., Christiano et al., 2005) and based on the fact that the share of wage income of the total urban income is nearly 75% (see Fig. A1 in Appendix A), household income is presumed to be slow to adjust, which means that it is allowed to react to shocks to consumption, money supply and asset prices only with a lag. However, as nominal wages take some time to adjust, real income is allowed to react immediately to shocks to inflation.

In line with Ludvigson et al. (2002), consumption is allowed to react immediately to shocks to real income and inflation. We assume that asset prices can influence consumption only after a lag of one quarter. This assumption is made because the amount of wealth is measured at the end of the period, while consumption is measured as a flow during the whole period. Along with the general literature on the monetary policy transmission mechanism (see, e.g., Bagliano and Favero, 1998), it is assumed that monetary policy can affect consumption and all the other variables in the model except asset prices only after a lag of one period. We also introduce sticky consumer prices, as is customary in the literature (Calvo, 1983).

It is challenging to construct a monetary policy reaction function for China – in particular because our monetary policy indicator M2 may deviate from the authorities' target in the short run. In the monetary policy literature, it is customary to allow monetary policy to react immediately to shocks in all other variables and we follow suit (see, for example, Bernanke and Blinder, 1992). Although the PBC has argued that it does not target asset prices in its monetary policy, the Chinese authorities, as mentioned above, seem to be keen on guiding developments in the real estate and stock markets, so that it is realistic to allow monetary policy to react to shocks in asset prices immediately as well.

Finally, asset prices are allowed to react to all shocks in the economy without delay, except for shocks to consumption. This assumption is necessary in order to implement a sufficient number of restrictions in the model. As the theoretical background behind this restriction is admittedly weak, we tested the obtained results by optional models where asset prices were allowed to react immediately to shocks in consumption.

4. SVAR estimation

We first test the order of integration of our time series. The results from the Augmented Dickey–Fuller (ADF)[11] and Phillips–Perron[12] unit root tests can be found in Tables A2 and A3 in Appendix A. The number of lags included in the tests was defined by the Akaike information criteria.[13] We included a trend and a constant in tests in levels for all variables other than consumer price inflation. A constant was included in all tests in differences. According to the ADF test, most of the series seem to be integrated of order one.[14] In the case of the Shanghai stock index, we found weak signs at the 5 percent significance level of stationarity even in levels. However, the Phillips–Perron test confirms all our time series (incl. the stock index) to be $I(1)$ variables.

Obviously, continuous structural reforms in the Chinese economy and also changes in the global economy make the existence of break points in the time series possible. By visual inspection, we may expect to find breaks, especially in inflation or stock market data, the stationarity of which we tested with a procedure which allows breaks in the time series and was suggested by Lanne et al. (2002). By using this method we did indeed find several breaks in both time series. However, the number of breaks is such that it is impossible to introduce all of them into our analysis. It is also difficult to sort out any specific date for a break in, for example, the stock exchange, taking into account the gradual nature of China's economic reforms. Furthermore, a recent study by Zhang and Clovis (2009) indicates that the major breaks in the inflation

[11] For the details, see Dickey and Fuller (1979).
[12] For the details, see Phillips and Perron (1988).
[13] For the details, see Akaike (1973, 1974).
[14] When consumption is tested in differences with 11 lags, as suggested by the Akaike information criteria, the null hypothesis of a unit root cannot be rejected. The same applies to residential prices, which were tested in differences with 12 lags. However, the high number of lags may be the reason for these results as it weakens the power of the test. When consumption and inflation were tested with the KPSS test, they were found stationary in their first differences.

dynamics already took place prior to the start of our research period. We decide to continue the estimation process without introducing any breaks into the system at this stage but will return to the question of the stability of the estimation results later on.

Next, we run cointegration tests to find out whether there are any long-run relationships between the variables. The results from the Saikkonen–Lütkepohl[15] and Johansen[16] cointegration tests can be found in Tables A4 and A5 in Appendix A. As above, the number of lags is decided on the basis of the Akaike information criteria, and we introduced a trend and a constant in all our tests. We clearly found signs of cointegration vectors. However, the number of vectors is highly dependent on the cointegration test. The reliability of the cointegration test results can be weak due to the shortness of the time series. It is also difficult to determine the exact number of cointegrating vectors in our model because we have no strong theoretical reasons to prefer a specific number of long-run vectors in the system. We thus continue to run VARs in levels without restricting the number of cointegrating vectors. According to Lütkepohl (2004), this practice does not lead to a misinterpretation of asymptotic properties of results as long as at least two lags are allowed. This procedure has also been followed by, e.g., Bagliano and Favero (1998).

We run separate models either with the stock market index or with residential prices and include a constant and a trend in both estimations. The chosen number of lags is two in both systems, based on the misspecification tests.[17] Also based on the results from the misspecification tests, we include an impulse dummy in our estimations for the last quarter of 2003, when the consumer price inflation rate experienced a one-time rise, mainly due to food prices, which can be considered exogenous to our model. The dummy is found statistically significant in both estimations.

We test the models for possible autocorrelation of residuals by using the Portmanteau and LM tests and also use the Jarque–Bera test for non-normality and ARCH-LM tests to find possible ARCH effects in the residuals. Neither of the models seems to have any major problems in passing most of the misspecification tests (see Tables A6 and A7 in Appendix A). In the model with stock prices, there is some indication of autocorrelation of residuals according to the Portmanteau test, but the result is significant only at the 10% level. In addition, the results from the LM test on the existence of residual autocorrelation in shorter lags do not signal problems in the system. In the model with residential prices, there are no signs of autocorrelation. However, the residuals from the income equation strongly indicate nonnormality. A closer look at the test results reveals that the failure of the normality test is due to kurtosis rather than excess skewness. According to Juselius (2006), VAR estimates are more sensitive to deviations from normality due to skewness than to kurtosis, and therefore we continue to report the results.

As we noticed above, China is a transition economy in which monetary policy and asset markets have been in a process of continuous reforms during the research period and it is thus important to test the stability of the models. According to our results from Chow break point and sample split tests, using bootstrapped *p*-values, there do not seem to be any problems in this respect as the test does not find any signs of a break point at 5% significance level. However, the test results have to be treated cautiously, as the short sample period obviously limits the possibilities for conducting break tests and reduces their efficiency. Unfortunately, we can run the CUSUM tests only if we exclude the dummy variable from the estimation. However, as the dummy is highly significant in both models, we are reluctant to leave it out of the final models.[18]

Because the matrix coefficients of the VAR analysis are difficult to interpret as such, we take a closer look at the dynamics of the system and report the impulse response functions. The resulting impulse responses of each variable to a shock of one standard deviation in each of the other

[15] For details, see Saikkonen and Lütkepohl (2000a,b,c).
[16] For details, see Johansen (1995).
[17] Due to our short sample we run out of degrees of freedom and cannot pass the misspecification tests if we introduce four lags as is typically done when using quarterly data.
[18] When we run the model without the impulse dummy for 4Q2003, the CUSUM test could not find any sign of instability at 5% significance level.

variables are reported in Figs. A3 and A4 in Appendix A. The responses are reported for 20 quarters using 1000 bootstrapping replications. The significance of the results can be interpreted based on the reported 95% Hall bootstrapped percentile confidence intervals.

Most of our results are as expected and remain unchanged in the two specifications. For example, a positive shock in income increases consumption, the result being strongly significant. In addition, the monetary policy reaction function seems reasonable. The central bank reduces the money supply in response to a positive shock in consumer price inflation. The money supply is also reduced after a rise in real income or consumption. However, in this regard we can find some differences between the two specifications: while in the model with stock prices the link from income and consumption to money supply remains negative although not statistically significant, in the specification with residential prices the originally negative reaction of money supply later turns positive. Another major difference in the results from the two specifications is related to the impulse response function of income in the aftermath of a positive shock to consumption. In the specification with stock prices, income is affected positively, even though the result is only borderline significant. In the model with residential prices, the reaction turns negative and is also significant after a lag of nearly two years. Unfortunately, we cannot find any robust explanation for the slightly different results from the two specifications. Taking into account China's nature as a transition economy and the often criticized quality of the Chinese data (see, for example, IMF, 2010), we can, however, be confident in noticing that most of the results from the two models are very similar.

Coming back to the monetary policy reaction function, we find that the money supply is reduced after a positive shock in either stock or residential prices. This indicates that the Chinese authorities also take into account asset price developments when deciding upon monetary policy. This result is somewhat contrary to the findings by Baharumshah et al. (2009), who found the short-run impact of stock prices on the broad money (M2) to be either mixed or slightly positive. The difference between the results is probably explained by the different research periods. The study by Baharumshah et al. (2009) uses data starting already in 1990, when the role of stock markets in China was still miniscule, while our data starts only in 1998. It could thus be that the increased significance of the stock markets in the economy has also forced the authorities to pay more attention to market developments. Regarding the effectiveness of monetary policy, our study confirms the positive link from money supply to consumer price inflation which has been found in the earlier papers on China's monetary policy (see, for example, Koivu et al., 2009; Laurens and Maino, 2007).

As expected, a positive shock to income increases stock prices in China. Somewhat surprisingly, the impact of an increase in income on residential prices is negative and significant after a lag. We assume that this is related to the supply of new apartments in the market. Fast economic growth leading to a positive shock in household income is often related to a construction boom in China which, after a lag, leads to an increase in housing supply and hence lower prices. Overall, the impact is rather small. The immediate impact of a consumption shock is negative for both stock and residential prices, reflecting households choosing to increase consumption instead of investing in stock markets or buying an apartment.

Next, we turn to analysing the wealth channel in China. Regarding the first part of the channel, the impulse response analysis indeed finds a link from monetary policy to asset prices. As expected, Chinese share prices react quickly and positively to an increase in liquidity. The size of the impact reflects the high volatility of China's stock markets. A 1% shock to M2 supply would imply about a 10% rise in the Shanghai A-Index. This reaction is statistically significant for about one year but reflects some sort of overshooting, as later on the impact of M2 on stock prices turns negative. The positive reaction of residential prices to a monetary policy shock is slower and also smaller than the reaction of stock prices, as expected. However, the positive impact lasts longer than the reaction of stock prices to a shock to the money supply.

The results for the second part of the wealth channel – the link from asset price developments to household consumption – are somewhat less clear. A positive shock in stock prices does indeed lead to an increase in household consumption, but the result is not statistically highly significant. The positive reaction of consumption to a shock to residential prices takes longer to realise.

Actually, the initial reaction of consumption to a rise in housing prices is negative. Only after a lag of almost two years does the reaction turn positive and statistically significant.

These results reflect the relatively small role that asset markets still play in household income and consumption in China at the aggregate level. Although the popularity of investing in stocks has increased over the years, the volume of investment in stocks is still small compared to bank deposits. Another reason for the rather weak link from stock prices to consumption may be the high volatility of China's stock market. As Lettau and Ludvigson (2004) showed, a temporary increase in wealth may have only a minor impact on consumption.

The result that residential prices first have a negative impact on household consumption is probably related to the fact that higher prices force some households to save even larger shares of their income in order to be able to buy an apartment. Probably only a few households are in the position to sell an apartment and thus benefit from higher prices.

Our result concerning the link from stock prices to consumption is in line with that of Peltonen et al. (2008). However, the findings regarding the impact of residential prices on consumption vary significantly between the two studies. A probable explanation for the different results is the data. A visual inspection of the data used by Peltonen et al. (2008) reveals that the annual changes in the price series that they use (residential property price index) are mainly negative during the last ten years. According to our data, price developments in the housing market have been mainly positive.

Finally, we find that the direct link from monetary policy to household consumption is weak in both of our specifications.[19] Although the first reaction of consumption to a loosening of monetary policy is positive, as expected, the result is not statistically significant. After a lag of about half a year, the impact turns negative. The weak link from monetary policy to household consumption can be explained by the fact that households are net savers and that household credit[20] only amounted to around 20% of GDP at the end of 2008. For example, the size of the mortgage market was very small during the early years of the period studied.[21] Our findings are supported by earlier studies. For example, Zhang and Wan (2002) found the direct link from monetary policy to household consumption in China to be weak.

As a robustness check, we estimated another set of impulse response functions stemming from a slightly different identification scheme. We now allow asset prices to react immediately to a shock in consumption, but in turn the monetary authorities are allowed to react to a shock in asset prices only after a lag of one period. Most of the results remain unchanged from the benchmark model. The biggest difference in the results concerns the reaction of asset prices to a monetary policy shock. The immediate positive reaction of the stock index to an increase in money supply now turns statistically insignificant and the impact of stock prices on consumption becomes less positive. On the other hand, the positive link from money supply to residential prices now becomes stronger than in the benchmark model and the result on the positive link from housing prices to consumption is confirmed. The robustness test thus tends to push our results in a direction where the role of residential prices in the Chinese economy appears more robust than the role of stock prices.

Our result that a monetary policy loosening increases asset prices – which are, at least to some extent, linked to higher consumption – need not imply that the wealth channel actually functions in the Chinese economy. In order to test the existence of the channel we need to explore whether changes in asset prices that are due to monetary policy have a significant impact on household consumption. For this purpose, we use the method by Ludvigson et al. (2002) and shut down the wealth channel by

[19] To further test the role of the monetary policy in the Chinese economy, we ran the same estimations by replacing M2 by the real deposit rate. Given households' high savings rate and the limited investment options outside bank deposits, the real deposit rate should be a relevant policy variable from the households' point of view. The authorities set a ceiling on deposit interest rates in China which can be exceeded by a maximum 10%. However, on top of the fact that the estimation had problems in passing some misspecification tests, the interest rate did not have a statistically significant impact on household income or consumption.

[20] Total of household business loans and consumer loans (incl. mortgages and car loans).

[21] The amount of mortgage loans rose from less than 0.2% of GDP at the end of 1997 to 3.4% of GDP already by the end of 2000. By the end of 2008, the ratio had risen to around 10%.

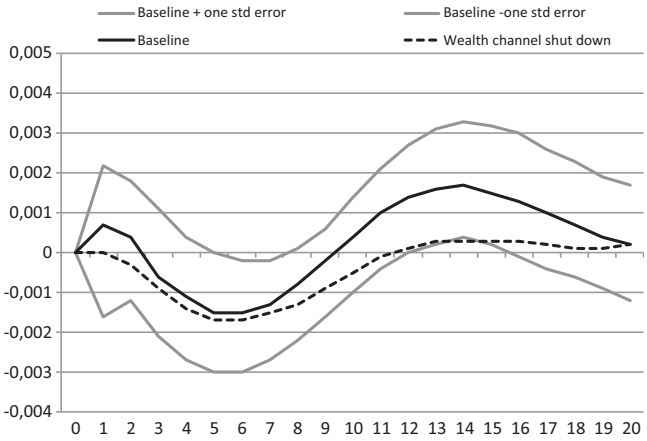

Fig. 2. Response of consumption to a shock to money supply via residential prices.

restricting both the contemporaneous and lagged effects from asset prices to consumption to zero. Then we compare the impulse responses of consumption to a monetary policy loosening as between the two cases where the wealth channel is allowed or not allowed to function. If the wealth channel were functioning, there would be a clear difference between the two impulse responses.

In the case of China, however, we see only a slight difference between the two responses. It seems that when the wealth channel is not allowed to operate, the late positive impact of monetary policy on household consumption is nil in the specification with residential prices (see Fig. 2). It therefore seems that the wealth channel does work in the right direction in the Chinese economy, but only to a very limited extent, as the difference between the two impulse responses is rather marginal. In addition, we could not find any evidence of a wealth channel functioning via the stock market in China. We thus conclude that the wealth channel does not function via the stock market and is weak via the housing market in China.

5. Conclusions

This paper aims to increase the understanding of the monetary policy transmission mechanism in China. In particular, we have tried to answer the question whether monetary policy influences household consumption via an impact on household wealth. Links through both the housing and stock markets are explored.

This is the first attempt to study the wealth channel in China although the question is highly relevant from the policy perspective, as for efficient decision making it is fundamental to have a deep knowledge of the monetary policy transmission mechanism in the economy. Taking into account the specific characteristics of the Chinese economy, for example the gradual reforms in the financial sector, it is not possible to rely on earlier findings on the advanced economies when making conclusions concerning the transmission mechanism in China. On the other hand, taking into account China's position as the world's largest emerging economy, the results using the Chinese data may have some implications for other emerging countries with similar economic structures.

In this study, we explore how important the impact of monetary policy on asset prices is from the point of view of household consumption. We analyse the wealth channel by using a structural VAR model and data for 1998–2008. According to the results, a loosening of monetary policy does indeed lead to higher asset prices in China. Furthermore, urban households' consumption reacts positively to a rise in either residential or stock prices, although the effects concerning the stock prices are weak. Finally, we test the existence of the wealth channel more formally to find out whether those changes in asset prices that are caused by monetary policy are significant enough to increase consumption. The

wealth channel is found to be very weak and functional only via the residential prices. There is no evidence at all of a wealth channel via the stock prices.

This outcome is not surprising when taking into account that even in the advanced economies the importance of the wealth channel has been estimated to be rather small (Ludvigson et al., 2002). Furthermore, as mentioned above, the share of property income of household income is still small in China and the volatility and unpredictability of the Chinese stock markets probably reduces the impact of stock prices on households' behaviour (Lettau and Ludvigson, 2004; Ludvigson et al., 2002). Higher housing prices may even encourage some households to increase their saving in order to be able to afford an apartment, and only a small proportion of households may be in the position to sell an apartment and thus benefit from higher residential property prices.

From the point of view of monetary policy, the conclusion from this paper is that the monetary authorities cannot rely on the wealth channel when estimating the impacts of monetary policy on household consumption. However, our finding that monetary policy does have a significant impact on asset prices may have important implications if the wealth channel exists in other parts of the Chinese economy. For example, fixed asset investment – which covers nearly half of China's GDP – may follow asset prices closely, which could also mean that the wealth channel would work in this regard. For future work, it would be essential to explore what kinds of links exist between monetary policy, asset prices and fixed asset investment in China.

This further illumination would also be important from the point of view of the recent economic developments in China. The country announced a vast stimulus package in autumn 2008 to keep the economy on a stable growth path in the aftermath of the international financial crisis. As part of the stimulus policies, the monetary policy stance was dramatically loosened and in fact the majority of the stimulus policies and related investment projects were financed by bank credit. As a result, Chinese banks' credit stock at the end of 2009 was 30% larger than a year earlier. Naturally, such a pronounced economic stimulus raised questions about negative side effects. In particular, the rapid recovery of the Chinese stock markets in the summer of 2009 was connected to the rapid credit growth, and later on the Chinese authorities became concerned about price increases in the real estate market.[22] Even though these recent events are not part of the data set used in this study, our analysis confirms that monetary policy can cause substantial movements in asset prices. Thus, if future work can find that these movements in asset prices do have an impact on, for example, fixed asset investment developments, the wealth channel has to be taken carefully into account when deciding upon monetary policy in China.

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[22] For example, China raised the minimum down payment on a second house to 40% and tightened land-sale regulations for developers, e.g. by introducing the first nationwide minimum down payment on land purchases in December 2009. At the same time, tax regulations on capital gains on house sales were tightened. Since then a number of other regulatory changes have been implemented in order to cool off price increases in the housing market.

Appendix A

Table A1
Data sources and definitions.

Variable	Definition		Source
Y	Disposable income per capita: urban households in 36 cities	Monthly data for 1998–2006 accumulated to quarterly level, deflated by CPI, seasonally adjusted with Tramo Seats and in logs	CEIC
C	Urban household living expenditure per capita in 36 cities	Monthly data for 1998–2006 accumulated to quarterly level, deflated by CPI, seasonally adjusted with Tramo Seats and in logs	CEIC
π	Inflation	Quarterly changes in seasonal CPI constructed by the author from month-on-month and 12-month inflation rates	CEIC
A	Asset prices	(i) Shanghai A-Share Stock Index, end of period, deflated by CPI and in logs. (ii) Residential price index constructed by the author from year-on-year changes, seasonally adjusted with Tramo Seats, deflated by CPI and in logs	CEIC
M2	Monetary policy indicator	M2 deflated by CPI, seasonally adjusted with Tramo Seats and in logs	CEIC

Table A2
Augmented Dickey–Fuller unit root test for 1998–2008.

Series	Det. term	Lags	Test stat.
C	c, t	12	−1.25
dC	c	11	−1.55
Y	c, t	0	−2.59
dY	c	0	−8.20***
M2	c, t	0	−1.82
dM2	c	0	−6.04***
π	c	9	−1.36
dπ	c	10	−3.55***
Shanghai	c, t	3	−3.48**
dShanghai	c	0	−4.64***
Resid. prices	c, t	12	−2.29
d Resid. prices	c	12	−1.00

c indicates a constant and t a trend. Maximum number of lags is 12. The number of lags is specified according to the Akaike information criterion.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Table A3
Phillips Perron unit root test for 1998–2008.

Series	Det. term	Bandwidth	Test stat.
C	c, t	4	−1.79
dC	c	4	−7.30***
Y	c, t	0	−2.60
dY	c	11	−9.53***
M2	c, t	3	−1.61
dM2	c	3	−6.66***
π	c	3	−2.80*
dπ	c	2	−8.21***
Shanghai	c, t	4	−2.17
dShanghai	c	3	−4.75***

Table A3 (*Continued*)

Series	Det. term	Bandwidth	Test stat.
Resid. prices	*c*, *t*	4	−1.71
d Resid. prices	*c*	4	−4.20***

c indicates a constant and *t* a trend. The estimation method is Bartlett Kernel, bandwidth selected by the Newey–West method.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Table A4
Saikkonen–Lütkepohl cointegration test.

Series	Det. term	Lags	Cointegration rank	Test statistic
Y, C, M2, π, Shanghai	*c*, *t*	6	0	75.19***
			1	44.11*
			2	18.45
			3	4.77
			4	0.67
Y, c, M2, π, Resid. prices	*c*, *t*	6	0	82.99***
			1	48.77**
			2	23.96
			3	12.40
			4	2.61

c indicates a constant and *t* a trend. Maximum number of lags is 6. The number of lags is specified according to the Akaike information criterion.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Table A5
Johansen cointegration test.

Series	Det. term	Lags	Cointegration rank	Test statistic
Y, C, M2, π, Shanghai	*c*, *t*	6	0	298.78***
			1	141.19***
			2	82.01***
			3	31.51***
			4	9.76
Y, C, M2, π, Resid. prices	*c*, *t*	6	0	375.79***
			1	235.19***
			2	97.55***
			3	42.45***
			4	5.62

c indicates a constant and *t* a trend. Maximum number of lags is 6. The number of lags is specified according to the Akaike information criterion.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Table A6
Misspecification tests on baseline model with Shanghai A-Index.

Test	Test statistics	*p*-Value
Portmanteau test for autocorrelation[a], 16 lags	388.21	.08*
LMF test for autocorrelation[b]		
4 lags	1.51	.10
1 lags	1.30	.19

Table A6 (*Continued*)

Test	Test statistics	*p*-Value
Jarque–Bera test for nonnormality for five system equations	4.00	.13
	0.73	.69
	2.47	.29
	1.75	.42
	4.78	.09*
ARCH LM test for autoregressive conditional heteroskedasticity,	17.46	.36
16 lags, for five system equations	18.10	.32
	17.74	.34
	14.22	.58
	7.42	.96

[a] Adjusted test statistic.
[b] LMF statistic.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Table A7
Misspecification tests on baseline model with residential prices.

Test	Test statistics	*p*-Value
Portmanteau test for autocorrelation[a], 16 lags	371.39	.21
LMF test for autocorrelation[b]		
4 lags	1.29	.22
1 lags	0.98	.50
Jarque–Bera test for nonnormality for five system equations	13.87	.00***
	0.36	.83
	3.92	.14
	0.56	.75
	0.22	.90
ARCH LM test for autoregressive conditional heteroskedasticity,	12.71	.69
16 lags, for five system equations	14.22	.58
	14.29	.58
	17.52	.35
	8.86	.92

[a] Adjusted test statistic.
[b] LMF statistic.
* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

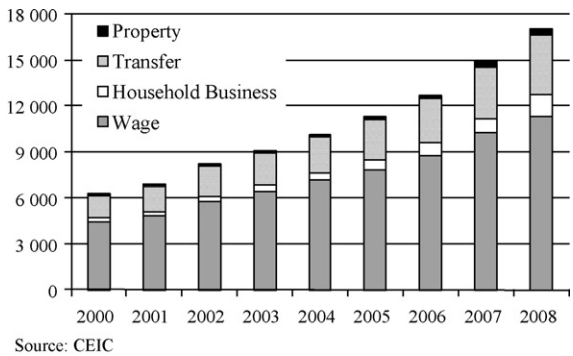

Fig. A1. Urban household income by category in China, RMB.

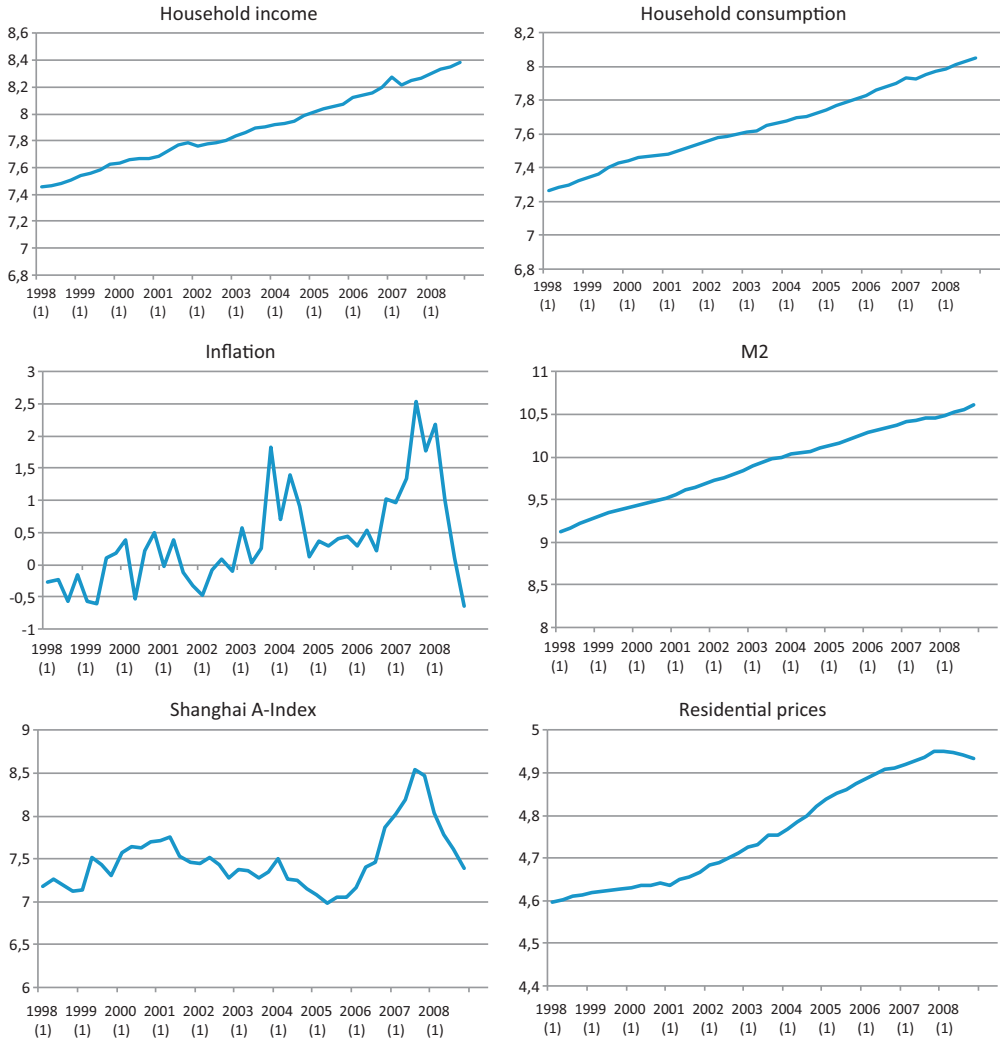

Fig. A2. The time series used in VAR estimation.

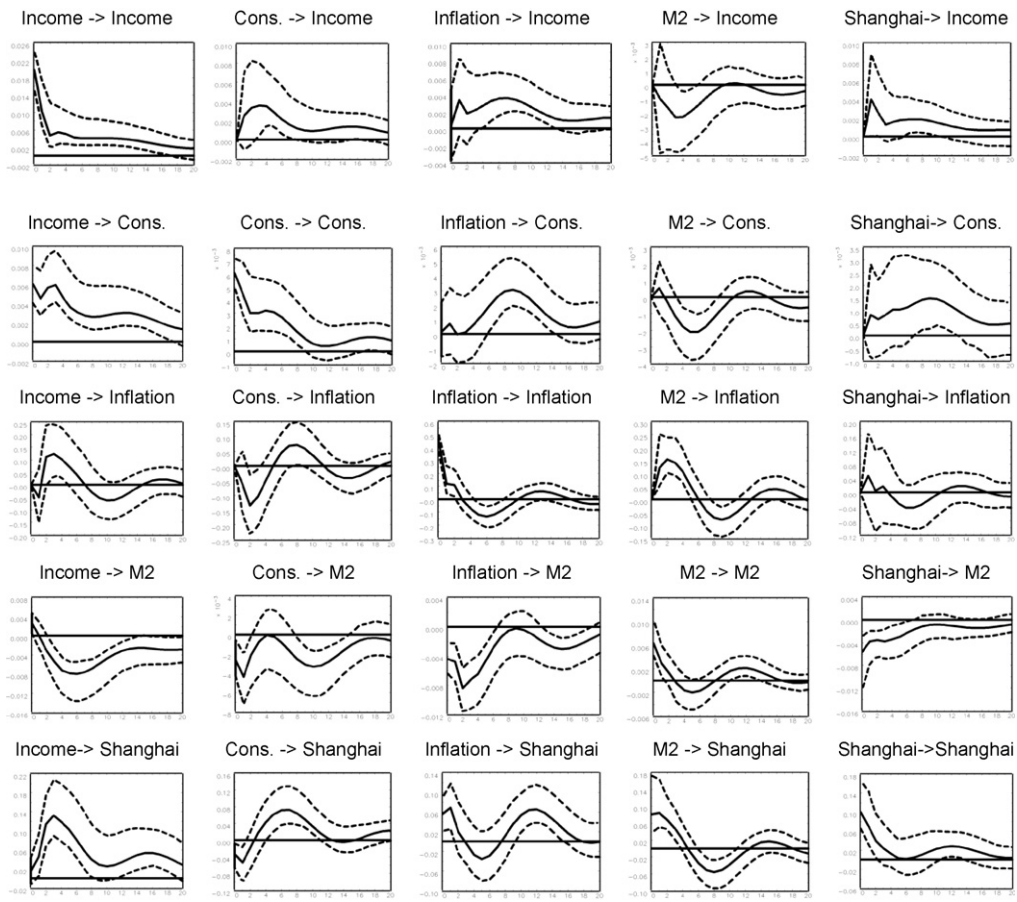

Fig. A3. Impulse response analysis with Shanghai A-Index.

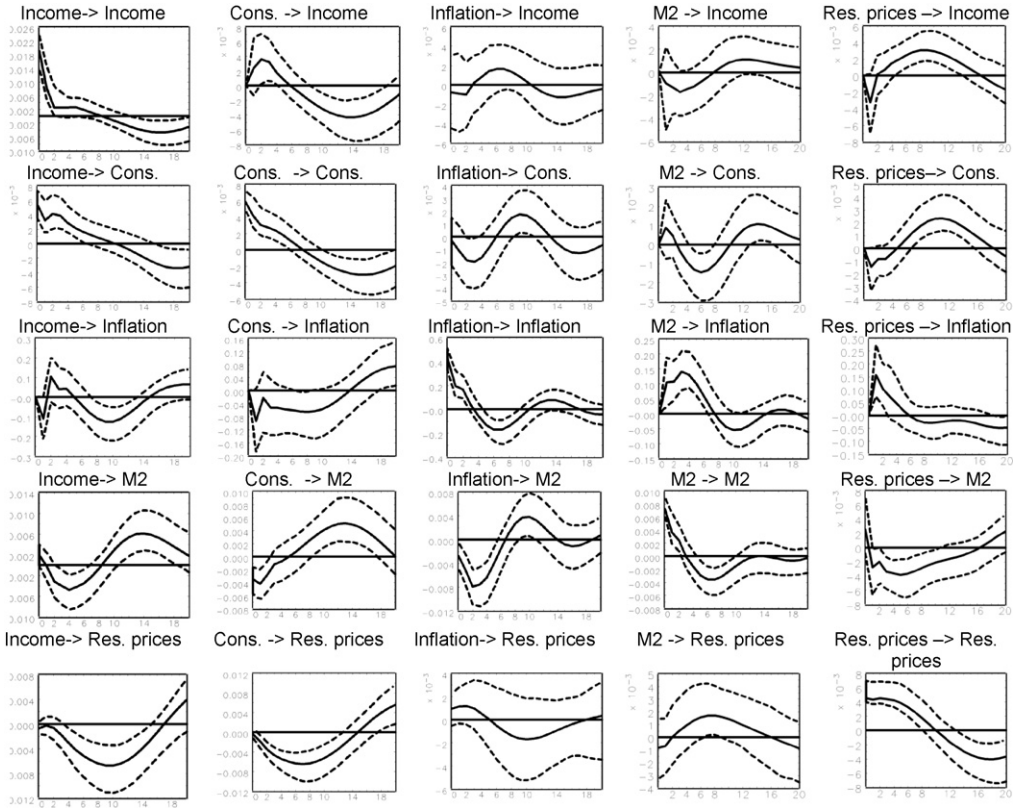

Fig. A4. Impulse response analysis with residential prices.

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Chapter 4

China's exchange rate policy and Asian trade

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China's exchange rate policy and Asian trade

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Abstract. This paper shows empirically that China's trade balance is sensitive to fluctuations in the Renminbi real effective exchange rate. However, the current size of the trade surplus is such that exchange rate policy, alone, will probably not be able to address the imbalance. The reduction in the trade surplus is limited mainly because Chinese imports do not react as expected to exchange rate appreciation. In fact, they tend to fall rather than increase. By estimating bilateral import equations for China and its major trading partners, we find that such reaction of imports to exchange rate appreciation is generally confirmed for South-East Asian countries but not for others. This might be a direct consequence of Asia's vertical integration as a large share of Chinese imports from Southeast Asia is directed to re-exporting.

JEL Classification: F1; F14.
Keywords: China; Trade; Exports; Real Exchange Rate.

Résumé. Cet article montre empiriquement que l'équilibre commercial de la Chine est sensible aux fluctuations du taux de change effectif réel du renminbi. Cependant, l'excédent commercial actuel est tel que la seule politique de change ne suffira pas à résorber ce déséquilibre. La réduction du surplus commercial est limitée en grande partie car les importations chinoises ne réagissent pas à l'appréciation du taux de change comme l'on pourrait s'y attendre. En réalité, les importations ont tendance à chuter et non à croître. L'estimation d'équations d'importations bilatérales entre la Chine et ses principaux partenaires commerciaux montre que cette réaction des importations à l'appréciation du taux de change se confirme pour les pays de l'Asie du sud-est mais pas pour les autres. Ceci serait l'illustration directe de l'intégration verticale des échanges en Asie, où une part élevée des importations de la Chine en provenance de l'Asie du sud-est est ensuite réexportée.

Classification *JEL* : F1 ; F14.
Mots-clefs : Chine ; commerce ; exportations ; taux de change réel.

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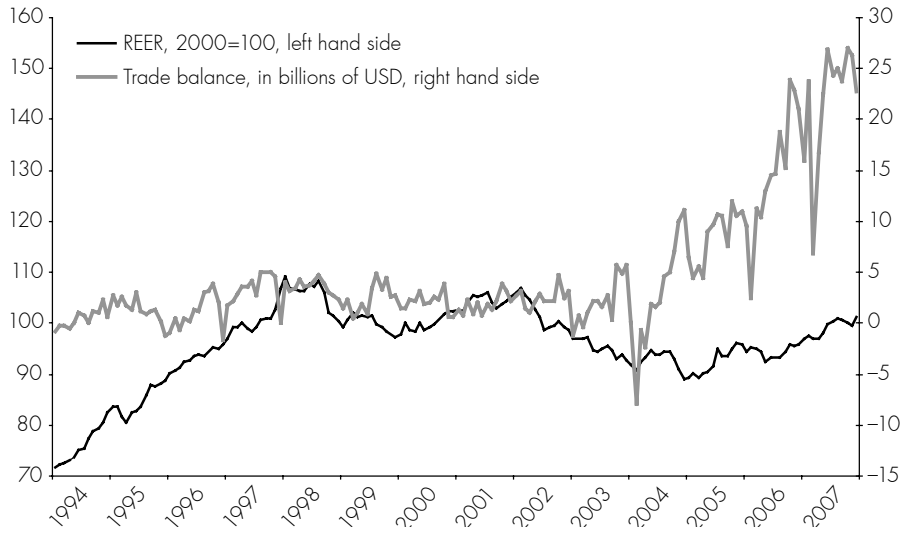
1. Introduction

China's share in world trade has increased extremely fast during the last years. In fact, it is already one of the largest exporters in the world, together with Germany and the US.[2]

China's trade was very much in balance until rather recently. According to China's customs statistics, trade surplus amounted to mere 32 billion US dollars (or 1.7 % of GDP) in 2004 (GRAPH 1). However, in 2005-2007 the trade surplus ballooned: it reached nearly 180 billion US dollars in 2006 (close to 7 % of China's GDP) and increased further in 2007.[3] In fact, the current account surplus amounted to over 10% of GDP in 2007.

On the one hand, there has been the impression that Chinese policy makers are maintaining an undervalued exchange rate so as to profit from external demand and achieve a much needed high growth rate. On the other hand, there have been doubts that the exchange rate can be an effective tool in reducing the trade surplus, as China is an economy in transition where prices may still play a limited role in supply and demand decisions.

Graph 1 - China's trade balance and real effective exchange rate, monthly figures



Source: China's customs statistics, CEIC Data Company (CEIC), International Finance Corporation (IFC).

2. According to the Direction of Trade Statistics (March 2007), China's share of world's total imports was already higher than the shares of Germany or the US. However, according to the countries' own statistics, the value of exports from Germany and the US are still higher than the value of the Chinese exports.

3. China's balance of payments trade statistics generally show slightly larger trade surpluses than the customs statistics. According to the balance of payments, the trade surplus in 2006 amounted to 218 billion US dollars or more than 8% of GDP.

Linked to the first argument, China is facing a strong pressure from industrial countries to appreciate the Renminbi. In fact, the real effective exchange rate (REER) experienced a very steep appreciation from 1994 until end-1997 but tended to depreciate since then until the move to a more flexible exchange rate regime was announced in July 2005. Thereafter the Renminbi has appreciated in real effective terms.

The large size of China's trade surplus makes the issue important not only for China but also for the rest of the world. Notwithstanding the general interest in the issue, the existing literature is not conclusive. The lack of appropriate data and long time-series has discouraged research on the link between the Renminbi exchange rate and China's trade. Since the summer of 2003, when discussions on the Renminbi undervaluation came to the forefront, research on China's exchange rate policy has blossomed but much of it has focused on estimating the long-run equilibrium exchange rate for China or exploring what kind of exchange rate regime best suits the Chinese economy. While both questions are clearly relevant, the most urgent issue – given the size of global imbalances – is whether China should let its currency appreciate as a tool to reduce its huge trade surplus.

Our paper analyzes empirically this question using cointegration analysis and data for the period 1994-2005. According to our results, a Renminbi real appreciation would reduce China's trade surplus in the long run but the effect would be limited. The relatively small impact – compared to the size of the imbalance – is mainly explained by the peculiar price elasticity we find for imports: namely, Chinese imports are negatively affected by Renminbi's real appreciation. By estimating bilateral import equations, we find that the imports from other Asian countries tend to fall but not the others. This apparently counterintuitive result might well be explained by the particular nature of intraregional trade in Asia, namely that of vertical integration. In fact, Chinese imports from the rest of Southeast Asia are mostly geared towards re-exporting. In addition, we show evidence that the Asian countries do not seem able to compensate the reduction in their exports to China by increasing exports to other countries as their total exports are generally negatively affected by Renminbi's appreciation. In other words, exports from South East Asian countries seem to be more complementary than a substitute to those of China.

The rest of the paper is organized as follows. Section 2 reviews the existing literature. Section 3 describes the methodology and the data used. Section 4 presents the results on how China's exports and imports react to changes in the exchange rate and demand. In Section 5, we try to dig deeper into the issue why Chinese imports do not get a boost from Renminbi's appreciation by estimating bilateral trade equations with its main trade partners and then by analysing selected Asian countries' export equations. Section 6 concludes.

2. Literature review

The existing literature on the impact of a Renminbi real appreciation on China's trade may be divided into two groups according to the policy implications. The first strand – and largest – shows evidence that a Renminbi's real exchange appreciation reduces the trade balance, either through exports or imports or both. The second strand either finds no significant impact on the trade balance or even a positive one. Table 1 summarizes the existing literature as well as the methodology used.

Within the first strand, Cerra and Dayal-Gulati (1999) estimate the price elasticities of China's exports and imports for the period 1983-1997 with an error correction model and find them to be negative and significant for exports (–0.3) and positive and significant for imports (0.7). In addition, they show that both elasticities increase over time. Dees (2001) improves on the previous analysis by separating China's exports and imports into two categories, those processed (i.e., imports of components for assembly) and ordinary ones. He finds that, in the long term, exchange rate appreciation decreases exports. He also reports that ordinary exports are more price sensitive than processing exports and imports for processing slightly increase in a case of a Renminbi appreciation. Bénassy-Quéré and Lahrèche-Révil (2003) simulate the impact of a 10 per cent Renminbi real depreciation and report an increase in China's exports to the OECD countries and a reduction of China's imports from emerging Asia if their exchange rates remained unchanged. Kamada and Takagawa (2005) do some model simulations to calculate the effects of China's exchange rate reform. They show that a 10 per cent revaluation would boost Chinese imports slightly while the impact on China's exports would be tiny. These four papers thus find exports to be affected negatively and imports positively by a Renminbi appreciation. All of these studies use data prior to China's WTO membership.

A few more papers using the data practically prior to the WTO membership concentrate on studying solely the Chinese exports. Yue and Hua (2002) and Eckaus (2004) both confirm the earlier result that a a real exchange rate appreciation reduces China's exports. As Cerra and Dayal-Guyati, but with more recent data, Yue and Hua show that Chinese exports are becoming more price-sensitive. Voon, Guangzhong and Ran (2006) use sectoral data for 1978-1998 and incorporate the degree of overvaluation of the Renminbi when estimating China's export equations; they also find a negative link between appreciation and China's exports.

The papers using more recent data support the earlier results on exports' negative exchange rate elasticity but challenged the result that a Renminbi appreciation would increase imports to China. Lau, Mo and Li (2004) estimate China's exports to and imports from the G-3 using quarterly data. In the long-run, an appreciation of the real effective exchange rate is found significant in lowering exports. Instead, neither ordinary imports nor imports for processing seem to be affected by the REER. In any event, the results are difficult to interpret since it is not clear how they discount exports and imports and the number of observations is small. Thorbecke (2006) uses a gravity model to study the effect of exchange rate

changes on triangular trading patterns in Asia. To that end, he disaggregates exports into intermediate, capital and final goods. His results indicate that a 10 per cent Renminbi appreciation reduces Chinese final exports by nearly 13%. However, the appreciation would not significantly affect Chinese imports from the US. Finally, Shu and Yip (2006) estimate the impact of exchange rate movements on the Chinese economy as a whole and find that an appreciation can reduce exports due to an expenditure-switching effect, resulting in a moderate contraction in aggregate demand.

While the earlier papers have come to a conclusion that a Renminbi appreciation would lead to a decline in China's trade surplus mainly *via* its negative impact on the Chinese exports, some other papers offer a somewhat different view on how exchange rate policy may affect China's trade surplus. For example, Jin (2003) estimates the relationship among real interest rates, real exchange rates and China's balance of payments and concludes that a real appreciation tends actually to increase the surplus of the balance of payments. Cerra and Saxena (2003) use sectoral data to study the behaviour of Chinese exporters and find that higher export prices have increased the supply of exports, particularly in recent years. The impact of nominal exchange rate on exports is not robust. In any event, their results – as any other with sectoral data – should be taken with care since only about half of Chinese exports are covered in the sectoral data and no quality adjustment is reported in the unit price series.

One of the most recent attempts to estimate Chinese import and export equations is that of Marquez and Schindler (2006). They use shares of world total trade instead of import and export volumes to avoid employing proxies for China's export and import prices. According to their results, the real appreciation of the Renminbi not only affects China's export share negatively but also the import share, at least for ordinary trade. While interesting, estimated impacts are on import and export shares so that no inference can be made on the trade account. In addition, no cointegration techniques are used so that only short-run elasticities can be estimated.

As a short summary, a clear majority of earlier studies have found that a real appreciation of exchange rate reduces Chinese exports. The result is robust to changes in research method, time period and data coverage. However, the results on Chinese imports' exchange rate elasticity are much more ambiguous. While the earlier studies found an appreciation to increase Chinese imports, the more recent studies have ended up with very different finding. Overall, no clear conclusions about the impacts of a Renminbi revaluation on China's trade balance can be made based on the earlier studies.

In this paper we look at the impact of the real exchange rate on China's trade with more recent data. In addition, cointegration techniques are used in order to focus on longer-term structural developments. We also expand the analysis from aggregate import and export equations to bilateral ones so as to investigate whether large differences exist among China's trade partners. This is particularly important for the rest of Asia, as we shall show later.

Table 1 - Earlier literature

Authors	Data	Methodology	Impact of REER on exports/imports	Estimated price elasticities	Impact of demand	Other control variables
Bénassy-Quéré and Lahrèche-Révil, 2003	Yearly 1984-2001	Gravity model	A Renminbi real depreciation increases China's exports to the OECD and reduces Asian exports to China.	–1.2 (exports)	-	-
Cerra and Dayal-Gulati, 1999	Quarterly, 1983-1997	Error Correction Model	No effect on exports/imports for 1983-97. For 1988 to 1997, negative and significant impact on exports and positive and significant on imports.	–0.3 (exports) 0.7 (imports)	Significant and positive for 1988-1997 period	FDI, industrial production, output gap
Cerra and Saxena, 2003	Quarterly sectoral data, 1985-2001	Dynamic OLS	Price elasticity of exports increases towards end of period. NEER does not have a robust significant impact and industry-level results mixed.	1985-2001: –1.0 1994-2001: 3.8 (export supply)	-	Domestic credit
Dees, 2001	Monthly, 1994-1999	Error Correction Model	Appreciation decreases exports. Effect stronger on ordinary exports than on processed ones. No significant effect on ordinary imports but appreciation slightly increases processed imports.	–0.3 (exports) 0.2 (imports for processing)	Positive and significant for exports and imports	Simulation of a shock to the economy gives the same results
Eckaus, 2004	Yearly, 1985-2002	OLS	Negative and significant effect on exports to the U.S. and China's share of U.S. imports.	–0.3 (exports to the U.S)	Positive and significant effect	
Kamada and Takagawa, 2005	Monthly, 1994-2000	Theoretical model and OLS estimation	Revaluation causes a one-time import boost in the model but OLS shows no significant effect.	-	-	-

Table 1 - continued

Authors	Data	Methodology	Impact of REER on exports/imports	Estimated price elasticities	Impact of demand	Other control variables
Lau, Mo and Li, 2004	Quarterly, 1995-2003	Dynamic OLS	Negative and significant effect on exports and imports for processing. No significant effect on ordinary imports.	–1.47 (exports) –1.28 (imports for processing)	Positive effect on exports	FDI, VAT tax rebates and exports
Marquez and Schindler, 2006	Monthly, 1/1997-2/2004	OLS, studies effect on China's market share in world exports and imports	An appreciation lowers ordinary imports but for processed imports effect not robust. Effect on exports also not robust.	10% appreciation reduces China's export share by 0.5% and the import share by 0.1%	Positive for imports but not robust for exports	FDI
Shu and Yip, 2006	Quarterly, 1995-2006	Error Correction Model	Appreciation reduces exports.	–1.3 (exports)	Positive and significant	Market share
Thorbecke, 2006	Annual, 1982-2003	Gravity model, Error Correction Model, OLS	In gravity model, an appreciation decreases China's exports. In VEC and OLS, exports to the U.S. decrease in a case of appreciation. No significant coefficient for imports. When studying US-China trade in a gravity model, no clear outcome.	–1.3 (exports)	Positive and significant for exports. Income elasticity for imports no robust	Distances and common language in gravity models
Voon, Guangzhong and Ran, 2006	Annual, sectoral data 1978-1998	OLS	Negative impact of an appreciation on exports.	-	Positive and significant for exports	Exchange rate volatility and misalignment
Yue and Hua, 2003	Annual, provincial 1980-2000	OLS, TSLS and fixed effect panel	Depreciation increases exports. Exchange rate sensitivity increases in the 1990s.	From –0.97 to –0.16 (exports)	Not significant	Domestic production capacity

3. Methodology and data

To assess the sensitivity of Chinese exports and imports to changes in the Renminbi real exchange rate, we estimate standard export and import equations. We use cointegration techniques because we are interested in the long-run relationships. In addition, we use a reduced form export and import equations to avoid simultaneous equation bias which would result from estimating supply and demand functions alone. However, to avoid potential problems with omitted variables, we include supply and demand determinants in the reduced form equation.[4]

The two estimating equations are as follows:

$$X_t = \alpha_0 + \alpha_1 \, REER_t + \alpha_2 Y_t^* + \sum_{i=3}^{n} \alpha_i controls_t + \varepsilon_t$$

$$M_t = \beta_0 + \beta_1 \, REER_t + \beta_2 \, Y_t + \sum_{i=3}^{n} \beta_i controls_t + \varepsilon_t$$

where X_t stands for the volume of exports from China, M_t for the volume of imports into China, $REER_t$ for the real effective exchange rate of the Renminbi, Y_t^* for foreign demand and Y_t for China's domestic demand. The estimated parameters are: α_1 exchange rate elasticity of exports, α_2 income elasticity of exports, β_1 exchange rate elasticity of imports and β_2 income elasticity of imports.

Given the importance of the processing sector for the Chinese economy, we estimate separate equations for processed and ordinary exports. In the same way, we differentiate between imports for processing and ordinary imports.[5] Graphs A1.1 and A1.2 (appendix 1) show the trends in ordinary and processed exports and imports: both grew much faster from 2001 onwards, in conjunction with China's WTO entry.

A noticeable difficulty in working with the Chinese trade data is that values and volumes cannot be easily disentangled as no export and import price indices exist at the aggregate level. We, therefore, need to use proxies for the price data. As a proxy for export prices, we use China's consumer price index (CPI). The reason why we take such a general price measure is that China's National Bureau of Statistics does not provide data for a producer price index and the whole sale price index does not exist for our whole sample.[6] For import prices we calculate a weighted index of China's twenty-five most important trade partners' export prices and deflate China's imports with this index (data sources can be found in

4. See Goldstein and Khan (1985) for a critique of the prevailing assumption in export equations that supply is infinitively elastic.

5. Imports for processing comprise imports of parts and components that are used in the processing sector as inputs to manufacture exports. Processed exports include components exported from China for assembly in other countries and exports of goods that are assembled using imported components. Ordinary trade, in turn, refers to goods which are not subject to further processing and not assembled from imported components.

6. We also prefer the CPI to other external deflators, such as a weighted average of China's partners import prices. This is because China's has rapidly increased its market share and it already is a major world exporter so it is hard to argue that it is a pure price taker.

TABLE A1.1, APPENDIX 1). As a robustness test, we use Hong Kong export prices as a proxy for China's export prices and the results are maintained.[7]

The real effective exchange rate (REER) is drawn from the IMF international financial statistics and is constructed as follows:

$$REER = \prod_{i=1}^{N} \left(rer_i \right)^{w_i}$$

where N stands for the number of currencies included in the index, w_i is the weight of the i_{th} currency and $rer_{i,t}$ is the bilateral real exchange rate against each of China's trading partners.[8] We also use the REER constructed by the BIS as a robustness test but the results do not change.

We expect the exchange rate elasticity for exports to be negative as Chinese products compete in the world market. The expected sign for the exchange rate elasticity of imports is less clear in the Chinese case. A real appreciation should foster imports if the gained purchasing power is stronger than the reduced demand following the associated fall in exports. The reaction will very much depend also on the import structure. If imports are mainly substitutes for the domestic production, the price elasticity should be positive i.e. an appreciation should increase imports. However, if imports are basically components and investment goods directed to the export industry, which is very large in China's case, they may be affected negatively by an appreciation in the same way as exports are.

Foreign demand for Chinese exports is measured by world imports (excluding imports to China) and deflated by the global import price index. Obviously, some production-based measure could have also been used but the data does not exist in monthly terms. Furthermore, that kind of data may have even more serious difficulties in capturing the fast growth in world trade in the last few years, clearly faster than GDP growth, due to the opening up of emerging economies.

For China's domestic demand for ordinary imports we take the volume of industrial production. GDP would of course be a broader measure of economic output but China's statistical authorities have yet to publish quarterly GDP statistics for 1994-2005 since the major statistical reform in 2005. For imports for processing, we use processed exports as a demand factor in the long-run. The expected sign for the income elasticity is positive both for exports and imports.

Additional controls are included in the export and import equations on the basis of their relevance in the trade literature as well as the Chinese case. For exports, we test for the relevance of value-added tax (VAT) rebates that are used in China as a policy tool either to encourage or discourage exports depending on the business cycles. The expected sign on VAT rebates is obviously positive.[9] In order to introduce supply considerations in our

7. The underlying assumption is that most of Hong Kong exports are originally produced in the Mainland China and that Hong Kong's mark-up of these goods remains relatively constant.

8. For more details, see Bayoumi *et al.* (2005).

9. Data for VAT rebates starts only from 1995 and ends already in 2004.

reduced–form equation, we use a measure of capacity utilization. The *a priori* is that high capacity utilization should point to potential supply constraints, which could hinder export growth. Capacity utilization is defined as the difference between the industrial production and its trend, the latter being calculated using a Hodrick Prescott filter.

The final control variable in the export equation is the real stock of inward foreign direct investment (FDI). While the relation between trade and exports is well established in the literature, it could be particularly relevant for China given the large amount of FDI directed to the export sector. Although in general one would expect that an increase in the stock of FDI should foster China's exports, the complicated structures of production chains, where components and unfinished products may travel via several countries before the final market, may complicate such *a priori*.[10]

Moving to the import equation, import tariffs clearly need to be included since they have experienced substantial reductions, particularly since WTO entry. The second control is again the FDI stock. We would, in principle, expect to find a positive coefficient on the FDI stock as far as foreign companies are more likely to use imported machinery, components and parts in their production than Chinese companies. However, as foreign companies start to gear the whole production chain to China, the need for imports could actually be reduced along an increase in the FDI stock.

Finally, a deterministic trend is included in both export and import equations when it is statistically significant. The trend variable should help to capture productivity improvements and the on-going reforms in the Chinese economy which we cannot easily measure otherwise.

All other variables except VAT rebates and import tariffs, which are measured as a share of value of exports and imports, are in logarithms. As Chinese may not follow the standard seasonal pattern, we prefer to use unadjusted series but to introduce dummies for the Chinese New Year and December.[11]

We use monthly data for the period 1994-2005. Starting the analysis prior to 1994 would have made little sense since that year was a breakthrough in China's market reforms. Some of the reforms are especially relevant for the question we pose to ourselves. Namely, the two exchange rate systems were unified, mandatory planning for imports was eliminated and licensing requirements and quotas were reduced. Also the price reform[12] was pushed forward, the Renminbi started to be convertible on the current account and private sector development benefited from the new company law.

The continuous move toward a market economy allowed China to enter the WTO in December 2001. Due to the lengthy preparation for the accession and the agreed transition period thereafter, it is very difficult to estimate when, and how much, China's WTO

10. Chinese monthly data on FDI only exists from 1997.

11. The final regression will only include the dummies when statistically significant.

12. According to the OECD Economic Survey (2005), the share of transactions conducted at market prices among producer goods increased to 78 % in 1995, from 46 % in 1991.

membership started to influence China's trade. Factual information points to 2000 as the point when China' entry become clear. We also support the choice of 2000 to break our sample by statistical techniques, namely we find a structural break in the beginning of 2000 through a Chow test. In conclusion, we test whether China's foreign trade has become more price sensitive with WTO by dividing our sample into two periods: from 1994 to the end of 1999 and from the beginning of 2000 to the end of our sample.

4. Results for China's import and export equations

As a preliminary step, we test for the order of integration of the variables included in our analysis. We use the Augmented Dickey Fuller (ADF) tests for the existence of a unit root. Nearly all variables are found non-stationary in levels but stationary in the first differences.[13] We, then, test for the existence of cointegration vectors using the Johansen procedure. We do find at least one cointegrating vector for each variable group. As proposed by Phillips and Loretan (1991),[14] this allows us to estimate a regression of the lagged determinants and their differences through a non-linear least square approach. Such approach will yield unbiased and consistent estimates of the long-run and short-run parameters.[15]

As mentioned earlier, we ran regressions on export and import equations for our full sample (1994-2005), and for a shorter period (from 2000 to 2005), which concentrates on the post-WTO experience. In both cases, we consider important to distinguish between processed and ordinary trade and, therefore, run separate equations for each of them both in the case of exports and imports. The maximum number of short-term lags introduced into equations was three and we finally included only those ones that were statistically significant.

The full results for the export equations can be found on table A1.2 (appendix 1).[16] As expected long-run exchange rate elasticities of China's exports – both processed and ordinary – are negative and significant in our full sample and also since WTO entry. When appropriately transformed (see table 2), the estimated long-run impact of the real exchange rate is around –1.3 for processed exports for both periods. For ordinary exports, it drops from –2.3 measured for the whole period to –1.6 for the most recent sub-sample. Our results are very close to those previously found by other authors using cointegration analysis (–1.5 for total exports according to Lau, Mo and Li, 2004 and –1.3 for Shu and Yip, 2006). They are also similar to the estimated export price elasticities for major industrial countries (–1.5 and –1.6 for the US and the UK, respectively, according to Hooper *et al.*, 1998).

13. There are only a couple of exceptions: capacity utilization, which appears to be I(0), and the FDI stock which is not stationary even in the first differences. The latter result seems to be due to the relatively large number of lags suggested by the Akaike information criteria. If we use only one lag, as suggested by the Schwarz criterion, we can reject the unit root even at a 1% level.

14. This approach tackles the simultaneity problem by including lagged values of the stationary deviation from the cointegrating relationship.

15. The results of unit root and cointegration tests are available on a request from the authors.

16. All the reported results pass the serial correlation test on residuals.

The long-run positive effect from the world demand to Chinese exports is very small and not statistically significant in our full sample but it does become significant after WTO membership. This is the case both for ordinary and processed exports. This result is in line with the idea that China was facing considerable barriers to profiting from other countries' growth before WTO entry. In addition, for the most recent sample, the income elasticity of Chinese exports is very close to one, as expected.

Table 2 - Long-run exchange rate and demand elasticities

		Ordinary exports	Processed exports	Ordinary imports	Imports for processing
Exchange rate elasticity	1994-2005	–2.3	–1.3	–1.0	–0.8
	2000-2005	–1.6	–1.4	–0.4	(–0.3)
Demand elasticity	1994-2005	(0.5)	(0.2)	–0.3	(0.2)
	2000-2005	1.0	0.8	0.3	0.4

Values in parentheses are not statistically significant.

As for the control variables, capacity utilization has a significant impact on exports only contemporaneously or with one month delay. The sign of the capacity utilization is negative, in line with the idea a larger share of the production stays in the domestic market in high growth periods. The VAT rebates are not statistically significant in any of the specifications and we thus leave them out from the final estimations as their inclusion would shorten the estimation period due to data constraints.[17] As mentioned above the data on FDI stock starts in 1997 and is thus introduced as an explanatory variable only during the most recent subperiod. Somewhat surprisingly, the FDI stock, however, does not affect Chinese exports statistically significantly. The trend is positive and significant for all equations while the Chinese New Year seems to decrease and December decrease exports quite noticeably. If we leave the trend out from estimations, the coefficients on both world demand and the FDI stock would become strongly positive and significant. However, our results on the exchange rate elasticity would remain very much unchanged.

The estimated coefficients of the import equations are shown in TABLE A1.3. Demand factors seem to play relatively moderate role in explaining imports in the past.[18] In the later subsample, imports for processing do react positively to external demand, measured by processed exports. Domestic industrial output increases ordinary imports as expected.

17. VAT rebates could not be included as a short-run variable because we only had annual data on tariffs and thus changes were rare throughout the sample.

18. In the case of ordinary imports, the income elasticity becomes positive and significant for 1994-2005 if we leave trend variable out from the regression.

As one would expect, the FDI stock appears to have a positive effect in the long-run both on ordinary imports and imports for processing. Finally, a reduction in import tariffs does seem to foster imports for processing in the long-run.[19] As for exports, dummies for the Chinese New Year as well as for December were significant in most cases.

Finally, the exchange rate elasticity of imports is always negative and generally significant. The only exception is the case of imports for processing in the latter subperiod where the negative coefficient on the exchange rate is significant only at 15% level. In addition to the direct link from the exchange rate, the imports for processing are affected by the exchange rate also indirectly via the demand component i.e. processed exports. When also the indirect link is taken into account, the negative reaction of imports for processing to a real appreciation is actually stronger than the reaction of ordinary imports.

As a summary, a Renminbi real appreciation tends to reduce imports rather than to increase them. While counterintuitive at first sight, such negative elasticity has already been reported in some of the most recent literature, such as Marquez and Schindler (2006). The finding basically implies that imports – even ordinary ones – are more sensitive to lower exports induced by the Renminbi real appreciation than to a rise in the purchasing power.

5. Looking at the reasons behind the negative exchange rate elasticity

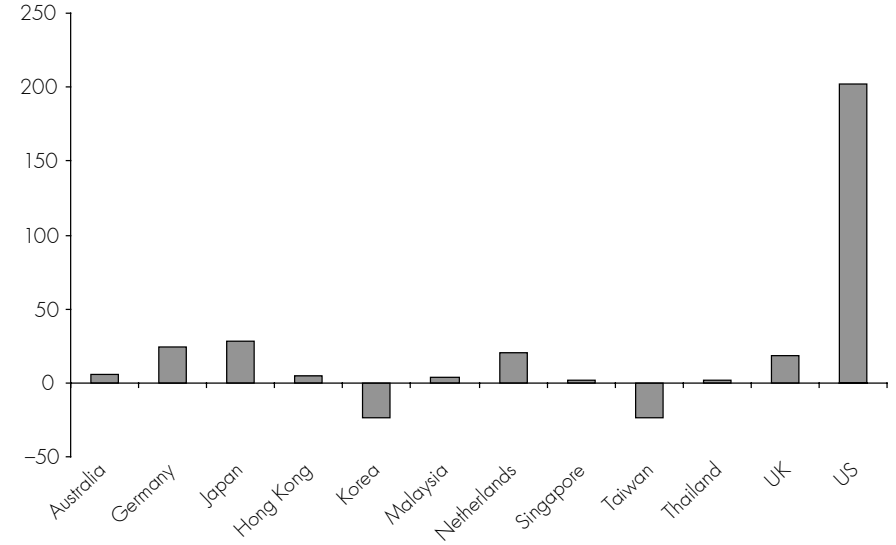
The fact that the impact of the Renminbi real appreciation on imports is negative is an interesting phenomenon which requires careful analysis. This is all the more so given its negative implications for the reduction of China's trade surplus in the event of a real exchange appreciation. Our *a priori* hypothesis is that this is related to the special characteristics of China's trade as illustrated by the large differences in China's bilateral trade balances across countries (GRAPHS 2 and 3).

China imports a large amount of intermediate goods from the rest of Asia for processing and re-exporting. As a result, the high degree of vertical integration among Asian exporting industries makes their exports more complementary than substitutes of Chinese goods. This implies that an appreciation of the Renminbi could lead to a decrease not only in Chinese exports but also in imports.

While the vertical integration applies more for the processing industry, one should not forget that also many ordinary imports function as inputs to the export sector, for example investment goods. Overall, it seems that only a small share of import products do compete with Chinese domestic production. This is because the share of non-high quality consumption goods in China's imports is relatively small. In addition, a considerable part of imports consists of energy and raw materials and some of the import products only follow foreign direct investment.

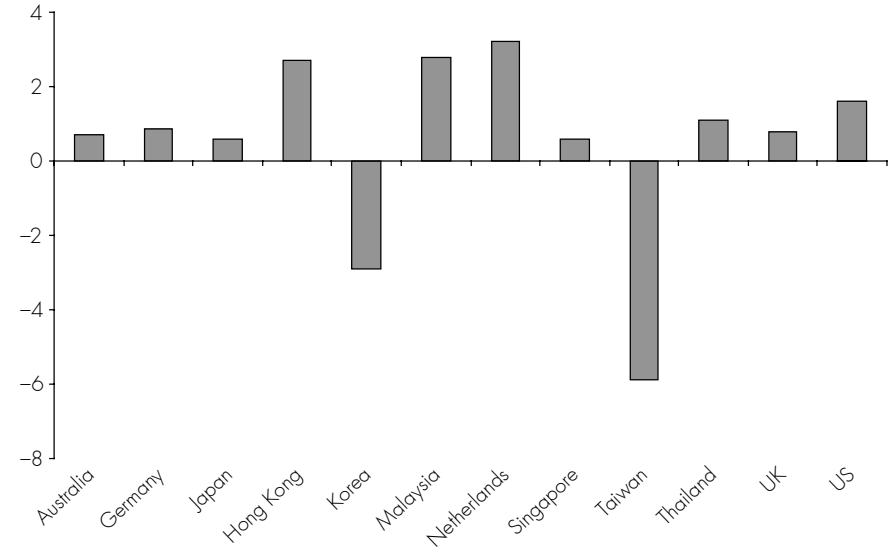
19. Import tariffs could not be included as a short-run variable because we only had annual data on tariffs and thus changes were rare throughout the sample.

Graph 2 - China's bilateral trade balances with selected countries in 2005, bn US$



Note: Data from partners' side.
Source: IMF Direction of Trade; the data for Taiwan from the Bureau of Foreign Trade.

Graph 3 - China's bilateral trade balances with selected countries in 2005, % of each country's GDP



Note: Data from partners' side.
Source: IMF Direction of Trade; the data for Taiwan from the Bureau of Foreign Trade.

In order to explore the issue further with readably available date, we run bilateral regressions for China's ten largest trade partners so as to assess possible different impacts of a Renminbi real appreciation across countries. Our *a priori* is that imports from Southeast Asian countries should respond negatively to a Renminbi appreciation, being mainly intermediary products for China to assemble and re-export. In turn, imports from other countries are expected to react to Renminbi appreciation more ambiguously depending their export structure. The estimated bilateral equations take the following format:

$$X_{tj} = \alpha_{0j} + \alpha_{1j}\, RER_{tj} + \alpha_{2j}\, Y^{*}_{tj} + \sum_{i=3}^{n} \alpha_{ij}\, controls_{tj} + \varepsilon_{tj}$$

$$M_{tj} = \beta_{0j} + \beta_{1j}\, RER_{tj} + \beta_{2j}\, Y_{t} + \sum_{i=3}^{n} \beta_{ij}\, controls_{tj} + \varepsilon_{tj}$$

Where Chinese exports and imports to/from country j (X_{tj} and M_{tj}, respectively) are explained by the bilateral real exchange rate (RER_{jt}), external and domestic demand (Y^{*}_{tj} and Y_{t}) and other control variables. Unfortunately, we cannot separate exports and imports for ordinary and processing products as no such data exists. As in the previous exercise, the CPI is used as a deflator for Chinese exports and imports to China are converted into volumes by using the export price index of each trade partner.[20] The bilateral real exchange rate between the Renminbi and the currency of each of China's export and import partners is measured in CPI terms. The demand for China's exports is proxied by the real GDP of each of its export partners while China's domestic demand is again captured by industrial production. We also introduce the stock of bilateral FDI in both export and import equations. As before, we introduce the capacity utilization for China's export equations. Finally, a trend was introduced when statistically significant.[21] Data sources are again reported in the TABLE A1.1.

We estimate the bilateral trade equations for 2000-2005 because for some countries, data did not exist for the whole period. This practise allows us to compare results between countries and also with those for aggregate export and import equations. Following the same procedure as before, we conduct unit root tests for all bilateral variables. Virtually all of them are I(1) and at least one cointegration vector was found for each bilateral import and export equation.[22]

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20. When we formulate the bilateral equations, we will not use China's trade data but the trade partners' statistics to alleviate the incorrect account of China's trade with Hong Kong. China's statistics show a large amount of exports to Hong Kong, which in reality only transit via Hong Kong to other countries. In any event, the data we use has other well-known caveats. For example, due to some taxation reasons and its large ports, the Netherlands is often signed as a final destiny although the goods might continue their way to other European countries. This explains the significance of the Netherlands as one of China's major trade partners and also its large trade deficit with China. In reality, the bilateral equation on the trade between China and the Netherlands reflects the dynamics of trade between China and Europe more generally.

21. The number of short-term lags included into the final estimations is again based on their statistical significance. We use now data that is seasonally adjusted by the authors by using the CensusX12 programme in order to avoid seasonal fluctuations in China's trade partners' data. If statistically significant, we continued to introduce dummies for Chinese New Year and December.

22. Capacity utilization was again I(0). The results of unit root and cointegration tests are available on a request from the authors.

The results for the bilateral export equations are very similar to our aggregate estimations and also across countries (TABLE A1.4).[23] The bilateral appreciation of the Renminbi real exchange rate against that of each of China's major partners reduces Chinese exports although for the US and Taiwan the link is not statistically significant. The only exception is Hong Kong which coefficient is positive but not statistically significant. The result for Hong Kong is not surprising given the difficulties in interpreting the trade data between the Mainland China and Hong Kong. After transformation (see TABLE 3), the exchange rate elasticity is highest for exports to Singapore if we ignore the insignificant coefficient on exports to the US.

We also find that economic activity in China's trade partners increases Chinese exports as one would expect. Bilateral income elasticities are highly significant for all countries except Germany. For the US and the European countries, such elasticities are very large.[24] This might be due to the relatively short time since China's entered WTO, a major structural change for world trade. In addition, it points to the importance of demand factors to explain the growing trade imbalance between China and the US or the EU countries.

In some cases, our measure of productivity gains, the trend variable, is also positive and significant. For Korea and Taiwan, however, the trend is negative. As for FDI, an increase of Korean or Taiwanese FDI into China raises Chinese exports to these countries but for Germany and Italy, the impact is the opposite. This might be due to the different behaviour in Asian and European multinationals when dealing with the Chinese markets. As mentioned above, a negative link could reflect a transfer of the entire manufacturing processes to China. While before it could be that some semi-finished products were first exported from China to Germany and only after some remodification shipped to the final destination, now the entire manufacturing process has probably been moved to China and there is no need to ship the product to Germany anymore. However, this result should be interpreted with caution as it demands deeper analysis.

The results for the bilateral import equations are much less homogenous as shown in TABLE A1.5.[25] First, our estimated long-run price elasticities show that a Renminbi real appreciation reduces imports from all Asian countries to China. The coefficient is significant for Korea and Thailand. For high-income countries – the US, Germany and Japan – the coefficient is negative but not statistically significant. Only for Russia and Australia, the coefficient is positive although not statistically significant.

As for the income elasticities, they are generally positive although rather low and not always statistically significant. Most countries' exports to China increase along bilateral FDI stock. China's imports from Japan, Taiwan, Germany, Russia, Malaysia and Thailand increase along FDI from these countries. Again, Korea is somewhat exceptional with negative and significant coefficient on FDI. TABLE 3 summarises the transformed long-run price and income elasticities for China's bilateral export and import equations.

23. We do not report the equation on China's exports to Japan as it does not pass the standard misspecification tests. All reported results have passed the LM test on residuals' serial correlation.

24. The high income elasticity of Chinese imports to US is found also by Mann and Plück (2005).

25. Out of China's ten most important import destinations, we drop Singapore due to econometric problems. All reported results have passed the LM test on residuals' serial correlation.

Table 3 - Bilateral long-run exchange rate and demand elasticities

	Export equation			Import equation	
	Bilateral RER	Demand		Bilateral RER	Demand
USA	(–2.0)	5.9	Japan	(–0.4)	(–0.7)
Hong Kong	(0.2)	1.5	Korea	–0.8	2.7
Japan*			USA	(–3.1)	1.2
Germany	–0.6	(2.0)	Taiwan	–1.1	6.8
Korea	–0.6	2.8	Germany	(–0.5)	(0.0)
Netherlands	–1.1	7.0	Singapore*	-	-
UK	–0.6	8.2	Russia	(1.2)	(–0.5)
Singapore	–1.6	1.8	Australia	(0.1)	1.3
Italy	–1.3	3.6	Malaysia	(–0.3)	(0.2)
Taiwan	(–0.4)	5.6	Thailand	–1.0	(0.5)

Values in parentheses are not statistically significant.

* Bilateral equations for trade with Japan and Singapore did not pass the misspecification tests.

To better understand the diverse results found for Chinese imports' exchange rate elasticity, we look into the composition of China's imports from each of its major trading partners (TABLE 4). Australia and Russia basically export energy and raw materials to China, which might explain the weak reactions of the Chinese imports from these countries for changes in the bilateral real exchange rate. Somewhat surprising is that an increase in China's economic activity does not have a significant positive impact on Russian imports. Actually, the link is negative although very far from being statistically significant. This could be explained by the underdeveloped transport connections between Russia and China. If the railway capacity has been used, no more oil could have been transported to China despite the level of demand. On the contrary, Australian imports do increase along China's industrial value-added.

Table 4 - Structure of imports to China from major partners as a share of total imports in 2005

	Agricultural product	Mineral products	Chemicals	Textiles	Base metals	Machinery	Electronics	Vehicles	Optical instruments
Australia	4.5	**52.8**	10.2	8.2	**12.7**	1.9	0.8	1	0.4
Germany	0.2	0.2	6.9	0.6	7.8	**35.9**	**13.1**	**11.9**	6
Japan	0.2	1.5	8.8	3.7	**11.4**	**21.5**	**30.0**	4.5	8.7
Korea	0.6	4.7	10.2	3.8	9.7	9.5	**33.6**	2.8	**14.8**
Malaysia	6.4	2.6	4.1	0.7	1.8	8.6	**63.0**	0.1	1.3
Russia	5.0	**48.4**	13.9	0.0	**16.2**	0.5	0.4	1.2	0.0
Taiwan	0.1	0.9	7.4	4.5	10	9.7	**38.7**	0.5	16.1
Thailand	6.1	5.9	4.4	2.6	2.9	**27.5**	**26.5**	0.3	1.3
USA	8.6	2	**11.3**	4.3	6.7	**17.1**	**17.5**	8.9	7.8

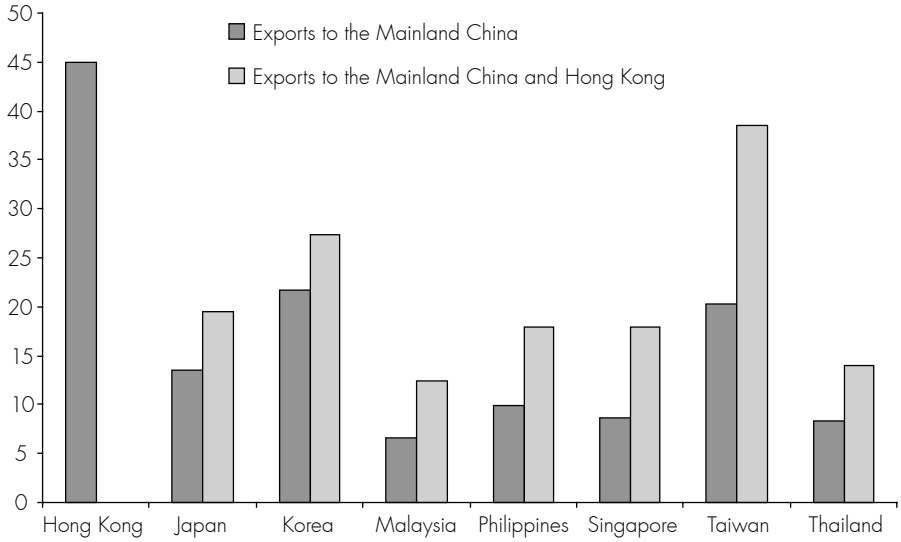
Source: CEIC.

A second group of countries that we can separate based on the results, are high-income countries. Exports from Germany, Japan and the US are not sensitive to changes in the bilateral real exchange rate. While in Germany's and Japan's cases the imports are clearly driven by the FDI, US imports seem to benefit more from overall economic development in China. This is natural when looking closely the import structure from these countries. While about a half of German and Japanese exports to China are machinery and electronics –products that are often used in the export-oriented and to a wide extent foreign owned industries– the imports from the US are much more widely disbursed from soybeans to airplanes and high-tech chips. While many of these products are directed to the domestic sector, there are no substitutes or Chinese competition for these products which very much explains the low and even negative exchange rate elasticity.

The third group of countries consists of emerging Asian countries which exports to China are negatively affected by a Renminbi appreciation. They mainly export products, parts and components to Chinese export industry and their exports to China are thus negatively linked to Renminbi appreciation.

As we can see from the GRAPH 4, the share of exports going to the Mainland China is very high for a number of Asian countries. If we assume that a part of the exports to Hong Kong also end up to the Mainland China the share becomes even larger. For example, exports from Taiwan to the Mainland China and Hong Kong consist of close to 40 % of all Taiwanese exports.

Graph 4 - Share of exports to the Mainland China and Hong Kong from selected Asian countries in 2005, %



Source: IMF Direction of Trade; the data for Taiwan from the Bureau of Foreign Trade.

Therefore, our results pointing to a Renminbi appreciation reducing imports from the rest of Asia to China should be a concern for many Asian countries. This is even more so if they are not able to compensate this effect by increasing exports to other destinations. This very much depends upon the degree of complementarity among Asian exports and also upon the reactions of the Asian supply chains to a Renminbi revaluation. While testing for this hypothesis would require a detailed sectoral analysis, we attempt to give a preliminary answer by estimating export equations for China's main trade partners in Asia.

The form of the export equation is the same we had for China earlier on so that we explain exports by the country's own real effective exchange rate and world demand. In addition, we include into the equation China's real effective exchange rate as an additional explanatory variable. The data on exchange rates is again CPI-based and the world demand is measured by world total imports. The trend is included when it is found statistically significant.

We estimate the export equations for China's main Asian trade partners for the period 2000-2005.[26] The data we use is seasonally adjusted by the authors by using CensusX12 programme. We find our variables again integrated of degree one and there exists at least one cointegrating vector among each group of variables.[27]

The detailed results from the export equations for the selected Asian countries are reported in the TABLE A1.6.[28] When transforming the obtained long-run coefficients (TABLE 5), we can see that exports from most Asian countries are negatively affected by China's real exchange appreciation. For Korea, Taiwan and Thailand, the negative impact of the Renminbi appreciation is statistically significant. The only exception is Malaysia, which exports would benefit from Renminbi real appreciation. However, this exceptionally result may be due to a fact that besides electronics, Malaysia also exports substantial quantities of oil and other raw materials. Thus, the country-based results from the export equations are very close to ones we found for China's bilateral import equations so that exports from many other Asian countries do not seem to be redirected fully to other countries when China's demand for imports shrinks. As expected income elasticities are always positive although not statistically significant in the case of Philippines and Thailand. Our results are thus very much in line with Ahearne *et al.* (2006) and Cutler *et al.* (2004) who found that common factors, like the world demand, drive exports both from China and the other Asian economies.

26. We had to drop Indonesia from the data sample due to lack of data.

27. The results of unit root and cointegration tests are available on a request from the authors.

28. All the reported results pass the LM misspecification test.

Table 5 - Export equations for China's major regional trading partners

	China's REER	REER	Foreign demand
Hong Kong	(–0.4)	(–0.5)	1.0
Japan*	-	-	-
Korea	–0.6	–0.3	1.2
Malaysia	1.4	–2.4	1.1
Philippines	(–0.3)	1.2	(0.3)
Singapore	(–0.1)	–1.1	1.9
Taiwan	–2.0	0.8	0.8
Thailand	–0.5	(0.5)	(0.2)

Values in parentheses are not statistically significant.

* Equation for exports from Japan did not pass the misspecification tests.

6. Conclusions

During the last few years, there has been an intensive discussion both in China and in international fora on the desirability of a Renminbi appreciation. Many have argued that exchange rate policy would not serve the purpose of reducing China's large trade surplus. This paper shows empirically that China's trade balance is sensitive to fluctuations in the real effective exchange rate. In fact, estimating long-run elasticities of Chinese exports and imports to changes in the Renminbi's real effective exchange rate for the period from 1994 to end-2005, we find strong evidence that a real appreciation reduces exports substantially in the long-run. This is the case both for processed exports (i.e. transformed and re-exported goods) and ordinary exports. However, real exchange rate appreciation reduces also imports to China. This limits the net impact of exchange rate policy on the trade surplus.

Based on our estimated elasticities for the period since WTO entry was known, a 5% real appreciation of the Renminbi effective exchange rate – other things given – would have led to about 7% reduction in export volume in 2005. When we take into account the direct link from the exchange rate on imports as well as the indirect link from a decrease in processed exports on imports for processing, total volume of imports would have decreased by about 4%. Based on these estimates, the trade surplus would have shrunk almost by a quarter from about USD100 billion to less than USD80 billion. However, these figures have to be treated with extreme care as this is just a very rough calculation without taking into account, for example, the pass-through effects from the exchange rate on export and import prices and thus on the trade surplus. It is likely that our figures overestimate the reduction in the trade surplus as in a case of appreciation, the export prices denominated in foreign currency would probably increase so that the actual impact on the trade balance would actually be even considerably smaller. On the other hand, fluctuations in the Renminbi exchange rate may not influence e.g. the oil world market price so that the pass-through effect on the

Chinese import prices could be much smaller. Unfortunately, pass-through effects in China are difficult to estimate due to lack of time series data on export and import prices.

Although not completely new, our finding that China's imports decrease as a result of the exchange rate appreciation is interesting enough to deserve further exploration. We explore the issue further by estimating bilateral equations for China's trade with its major trading partners. It seems that the Renminbi bilateral real appreciation against the currency of a trading partner generally reduces exports particularly from other Asian countries. The result for Chinese imports from Asia is probably explained by the high degree of vertical integration of the exporting sectors of Asian countries. Such Asian production network makes products from other Asian countries more of a complement than a substitute. This hypothesis is supported by our results according to which the total exports from Asian countries – and not only exports to China – are negatively affected by a Renminbi's real appreciation.

These findings raise concerns in terms of Asia's reaction to a sudden appreciation of the Renminbi, particularly if Asian countries also appreciate against other currencies. Although this study only concentrates on the volumes of imports and exports – so that the conclusions cannot be comprehensive – it does serve to note the importance of investigating further potential effects from a Chinese real appreciation and different combinations of exchange rate policies in Asia. Even though there are a number of papers on this issue, studies using fresh data are needed.

Finally, while Chinese exports have clearly benefited from fast economic growth in advanced economies, the income elasticity of the Chinese imports is found rather low in this paper. It seems that imports to China are more dependent on foreign direct investment than economic activity in the country. Although the data sample in this paper runs only until the end of 2005, these results are confirmed by the more recent economic developments. Strong external demand and increasing FDI inflows kept Chinese exports and imports growing until summer 2008. Since then, the worldwide economic downturn and sudden drops in the FDI have contributed to much weaker Chinese exports as well as imports, specially from Asian partners. In fact, intra-Asian trade has plummeted in the past few months.

A. G.-H. & T. K.[29]

29. The opinions expressed in this article are the authors' and not necessarily those of the BIS, the BBVA or the Bank of Finland. Useful comments have been received by Claudio Borio, Carmen Broto, Pertti Haaparanta, Dong He, Iikka Korhonen, Li-gang Liu, Arnaud Mehl, Aaron Mehrotra, Madhusudan Mohanty, Eiji Ogawa, Jimmy Ran, Eli Remolona, Daniel Santabarbara, Sweta Saxena, Chang Shu, Francisco Vazquez, Raymond Yip and Geng Xiao. We also appreciate able research assistance by Eric Chan and Enrique Martinez Casillas. Remaining errors are obviously the authors'.

Appendix 1

Table A1.1 - Data sources

China's export and import equations

Variable	Explanation	Frequency	Source	Method
processed exports	The volume of China's processed exports	Monthly	CEIC	Original data in US dollars. Converted to Renminbi and deflated by China's CPI. In logs.
ordinary exports	The volume of China's ordinary exports	Monthly	CEIC	Original data in US dollars. Converted to Renminbi and deflated by China's CPI. In logs.
imports for processing	The volume of China's imports for processing	Monthly	CEIC	Original data in US dollars. Converted to Renminbi and deflated by China's import price index. In logs.
ordinary imports	The volume of China's ordinary imports	Monthly	CEIC	Original data in US dollars. Converted to Renminbi and deflated by China's import price index. In logs.
	China's import price index	Monthly	IFS, own calculations	Index was calculated by taking weighted average of China's 25 most important trading partners' export price indices.
demand for exports	The volume of world total imports excl. imports to China	Monthly	IFS	In US dollars, converted into volumes by world import price index (IFS), in logs.
demand for imports	The volume of industrial production in China	Monthly	CEIC	Index constructed by using real growth rates, in logs.
REER	China's real effective exchange rate	Monthly	IFS	CPI based measure
capacity utilization	Estimate for output gap	Monthly	CEIC, own calculations	Business cycles estimated by using Hodrick-Prescott filter on industrial production data (CEIC)
import tariffs	Weighted average import tariffs as a share of total imports	Annual	IMF Occasional Paper, WTO	The authors calculated the weighted average for 2001-2005 with help of WTO tariff data. Data for 1999-2000 was interpolated as it was not available.

Table A1.1 - continued

Variable	Explanation	Frequency	Source	Method
VAT rebates	Value-added tax rebates on exports as a share of total exports	Annual	WTO	The amount of value-added tax returned to the exporters as a share of total exports
FDI	Accumulation of foreign direct investment into China	Monthly	CEIC	Original data in US dollars. Converted to Renminbi and deflated by China's CPI. In logs.
	China's CPI	Monthly	CEIC	

China's bilateral export and import equations

Variable	Explanation	Frequency	Source	Method
exports	The volume of China's bilateral exports	Monthly	Direction of trade, except data for Taiwan from CEIC	Data from China's trade partners' side. Original data in US dollars. Converted to Renminbi and deflated by China's CPI. Seasonally adjusted. In logs.
imports	The volume of China's bilateral imports	Monthly	Direction of trade, except data for Taiwan from CEIC	Data from China's trade partners' side. Original data in US dollars. Deflated by trade partners' export prices. Seasonally adjusted. In logs.
	Trade partners' export prices	Monthly	IFS, except data for Taiwan from CEIC	Unit price index, not available for Malaysia and Taiwan for which we used CGPI data. For Russia we used IFS export price index for oil-exporting countries.
demand for exports	Real GDP in each trading partner	Quarterly	Bloomberg	The quarterly data on real GDP was interpolated into a monthly data. Seasonally adjusted. In logs.
demand for imports	The volume of industrial production in China	Monthly	CEIC	Index constructed by using real growth rates. In logs.
RER	Bilateral real exchange rate	Monthly	Own calculations	Based on nominal exchange rate and CPI data. For Australia, monthly CPI data was not available export price data was used.

Table A1.1 - continued

Variable	Explanation	Frequency	Source	Method
	Bilateral nominal exchange rate	Monthly	IFS, except data for Germany, Netherlands and Italy from BIS and for Russia and Taiwan from Bloomberg	
	Consumer price index	Monthly	BIS, except data for Taiwan from Bloomberg	
bilateral FDI	Accumulation of bilateral direct investment into China	Monthly	CEIC	Original data in US dollars. Converted to Renminbi and deflated by China's CPI. Seasonally adjusted. In logs.

Export equations for selected Asian countries

Variable	Explanation	Frequency	Source	Method
exports	The volume of each Asian country's total exports	Monthly	IFS, except data for Taiwan from CEIC	Original data in US dollars. Deflated by each country's export price index. For Malaysia, Philippines and Taiwan, export price data was not available and CPI was used. Seasonally adjusted. In logs.
	Each Asian country's export prices	Monthly	IFS, except data for Taiwan from Bloomberg	Unit price index.
demand for exports	The volume of world total imports	Monthly	IFS	Original data in US dollars. Deflated by the world import price index (IFS). Seasonally adjusted. In logs.
China's REER	China's real effective exchange rate	Monthly	IFS	CPI based measure
REER	Each Asian country's real effective exchange rate	Monthly	BIS	

Table A1.2 - China's export equations

	Dependent variable			
	Full sample		From WTO onwards	
	D_ordinary exports	D_processed exports	D_ordinary exports	D_processed exports
Long–run coefficients				
C	6.358***	4.966**	5.578	4.789
	(2.092)	(1.424)	(5.965)	(6.094)
world imports$_{t-1}$	0.256	0.110	1.006***	0.598*
	(0.243)	(0.176)	(0.326)	(0.360)
reer$_{t-1}$	–1.190***	–0.649***	–1.604***	–0.996***
	(0.191)	(0.108)	(0.246)	(0.209)
ordinary exports$_{t-1}$	–0.519***		–1.005***	
	(0.066)		(0.095)	
processed exports$_{t-1}$		–0.485***		–0.719***
		(0.055)		(0.104)
fdi$_{t-1}$			–0.099	–0.107
			(0.399)	(0.391)
trend	0.006***	0.006***	0.011***	0.010**
	(0.002)	(0.001)	(0.004)	(0.004)
New Year dummy	–0.265***	–0.257***	–0.269***	–0.252***
	(0.030)	(0.022)	(0.029)	(0.029)
December dummy	0.161***	0.104***		
	(0.032)	(0.023)		
Short–run coefficients				
D_world imports$_t$	0.381*	0.406***	–0.055	0.209
	(0.209)	(0.149)	(0.216)	(0.203)
D_world imports$_{t-1}$			–0.976***	–0.398*
			(0.229)	(0.203)
D_world imports$_{t-2}$			–0.752***	–0.523***
			(0.167)	(0.141)
D_world imports$_{t-3}$				
D_reer$_t$	–0.673	–0.214	–1.494**	–1.160**
	(0.730)	(0.539)	(0.617)	(0.537)
D_reer$_{t-1}$	0.928	1.022*	1.518**	0.951*
	(0.750)	(0.537)	(0.647)	(0.565)
D_reer$_{t-2}$	–0.023	–0.522		
	(0.740)	(0.529)		

Table A1.2 - continued

	Dependent variable			
	Full sample		From WTO onwards	
	D_ordinary exports	D_processed exports	D_ordinary exports	D_processed exports
D_reer_{t-3}	1.485**	1.059**		
	(0.734)	(0.526)		
$D\_capacity\ utilization_{t}$		–0.607**	–0.591*	–1.213***
		(0.256)	(0.315)	(0.294)
$D\_capacity\ utilization_{t-1}$			–0.709**	–0.626*
			(0.341)	(0.321)
$D\_capacity\ utilization_{t-2}$				
$D\_capacity\ utilization_{t-3}$				
D_fdi_{t}				
D_fdi_{t-1}				
D_fdi_{t-2}				
D_fdi_{t-3}				
$D\_ordinary\ exports_{t-1}$	–0.167***		0.238***	
	(0.060)		(0.078)	
$D\_processed\ exports_{t-1}$		–0.099*		–0.056
		(0.055)		(0.085)
Sample period	5/1994-12/2005	5/1994-12/2005	1/2000-12/2005	1/2000-12/2005
Observations	140	140	72	72
R^2 adjusted	0.70	0.78	0.83	0.85

Standard errors in parentheses. * Indicates significance at 10% level, ** at 5% level and *** at 1% level.

Table A1.3 - China's import equations

	Dependent variable			
	Full sample		From WTO onwards	
	D_ordinary imports	D_imports for processing	D_ordinary imports	D_imports for processing
Long–run coefficients				
C	2.483***	6.465***	–0.962*	–2.520
	(0.302)	(0.866)	(0.489)	(2.052)
domestic demand$_{t-1}$	–0.099**		0.095***	
	(0.042)		(0.033)	
processed exports$_{t-1}$		0.134		0.448***
		(0.118)		(0.152)
reer$_{t-1}$	–0.343***	–0.700***	–0.155**	–0.365
	(0.059)	(0.119)	(0.059)	(0.247)
import tariffs$_{t-1}$		–0.329***		–0.339***
		(0.076)		(0.120)
fdi$_{t-1}$			0.102**	0.685***
			(0.050)	(0.212)
ordinary imports$_{t-1}$	–0.327***		–0.355**	
	(0.122)		(0.166)	
imports for processing$_{t-1}$		–0.879***		–1.132***
		(0.140)		(0.176)
trend	0.005***	0.007***		
	(0.000)	(0.001)		
New Year dummy	–0.054***	0.239***	–0.014*	–0.220***
	(0.008)	(0.020)	(0.008)	(0.022)
December dummy	0.074***	0.117***		
	(0.010)	(0.025)		
Short–run coefficients				
D_domestic demand$_t$		1.079***	0.140***	2.027***
		(0.280)	(0.043)	(0.306)
D_domestic demand$_{t-1}$			–0.105**	1.150***
			(0.040)	(0.346)
D_domestic demand$_{t-2}$			–0.189***	
			(0.030)	
D_domestic demand$_{t-3}$				
D_reer$_t$	0.207	0.303	–0.445***	–0.998*
	(0.237)	(0.582)	(0.148)	(0.609)

Table A1.3 - continued

	Dependent variable			
	Full sample		From WTO onwards	
	D_ordinary imports	D_imports for processing	D_ordinary imports	D_imports for processing
D_reer_{t-1}	0.030	1.338**	0.520***	2.286***
	(0.238)	(0.579)	(0.157)	(0.606)
D_reer_{t-2}	–0.002	–0.566		
	(0.245)	(0.571)		
D_reer_{t-3}	0.492**	1.535***		
	(0.236)	(0.560)		
D_fdi_{t}			0.043	–1.231
			(0.253)	(0.943)
D_fdi_{t-1}			0.933***	0.452
			(0.248)	(0.883)
D_fdi_{t-2}			0.153	–2.725***
			(0.241)	(0.779)
D_fdi_{t-3}			–0.551***	
			(0.206)	
$D\_ordinary\ imports_{t-1}$	1.526***		2.155**	
	(0.504)		(0.840)	
$D\_imports\ for\ processing_{t-1}$		0.045		–0.096
		(0.058)		(0.077)
Sample period	5/1994-12/2005	5/1994-12/2005	1/2000-12/2005	1/2000-12/2005
Observations	140	140	72	72
R^2 adjusted	0.95	0.77	0.97	0.83

Standard errors in parentheses. * Indicates significance at 10% level, ** at 5% level and *** at 1% level.

Table A1.4 - China's bilateral export equations

	Dependent variable: D_exports from China to country i								
	US	HK	Germany	Korea	Netherlands	UK	Singapore	Italy	Taiwan
Long–run coefficients									
C	–19.128***	–8.191***	–8.784	–34.200***	–20.457**	–60.640***	–5.625	–23.138	–42.16***
	(6.164)	(2.153)	(26.864)	(10.334)	(8.290)	(14.000)	(5.366)	(19.809)	(9.550)
GDP^i_{t-1}	3.426***	1.020***	2.340	2.821***	2.947***	5.811***	1.664***	4.659**	5.224***
	(0.906)	(0.339)	(2.332)	(0.881)	(1.055)	(1.328)	(0.429)	(1.907)	(1.179)
rer^i_{t-1}	–1.173	0.108	–0.727***	–0.629***	–0.442**	–0.456***	–1.473***	–1.649***	–0.334
	(1.157)	(0.749)	(0.199)	(0.179)	(0.173)	(0.122)	(0.495)	(0.249)	(0.493)
FDI^i_{t-1}	0.082	0.014	–2.233***	1.448***	0.076	–0.075	–0.086	–4.178***	1.658***
	(0.196)	(0.183)	(0.363)	(0.325)	(0.103)	(0.144)	(0.142)	(0.762)	(0.480)
$exports^i_{t-1}$	–0.058	–0.112	–1.194***	–1.130***	–0.419***	–0.707***	–0.924***	–1.295***	–0.940***
	(0.105)	(0.110)	(0.176)	(0.158)	(0.117)	(0.135)	(0.185)	(0.163)	(0.181)
trend			0.040***	–0.019*			0.011**	0.046***	–0.007*
			(0.006)	(0.007)			(0.005)	(0.007)	(0.004)
New Year dummy				–0.019***					
				(0.009)					
Short–run coefficients									
$D\_GDP^i_t$			–3.412		–2.574*		1.230**		0.418
			(2.884)		(4.030)		(0.575)		(1.214)

Table A1.4 - continued

	US	HK	Germany	Korea	Netherlands	UK	Singapore	Italy	Taiwan
$D\_GDP^i_{t-1}$			−2.156		−4.532				−1.547
			(3.036)		(3.945)				(1.433)
$D\_GDP^i_{t-2}$			−1.772		3.978				−1.685
			(2.960)		(3.867)				(1.377)
$D\_GDP^i_{t-3}$			−8.127***		−10.298***				−3.041**
			(2.633)		(3.617)				(1.217)
$D\_rer^i_t$			−0.562**		−0.340	−1.143***	−1.319**	−0.922***	−2.093***
			(0.275)		(0.371)	(0.244)	(0.608)	(0.339)	(0.715)
$D\_rer^i_{t-1}$					0.646*	−0.024	0.944	0.716**	−0.389
					(0.396)	(0.275)	(0.584)	(0.329)	(0.777)
$D\_rer^i_{t-2}$						0.754***	0.619	0.757**	−1.781**
						(0.255)	(0.588)	(0.338)	(0.771)
$D\_rer^i_{t-3}$							1.352**	0.864**	
							(0.578)	(0.330)	
$D\_FDI^i_t$					−2.003*	−0.193		−3.449**	3.471
					(1.095)	(0.916)		(1.370)	(2.315
$D\_FDI^i_{t-1}$					1.944*	−1.096		2.468**	0.528
						(0.845)		(1.222)	(2.167)
$D\_FDI^i_{t-2}$						2.821***		3.530**	−4.231*
						(0.848)		(1.214)	(2.180)
$D\_FDI^i_{t-3}$									

Table A1.4 - continued

	US	HK	Germany	Korea	Netherlands	UK	Singapore	Italy	Taiwan
$D\_Cutilization_t$	0.197	–1.047***		–0.794**	–0.311				–0.967***
	(0.284)	(0.221)		(0.282)	(0.459)				(0.341)
$D\_Cutilization_{t-1}$	–0.989***				–0.155				
	(0.284)				(0.632)				
$D\_Cutilization_{t-2}$					0.497				
					(0.643)				
$D\_Cutilization_{t-3}$					1.040**				
					(0.463)				
$D\_exports^i_{t-1}$	–0.058	–0.112	0.108	0.010	–0.088	–0.123	–0.070	0.152	–0.002
	(0.105)	(0.110)	(0.131)	(0.106)	(0.129)	(0.111)	(0.129)	(0.112)	(0.124)
Sample period	1/00-12/05	1/00-12/05	1/00-12/05	1/00-12/05	1/00-12/05	1/00-12/05	1/00-12/05	1/00-12/05	1/00-12/05
Observations	72	72	72	72	72	72	72	72	72
R^2 adjusted	0.53	0.59	0.55	0.64	0.38	0.60	0.47	0.57	0.56

Standard errors in parentheses. * indicates significance at 10% level, ** at 5% level and *** at 1% level.

Table A1.5 - China's bilateral import equations

	Dependent variable: D_imports from country i to China								
	Japan	Korea	US	Taiwan	Germany	Russia	Australia	Malaysia	Thailand
Long–run coefficients									
C	–3.501***	2.626**	5.902	–33.69***	–1.464	–0.787	–7.564***	–3.289	–0.249
	(0.963)	(3.003)	(10.123)	(10.706)	(1.294)	(6.754)	(1.838)	(3.825)	(1.125)
China's demand$_{t-1}$	–0.248	1.888***	0.643***	2.657**	0.018	–0.250	1.562***	0.119	0.272
	(0.197)	(0.621)	(0.224)	(1.149)	(0.175)	(0.626)	(0.394)	(0.472)	(0.193)
rer$^{i}_{t-1}$	–0.134	–0.588***	–1.630	–0.441	–0.248	0.555	0.161	–0.188	–0.582**
	(0.136)	(0.201)	(1.781)	(0.487)	(0.174)	(0.858)	(0.132)	(0.854)	(0.236)
FDI$^{i}_{t-1}$	0.884***	–1.022***	–0.073	3.469***	0.598***	0.314*	–0.106	1.159**	0.924***
	(0.299)	(0.380)	(0.390)	(0.889)	(0.220)	(0.172)	(0.190)	(0.566)	(0.309)
China's imports$^{i}_{t-1}$	–0.360***	–0.711***	–0.529***	–0.394***	–0.536***	–0.118	–1.169***	–0.585***	–0.574***
	(0.104)	(0.131)	(0.128)	(0.113)	(0.136)	(0.125)	(0.158)	(0.139)	(0.112)
trend		0.011**		–0.039**					
		(0.006)		(0.015)					
New Year dummy	0.049**								
	(0.019)								
Short–run coefficients									
D_China's demand$_{t}$		2.218***		2.530***			1.064**		
		(0.377)		(0.688)			(0.441)		

Table A1.5 - continued

	Japan	Korea	US	Taiwan	Germany	Russia	Australia	Malaysia	Thailand
D_China's demand$_{t-1}$									
D_China's demand$_{t-2}$									
D_China's demand$_{t-3}$									
D_rer$^{i}_{t}$		−0.928**							−0.467
		(0.392)							(0.635)
D_rer$^{i}_{t-1}$									1.547**
									(0.602)
D_rer$^{i}_{t-2}$									
D_rer$^{i}_{t-3}$									
D_FDI$^{i}_{t}$	−1.023	3.749*		8.455***			−0.371		−0.755
	(1.504)	(1.977)		(3.145)			(0.884)		(2.423)
D_FDI$^{i}_{t-1}$	−4.306***	1.075		−2.108			−0.513		−5.238**
	(1.444)	(2.101)		(3.083)			(0.953)		(2.448)
D_FDI$^{i}_{t-2}$		−1.398		−5.730**			−1.998**		
		(2.071)		(2.854)			(0.951)		

Table A1.5 - continued

	Japan	Korea	US	Taiwan	Germany	Russia	Australia	Malaysia	Thailand
$D\_FDI^{i}_{t-3}$		5.271***							
		(1.822)							
$D\_China's\ imports^{i}_{t-1}$	–0.347**	–0.095	–0.193*	–0.328***	–0.239**	–0.118	0.112	–0.077	–0.050
	(0.118)	(0.098)	(0.115)	(0.107)	(0.116)	(0.125)	(0.111)	(0.122)	(0.108)
Sample period	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05
Observations	72	72	72	72	72	72	72	72	72
R^2 adjusted	0.37	0.73	0.33	0.48	0.35	0.22	0.52	0.27	0.36

* Standard errors in parentheses. *indicates significance at 10% level, ** at 5% level and *** at 1% level.

Table A1.6 - Export equations for selected Asian countries

Dependent variable: D_Total exports from Asian country i

	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
Long–run coefficients							
C	0.875	–1.019	–0.335	–0.827	–4.598*	1.805	1.276
	(2.086)	(1.104)	(1.274)	(1.973)	(2.318)	(2.423)	(2.356)
world imports$_{t-1}$	0.962***	0.841***	0.644***	0.075	1.422***	0.465**	0.149
	(0.235)	(0.211)	(0.160)	(0.112)	(0.169)	(0.214)	(0.187)
China's reer$_{t-1}$	–0.383	–0.443***	0.817**	–0.087	–0.087	–1.105***	–0.317*
	(0.304)	(0.130)	(0.374)	(0.233)	(0.202)	(0.360)	(0.190)
reer$^{i}_{t-1}$	–0.483	–0.182**	–1.394***	0.320**	–0.774***	0.426*	0.328
	(0.309)	(0.087)	(0.465)	(0.150)	(0.453)	(0.214)	(0.255)
exports$^{i}_{t-1}$	–1.004***	–0.719***	–0.582***	–0.268***	–0.734***	–0.558***	–0.679***
	(0.167)	(0.141)	(0.134)	(0.080)	(0.146)	(0.142)	(0.133)
trend					–0.002**		0.002*
					(0.001)		(0.001)
Short–run coefficients							
D_world imports$_t$	0.545***	1.174***	0.726***	0.787***	1.449***	0.919**	0.447
	(0.184)	(0.138)	(0.213)	(0.291)	(0.169)	(0.379)	(0.275)

Table A1.6 - continued

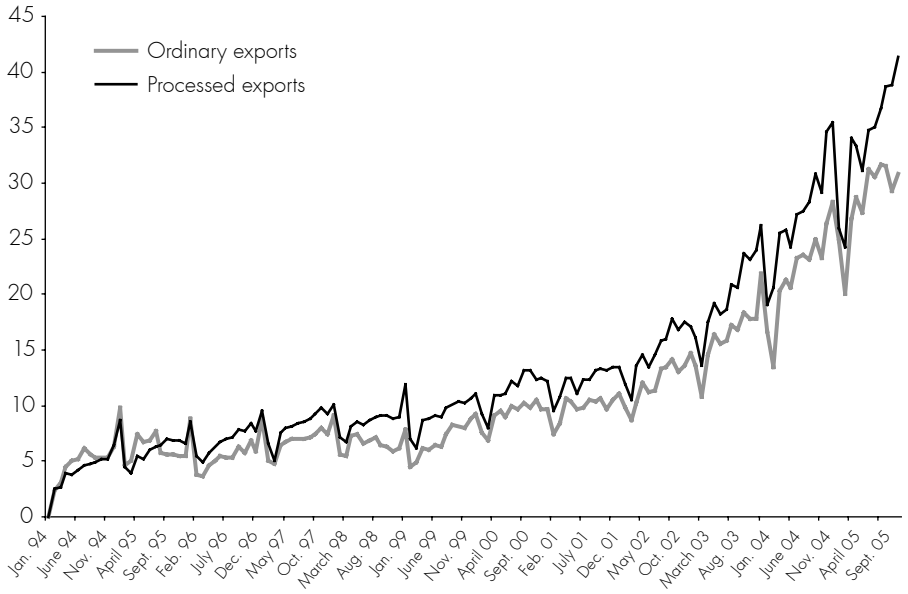
	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
D_world imports$_{t-1}$		0.262	0.658**	0.507		0.455	0.406
		(0.209)	(0.254)	(0.346)		(0.399)	(0.333)
D_world imports$_{t-2}$		0.302**	0.443*	0.519*		1.154***	0.492*
		(0.135)	(0.259)	(0.277)		(0.334)	(0.262)
D_world imports$_{t-3}$			0.459**				
			(0.201)				
D_China's reer$_t$	–0.596		–0.590*	–0.275**			–1.652***
	(0.396)		(0.352)	(0.122)			(0.441)
D_China's reer$_{t-1}$	0.446						1.384***
	(0.426)						(0.482)
D_China's reer$_{t-2}$	–0.448						
	(0.397)						
D_China's reer$_{t-3}$	0.864**						
	(0.410)						
D_reer^i_t				0.213		–0.891	1.008*
				(0.333)		(0.583)	(0.569)
D_reer$^i_{t-1}$				–0.518		0.689	–1.067*
				(0.320)		(0.583)	(0.586)
D_reer$^i_{t-2}$				–0.238*		–1.074*	
				(0.327)		(0.599)	

Table A1.6 - continued

	Hong Kong	Korea	Malaysia	Philippines	Singapore	Taiwan	Thailand
$D\_reer^{i}_{t-3}$							
$D\_exports^{i}_{t-1}$	–0.002	–0.049	–0.324***	–0.275**	–0.235***	–0.325***	0.148
	(0.114)	(0.112)	(0.100)	(0.122)	(0.081)	(0.112)	(0.115)
Sample period	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05	1/00–12/05
Observations	72	72	72	72	72	72	72
R^2 adjusted	0.53	0.70	0.65	0.28	0.70	0.55	0.46

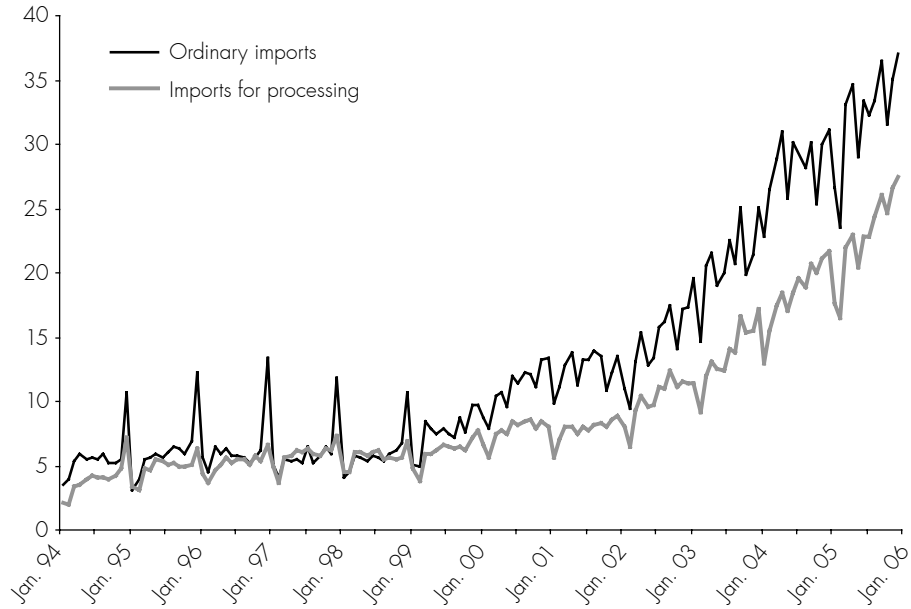
Standard errors in parentheses. * indicates significance at 10% level, ** at 5% level and *** at 1% level.

Graph A1.1 - Ordinary and processed exports, bn US$



Source: CEIC.

Graph A1.2 - Ordinary and processed imports, bn US$



Source: CEIC.

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Chapter 5

Is there a bank lending channel in China

Is there a bank lending channel in China?

Abstract

In this paper we examine whether banks' loan supply plays a role in monetary policy transmission in China. While a number of earlier studies have found the bank lending channel to exist in many advanced and emerging economies, the results so far for China are far from conclusive. We explore the bank lending channel in China, applying both the TSLS and GMM methods to 2002–2009 data on six bank groups. Our findings confirm the earlier result that interest rates still play only a minor role in the Chinese economy, and so the People's Bank of China's use of a wide selection of monetary policy tools seems reasonable. The results indicate that the largest banks – state owned and joint-stock banks – respond most actively to shifts in monetary policy stance while the foreign owned banks and rural credit cooperatives are nearly immune to monetary policy. We also find weak evidence that higher levels of capital would reduce banks' sensitivity to monetary policy. While similar results have been found for many advanced economies – results that might well suggest the existence of a functioning bank lending channel – our finding can only be considered a pre-liminary finding, due to the weak statistical significance and small sample size.

1 Introduction

Both the theoretical and empirical literature on the bank lending channel began to mushroom about two decades ago. Although the idea that monetary policy can affect banks' loan supply is considerably older, Bernanke and Blinder (1988) provided a theoretical framework for it. They showed that monetary policy can have an additional transmission channel by affecting banks' loanable funds and thus their lending. Over the last decade, numerous empirical papers have studied whether the bank lending channel exists, not only in the advanced economies but also in the emerging markets. Regarding China, however, the literature is scarce and does not provide a conclusive answer to the question of whether the bank lending channel exists there. This paper aims to fill that gap in the literature.

Most empirical studies have found that monetary policy can indeed have an impact on banks' lending although the exact form of the bank lending channel varies among countries. Furthermore, the economic significance of the channel has been estimated to be rather small, partly due to rapid development of new financial instruments and central banks' concentration on price-based policy tools, particularly in the advanced economies.[1] The onset of the financial crisis in the second half of 2000s, however, put the spotlight on banks in the discussion of a monetary policy transmission mechanism.

The structure of the Chinese financial system seems favourable for fulfilling the essential requirements set out in the theoretical literature for the lending channel. First, banks play such a dominant role in China's financial sector that at least some economic agents are dependent on bank financing, these being unable to obtain other types of external finance. Second, monetary policy still relies on quantitative tools such as reserve requirements and hence seems to be able to influence banks' lending. On the other hand, the importance of the bank lending channel may be small due to the large share of investment that is financed from companies' own cash flows.[2] Moreover, households' high savings rate and small credit stock suggest that borrowed funds play a rather limited role in household consumption (Koivu, 2012).

This study is motivated by the fact that a requisite of optimal policy-making is an understanding of the mechanisms through which monetary policy can affect real economic activity. In China's case, an understanding of the transmission mechanisms is further motivated by on-going reforms in both monetary policy and in the financial sector, which could lead to substantial alterations in the transmission mechanisms. Because many economists still claim that banks are not totally market or profit oriented (see eg Podpiera, 2007), it is particularly interesting to find out how banks react to changes in the stance of monetary policy. Obvi-ously, knowledge of the dynamics of the Chinese financial system is essential also for policy-makers in other countries, China being one of the largest economic powers in the world.

[1] See eg remarks by Ben S. Bernanke on June 15, 2007 at the conference on The Credit Channel of Monetary Policy in the Twenty-first Century at the Federal Reserve Bank of Atlanta, Atlanta, Georgia. More evidence was found by Loutskina and Strahan (2006) and by Altunbas, Gambacorta and Marques-Ibanez (2009).

[2] For example, in 2004–2009 around 30% of all fixed-asset investment in China was financed from companies' own funds.

This paper studies the monetary policy transmission mechanism using TSLS and GMM methods. These particular estimation procedures were chosen because we use lagged values of dependent variable as explanatory variables in the regressions, which means that the OLS method may give spurious results. In the estimation procedure we follow closely the earlier literature on the bank lending channel and study whether banks' reactions to shifts in monetary policy are affected by their capitalisation levels. In a number of earlier studies on other countries, higher levels of capitalisation have made banks more immune to shifts in monetary policy. This has been seen as evidence of a functioning bank lending channel in the economy. Taking into account the specific characteristics of the Chinese banking sector as well as the data limitations, we also test whether banks' dependency on deposit financing affects their reactions to changes in monetary policy.

This study confirms the earlier results that the interest rate still does not function as an effective monetary policy tool in the Chinese economy. In some cases, a hike in the interest rate actually leads to faster credit growth. Even the affects of changes in the reserve requirement are found to be weak and short-lived. As a result, the use of a wide selection of monetary policy tools seems to be justifiable in China's case. The most efficient monetary policy indicator is found to be a value indicator constructed by Shu and Ng (2010) based on announcements by the People's Bank of China (PBC). A rise in this index, which indicates monetary tightening, leads to a decline in bank-credit growth.

Regarding the existence of the bank lending channel in China, we notice that the impacts of monetary policy vary significantly among bank groups. While the large state owned banks and joint stock commercial banks do react to monetary tightening by slowing their lending growth, the reactions of foreign owned banks and rural credit cooperatives are considerably weaker. From the policy-making viewpoint, the result is of course encouraging, given that the large state owned banks and joint stock commercial banks cover the major part of the banking sector. However, with such a small sample size it is rather difficult to connect the differences in banks' reactions to their characteristics, which could be taken as a sign of a bank lending channel. We are able to find only weak evidence that better capitalised banks are more immune to a monetary policy tightening than are banks with less capital.

This paper is organised as follows. We first provide a short overview of the earlier theoretical and empirical literature on the lending channel. In section 3, we briefly describe the functioning of

monetary policy and the banking sector in China and discuss whether the preconditions for the existence of a lending channel are in place. Section 4 concentrates on analysing the bank lending channel in China by first describing the data used in the study. The estimation methods and results are summarised next. Finally, some conclusions are drawn in section 5.

2 Earlier literature on the bank lending channel

The basic IS/LM model does not allow banks to play any particular role in the monetary policy transmission mechanism. By removing some of the assumptions of that basic model, Bernanke and Blinder (1988) develop a theoretical framework in which monetary policy can affect banks' loan supply and thus the real economy via the bank lending channel. In their model, contractionary monetary policy reduces reserves and thus deposits, which forces banks to seek financing other than via reservable deposits. For banks that are illiquid or undercapitalised, the additional sources of finance can be scarce and costly, so that some banks will prefer to reduce their lending. The impacts of monetary policy running through the traditional interest rate channel are thus magnified, as monetary policy can also impact bank lending by affecting banks' loanable funds.

Besides making a difference between deposits and other forms of financing available for banks, another distinction between the traditional IS/LM model and the one by Bernanke and Blinder (1988) is that in the latter model, bank credit is not a perfect substitute for bonds. By making this distinction, the authors remove the possibility that banks would simply reduce their bond holdings as a reaction to a decline in deposits caused by a monetary tightening. In that case, monetary policy could affect bond interest rates but not banks' loan supply.

Two prerequisites for the existence of a bank lending channel emerge. First, at least some agents in the economy, either enterprises and/or households, have to be dependent on bank financing. Second, monetary authorities have to be able to affect the amount of banks' loanable funds eg via imposition of a reserve requirement.

The first requirement is closely related to the concept of imperfect information. In the financial sector, banks function as special intermediaries of finance by gathering information about their customers so as to overcome the problem of imperfect and asymmetric

information. As a result, the form of finance they provide is special and cannot always be replaced by other forms of finance. For this reason, a functioning bank lending channel is likely to have a stronger impact on small companies and households, which are more dependent on bank finance than on large enterprises, which are more commonly listed on a stock exchange or can issue bonds.

As Disyatat (2010) notes, the second prerequisite connects the traditional form of the bank lending channel tightly to the concept of money multiplier. Moreover, the theory by Bernanke and Blinder (1988) is built on the assumed strong link from bank deposit to loan supply. However, Disyatat (2010) notes that in liberalised economies an adequately capitalised banking system can always lend enough to meet the demand. This is due to the fact that quantitative constraints on banks' lending have become less effective as the role of reserve requirements have decreased. As a result, the only exogenous constraint on loan supply is in a form of capital requirement.

Thus, Disyatat (2010) does not consider the traditional form of the bank lending channel by Bernanke and Blinder (1988) relevant for the current environment but proposes an alternative theoretical framework which provides a channel for monetary policy to influence bank lending. This bank lending channel functions via banks' balance sheets. A tightening of monetary policy leads to a reduction in banks' leverage via its impacts on banks' cash flows, net interest margins, and asset valuations through both prices and the discount factor. The resulting losses on banks' assets can result in a diminution of bank capital and lead to a cutback in the supply of credit. Thus, even though the basic two requirements for the existence of a bank lending channel remain the same, the dynamics behind the second requirement are modified.

When the empirical papers on the bank lending channel started to come out it became clear that the theory by Bernanke and Blinder (1988) was difficult to test empirically. The first empirical paper on the bank lending channel was written by Bernanke and Blinder (1992). According to their VAR and impulse response analysis of US data, bank loans reacted more slowly to monetary tightening than did deposits and securities. Although the authors viewed the result as evidence of a lending channel, the paper could not give a convincing answer to the question of whether the loans actually reacted to changes in monetary policy or only passively adjusted to economic activity.

Searching for a more conclusive result, Kashyap, Stein and Wilcox (1993) studied the mix of business financing. They found that in the event of monetary tightening, firms shifted the focus of their external

financing from bank loans to issuance of commercial paper. Although the authors saw the result as support for the existence of a lending channel, Oliner and Rudebusch (1996) argued that the result could actually be due to the fact that different enterprises may react differently to a policy tightening. If, as a consequence of monetary policy tightening, small companies have to adjust their borrowing more than large enterprises, the results obtained by Kashyap, Stein and Wilcox (1993) may simply reflect this phenomenon and hence not provide convincing evidence of a bank lending channel.

Oliner and Rudebusch (1996) themselves found support for their argument using firm-level data, which enabled the authors to separate small and large firms in the U.S. manufacturing sector. They found that monetary contraction shifted all kinds of financing from small to large firms. Thus, the decrease in the share of bank loans in total financing was only natural because large firms often rely less on loans than do small firms. More evidence on the reactions of small firms to monetary tightening being stronger than those of large firms was found in the US data by Gertler and Gilchrist (1994).

These first steps in empirical analysis of the existence of the bank lending channel thus clearly showed that the empirical testing of the theory by Bernanke and Blinder (1988) was hindered by the difficulties in separating credit supply and demand. Although the bank lending was found to react negatively to a monetary tightening it was not possible to analyse the extent of the decline attributable to supply conditions.

As a result, empirical studies on the bank lending channel moved on to analyse bank lending with respect to banks' characteristics and balance sheets even prior to the existence of a suitable theoretical framework. Kashyap and Stein (1995) were the first to use bank-level data. They analysed whether small and large banks' balance sheets react differently to a monetary policy tightening in the US. They found that smaller banks react more strongly to a monetary contraction than larger banks. In a later study, Kashyap and Stein (2000) found even more convincing evidence of a bank lending channel when they also included the level of bank liquidity in the estimation. According to their results, small illiquid banks react more to a monetary tightening than do large liquid banks. Kishan and Opiela (2000) added the bank capital leverage ratio as a third bank characteristic in studying the lending channel. Using US data, they found that banks' capitalisation also plays a role in monetary policy transmission. In their later paper, Kishan and Opiela (2006) found banks' response to policy stance to be asymmetric. Since implementation of Basel I and the Federal Deposit Insurance

Corporation Improvement Act (FDICIA), contractionary monetary policy has had a restraining effect on the growth of lending by banks with low levels of capitalisation. On the other hand, the response of banks with low levels of capitalisation on monetary easing was found weak. The opposite is true for banks with high levels of capitalisation. Ashcraft (2006) studied whether banks affiliated with multinational holding companies react differently to monetary tightening. According to his results, based on extensive panel data on US banks, the lending of banks not affiliated with multinational companies is more sensitive to insured deposit growth. The result holds on the aggregate level, so that total lending is affected by monetary policy. However, Ashcraft did not find evidence that a decrease in bank lending would have a significant impact on real economic activity in the US.

Thus, the evidence from the US that big, liquid, highly capitalised and international banks are less affected by monetary policy tightening than the other banks seems to be rather convincing. More recently, studies covering also other economies such as the euro area, Eastern European countries and a growing number of other emerging economies have mushroomed. However, the results concerning the bank lending channel in the euro area are not as unanimous as those for the US. Although the bank lending channel is found to function in most cases, the findings vary not only across countries but also in respect to the bank characteristic that is important in terms of the bank lending channel. For example, findings from a number of country-specific studies (results from a number of parallel studies are summarised in Ehrmann et al 2001) using quarterly bank-level data and the GMM method suggest that the level of bank liquidity affects monetary policy transmission mechanisms in most Western European countries but bank size and level of capitalisation affect the banks' reactions to monetary-policy shocks only in some countries. Somewhat different results were found by Altunbas, Fazylov, and Molyneux (2002), who studied 11 EMU countries in 1991–1999. Using annual data for the whole area, they found evidence that capitalisation affects the way banks react to monetary policy, in that undercapitalised banks tend to be more responsive to monetary policy. However, in their country-specific estimations on the four largest EMU countries, the authors could find weak evidence of a bank lending channel only in Italy and Spain. Using data solely on Italian banks, Gambacorta and Mistrulli (2004) confirmed the result that the level of bank capital does affect the way banks react to a monetary tightening. Gambacorta (2005) found that, besides an abundance of capital, several other factors reduced a bank's sensitivity to monetary policy: liquidity level, the bank's affiliation with a larger financial

group, and its access to internal capital markets. Otherwise, the size of the bank did not have a significant impact. In a separate study on the bank lending channel in Germany, Hülsewig, Mayer and Wollmershäuser (2006) used a VAR model and aggregate-level data. The authors compared theoretical and empirical impulse responses to a monetary policy shock and found evidence of a functioning bank lending channel in Germany. Finally, in a more recent study by Brissimis and Delis (2010) higher levels of both liquidity and capitalisation were found to make banks' less sensitive to monetary tightening, in both the US and euro area.

The recent variation in results might be related to the finding that developments in banks' product range and changes in banks' practises influence the functioning of the bank lending channel. For example, Loutskina and Strahan (2006) and Altunbas, Gambacorta and Marques-Ibanez (2009) found that the increase in banks' securitisation activity has reduced the effectiveness of the bank lending channel. As banks' new practices such as the securitisation have proceeded at different pace in different countries, it may have led to the different results concerning the bank lending channel in eg euro area.

Finally, Ciccarelli, Maddaloni and Peydró (2010) attempted to overcome the difficulties of the earlier papers in distinguishing between the demand and supply sides of bank lending by using bank lending surveys to study whether the supply of bank loans is affected by monetary policy. Using the VAR method, the authors confirm that the bank lending channel is found to function in both the US and euro area.

For our purposes here, the papers on emerging economies are the most interesting. Actually, there is a good deal of evidence of a bank lending channel in a number of emerging markets. A high level of liquidity, in particular, seems to decrease the negative impact of a monetary policy contraction on bank lending in a number of new EU member countries in Central and Eastern Europe (summarised by Brooks, 2007). Bank capitalisation also plays a role in monetary policy transmission, but bank size is found to be important only in Hungary. Very similar results were presented in a recent paper on the new EU member countries by Matousek and Sarantis (2008). They found evidence of a bank lending channel in all eight CEE countries studied. The channel seemed to have also macroeconomic relevance.

These results are supported by evidence from Turkey, where the level of liquidity, but not capitalisation or size, has a robust impact on the way bank lending reacts to a monetary policy contraction (Brooks, 2007). Using VAR analyses, the lending channel has been found to function also in Chile and Egypt (Alfaro et al, 2003, Al-Mashat and

Billmeier 2007). Arena, Reinhart and Vázquez (2007) studied the bank lending channel in a number of Asian and Latin American emerging countries. They studied whether a bank's size, liquidity or capitalisation affects its lending and found weak evidence that the level of capitalisation or liquidity affects the way a bank reacts to changes in monetary policy. Less capitalised or illiquid banks reduced their lending more than did highly capitalised, liquid or foreign banks when interest rates rose. In conclusion, the evidence of a bank lending channel from emerging economies is quite convincing.

Regarding the bank lending channel in China, a paper by Liu and Xie (2006) describes the Chinese financial sector from the perspective of a bank lending channel but does not include any econometric estimation. The only systematic research paper that we are aware of is by Gunji and Yuan (2010), which is based on bank-level data for 1985–2007. In the baseline model, the authors find that the bigger the bank, the less affected it is by monetary policy. Similarly, high profitability helps to shield a bank from monetary policy while the level of liquidity or capital does not seem to affect its lending. However, when the authors follow more closely the earlier literature on the bank lending channel by including lagged values of the dependent variable in GMM regressions, the results are nearly reversed: neither size nor profitability has a statistically significant impact on the way a bank reacts to changes in monetary policy. While liquidity and capital now seem to affect banks' behavior, the sign of the interaction term is contrary to expectations, so that a higher level of capital or liquidity increases a bank's vulnerability to monetary policy. We thus conclude that the results so far on China's bank lending channel are inconclusive.

3 Some characteristics of the Chinese banking sector and monetary policy

As we saw above, there are two prerequisites for a bank lending channel to exist in an economy: at least some of the economic agents must be dependent on bank financing and monetary authorities must be capable of affecting commercial banks' lending. In this section we examine whether these two prerequisites can obtain at some point as regards China's banking sector.

While in the advanced economies, the development of diversified financial markets and current practices in both monetary policy and the banking sector have likely reduced the importance of the bank

lending channel, in the Chinese economy this does not seem to be the case. First of all, China's banking sector is exceptionally large. At the end of 2009, the sector's total assets[3] amounted to more than 200% of GDP, making China's banking sector one of the biggest in the world. The vast banking industry reflects not only banks' traditional role as a part of the political system but also the lack of other investment and financing opportunities. Although the size of the stock market has recently increased, its share in companies' external finance is still modest, and access to the stock markets remained until recently very limited for privately-owned and medium-sized companies. In addition, the corporate bond market is still miniscule. It is thus clear that China fulfils the first prerequisite, namely that bank credit plays an essential role in the economy and the large volume of financing that it provides would be difficult to replace with any other form of financing.

On the other hand, certain characteristics of the underdeveloped financial markets may also diminish the importance of bank credit in the Chinese economy. In particular, bank lending has been channelled to a large extent to the state-owned companies (see eg Liu and Xie, 2006). The limited access of small and medium-sized enterprises as well as households to external finance reduces their vulnerability to monetary contraction (Koivu, 2012). Thus, even if the bank lending channel exists, its impact on these parts of the economy is likely to be limited.

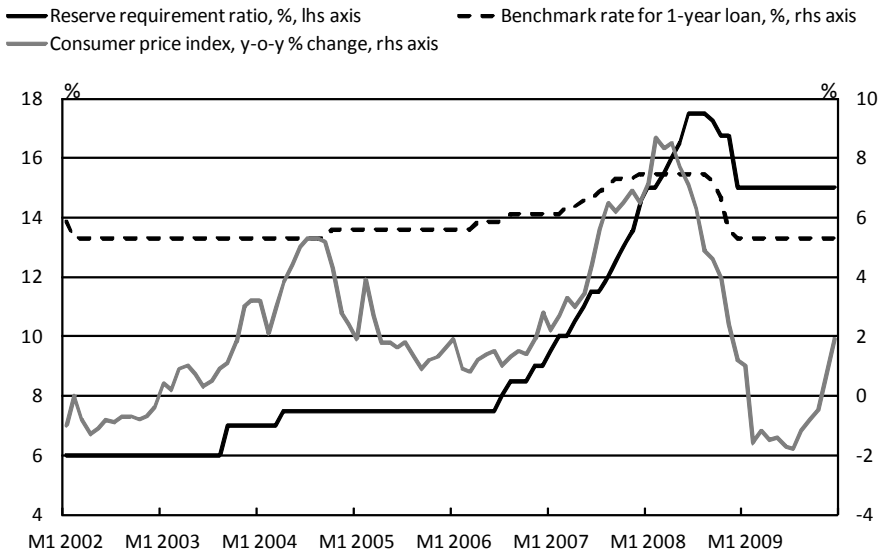
The fulfilment of the second prerequisite for the bank lending channel – the capability of authorities to affect bank lending – is facilitated by the fact that Chinese banks are still mainly publicly owned. Reflecting this ownership structure, the banking sector still has strong links to the public sector (Shih, 2008).

The existence of a bank lending channel is probably also supported by the nature of Chinese monetary policy. The use of quantitative rather than price-based policy tools increases the possibility that the bank lending channel in its traditional form exists in China. For example, in 2007 alone, China raised the commercial banks' reserve ratio numerous times, in all from 9% to 14.5%, and in autumn 2008 the requirement was quickly lowered in response to onset of the global financial crisis (Figure 1). As another example of the use of quantitative monetary policy tools, the authorities still give direct guidelines to commercial banks, to either limit or boost credit growth.

[3] The banking sector here includes policy banks, state-owned commercial banks, joint stock commercial banks, cooperative financial institutions, Post Savings Bank of China and finance companies.

At the same time, the use of interest rates as a monetary policy tool is still limited. Supporting this view, a number of studies have found quantitative tools to have had a significant impact on the real economy while the role of interest rates in the Chinese economy is still considered small (see eg Koivu, 2009, Laurens and Maino, 2007, Mehrotra, 2007 and 2008).

Figure 1 **Consumer price inflation and use of monetary policy variables in China: commercial banks' reserve requirement and 1-year lending rate, %**



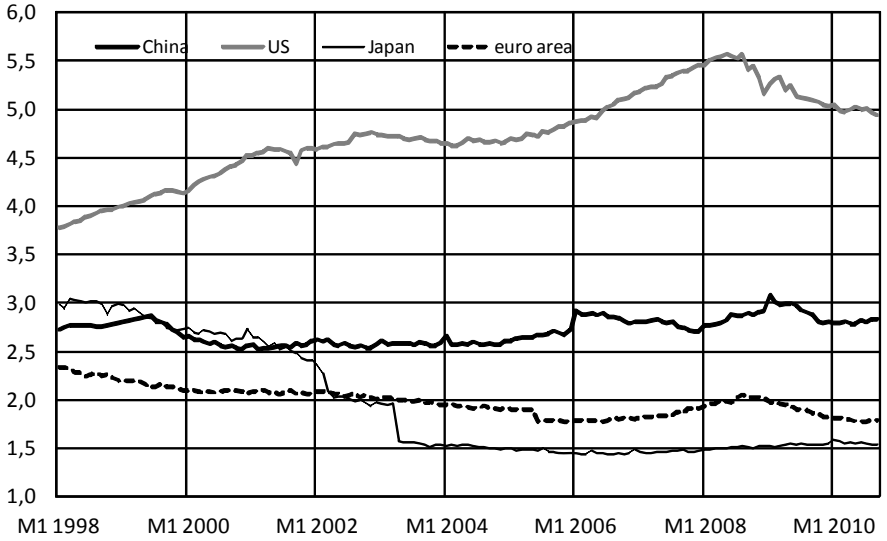
Source: CEIC.

The authorities' power over the banks' loanable funds is increased by the fact that the commercial banks have only limited access to forms of financing other than deposits of households and non-financial corporations. Earlier on, central bank lending was another source of finance for banks, but over the recent decade this source has been strictly limited, as the monetary authorities has been keen to control the amount of liquidity in the economy in the presence of vast inflows of foreign exchange. The establishment of the interbank market in the second half of the 1990s did not significantly change banks' situation, as the market remained small and illiquid for many years (Xie, 2004). Only in very recent years, has the interbank market grown rapidly, and

it now seems to be increasingly effective in channelling money between Chinese banks.

The authorities' relatively strong influence on banks' loanable funds in China is reflected in the relatively modest in variation in the money multiplier.[4] In many advanced economies, where the central banks have concentrated on guiding the target interest rates, the variation in the money multiplier has been more considerable (Figure 2).

Figure 2 **Money multiplier in China and selected advanced economies**



Source: IFS.

4 Studying the bank lending channel in China

Now that we have seen that the two prerequisites for the existence of a bank lending channel are fulfilled in China, we turn to the question of whether the bank lending channel actually functions in the economy. First we approach the topic by analysing descriptively banks' behaviour after an identified change in the country's monetary policy

[4] Defined as M2/M1, except for China's money multiplier: (money + quasi-money)/money.

stance, after which we analyse the bank lending channel more formally by carrying out TSLS and GMM analyses.

As noted above, the earlier results on the bank lending channel in China are inconclusive. We aim to deepen the picture of the dynamics between monetary policy and banking sector in China by using quarterly data in contrast to Gunji and Yuan (2010), who use annual data. Unfortunately, the quarterly data are available only for six bank groups[5] for 2002–2009.

When studying China's monetary policy one of the challenges is to decide on a monetary policy indicator. As mentioned above, China has regularly used a wide selection of monetary policy tools[6] and there is no consensus among researchers as to how to define the monetary policy stance in China. This is not so much of a problem for our first aim, which is to analyse commercial banks' lending descriptively. For this purpose we can identify three turning points in the monetary policy stance during our research period by analysing the changes in both the reserve ratio and the benchmark interest rate for 1-year loans (Figure 1). Based on these time series we find that a minor shift in China's monetary policy occurred in the second half of 2003 when the authorities began to tighten the policy stance eg by boosting the reserve ratio twice. Also the benchmark rate for bank credit was raised in the first half of 2004. An even more definite period of monetary tightening began in the second half of 2006 and lasted for about two years. This period involved not only a number of hikes in the reserve requirement but also some increases in benchmark interest rates. Both episodes of tightening were motivated by rapid increases in inflation. In our research sample, the only period when monetary policy was significantly eased began right after the full onslaught of the global financial crisis in the autumn of 2008.

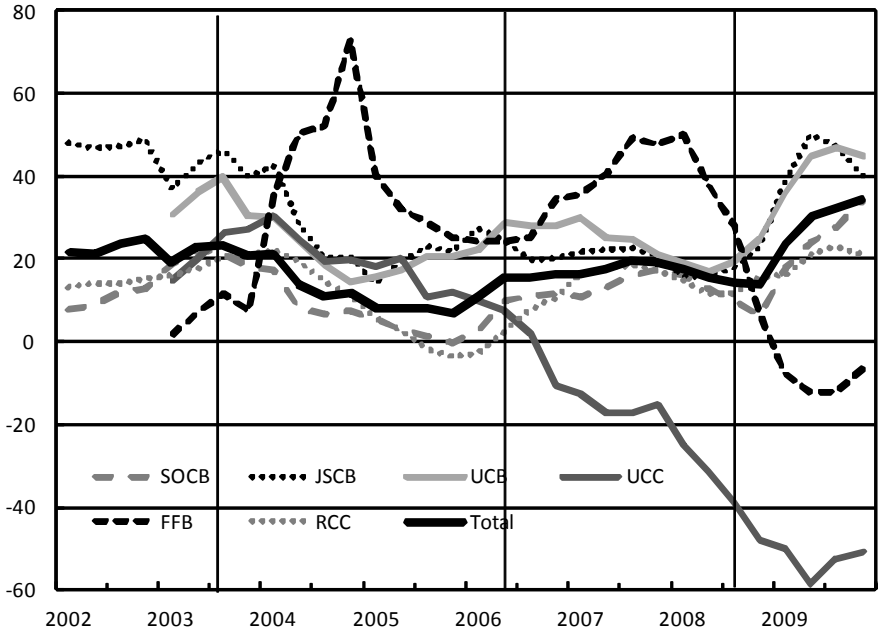
If we now turn to an analysis of what happened to credit growth after these three turning points, we find that in 2004 credit growth slowed significantly after monetary tightening measures were implemented (Figure 3). In 2007–2008, somewhat surprisingly, the reaction was considerably milder, although the tightening was much more pronounced than during the previous period of tightening. On the other hand, credit growth responded very quickly and strongly to the loosening of monetary policy since the autumn 2008.

[5] The groups: 1) large state-owned banks; 2) joint stock commercial banks; 3) urban city banks; 4) foreign-funded banks; 5) urban credit cooperatives; and 6) rural credit cooperatives.

[6] A useful summary of Chinese monetary policy tools is found eg in Geiger (2006).

Interestingly, one finds substantial differences among bank groups' reactions to the shifts in monetary policy. For example, lending by foreign funded banks seems to be nearly immune to the stance of monetary policy. In this group, credit growth accelerated during both periods of tightening and has actually slowed down since the second half of 2008. Another major exception is the group of urban credit cooperatives, whose lending has been declining since 2006 in the face of substantial structural reforms. Among the other bank groups, the overall trends in credit growth have been similar.

Figure 3 **Credit growth in China in 2002–2009, annual %-change**



Source: CEIC, People's Bank of China.
Note: SOCB = state owned commercial banks, JSCB = joint stock commercial banks, UCB = urban commercial banks, UCC= Urban credit cooperatives, FFB = foreign funded banks, RCC = rural credit cooperatives. The vertical lines indicate turning points in monetary policy in 2003, 2006 and 2008.

Obviously, the descriptive analysis is not sufficient to determine which factors cause the shifts in credit growth. Thus, in order to further illuminate the dynamics of credit growth, we turn to econometric analysis. We analyse the bank lending channel in China following the approach by Kashyap and Stein (1995). This kind of specification, where credit growth is explained by macroeconomic

factors, monetary policy and bank-specific factors, is commonly used in the bank lending channel literature and allows us to compare our results for China with those for other countries. The equation to estimate is

$$\Delta L_{i,t} = a\Delta L_{i,t-1} + \sum_{j=1}^{4} b_j \Delta M_{t-j} + \sum_{j=1}^{4} c_j \Delta MP_{t-j} + \sum_{j=-1}^{4} e_j \Delta MP_{t-j} \cdot X_{t-j} + \lambda X_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where $\Delta L_{i,t}$ denotes the real growth rate of bank loans in period t and M is a set of macroeconomic variables. MP_t is a monetary policy indicator and $X_{i,t}$ is the bank-specific variable. In studying the bank lending channel, we are particularly interested in the interaction term $\Delta MP_t \cdot X_{i,t}$, which indicates whether bank characteristics play a role in the monetary policy transmission mechanism. In the equation, i = 1,…, N refers to each banking group and ε is the error term. To avoid the problem of endogeneity, we have lagged all the explanatory variables.

The exact sources and definitions of the data are found in Table A1 in the Appendix. We measure credit growth in China by using data on banks' claims in the non-financial sector.[7] The set of macroeconomic variables is supposed to capture changes in credit demand, which we try to measure by using data on industrial output. We use industrial output instead of GDP simply because there are no official quarterly data on real GDP for our research period. Both credit stock and industrial production are in logs and real terms.

As already mentioned, there is no consensus among researchers as to how to define the monetary policy stance in China. While the monetary aggregates are often believed to best describe the policy stance, their use in this study would be problematic. Using reserve money would be problematic because the continuous changes in the reserve requirement may lead to misinterpretations of this indicator (Koivu, 2012). On the other hand, wider monetary aggregates (eg M2) are closely related to our dependent variable and so cannot be used. We end up introducing three indicators for China's monetary policy: the reserve ratio, an interest rate, and the value indicator for monetary policy developed by Shu and Ng (2010). The trends in the monetary policy indicators are presented in Figure A1 in the Appendix. The

[7] Unfortunately, sectoral credit data, which would enable more detailed analysis, are not available.

reserve ratio has since 2003 been specified for each banking group, and we use these group-specific ratios in our estimations. As the interest rate, we use a 7-day repo rate, argued to be the most significant of the Chinese interbank interest rates, given the liquid markets and frequent observations (Peng, Chen and Fan, 2006). This particular interest rate also follows rather closely the path of benchmark lending and deposit rates set by the PBC. According to Shu and Ng (2010), the value indicator is a 7-step measure that takes into account 'apart from the stated broad policy direction, information such as the PBoC's assessments on the near-term overall economic performance and the aims of macroeconomic adjustment'. The major sources used for the indicator are PBC's Monetary Policy Reports and the announcements of the quarterly meetings of the PBC Monetary Policy Committee.

The choice of bank-specific variables is restricted by the availability of data. As mentioned above in the earlier papers the banks are often characterised by their size, level of liquidity and capital, and in some cases by their profits or links to multinational banks. However, data are not available on all these indicators, so we end up using two banking sector indicators: the level of capitalisation (Cap) and the share of deposits (Dep) in banks' total liabilities.[8] While capitalisation is commonly used in the earlier literature, the decision to use the share of deposits as an additional indicator is based on the theory by Bernanke and Blinder (1988). Accordingly, a monetary policy tightening forces banks to replace the loss of deposits with another kind of financing. This replacement is assumed to be more difficult and costly for banks that are not used to seeking financing from other sources. As a result, lending by banks that are more dependent on deposits might decrease more after a monetary policy tightening than would lending by banks with more diversified liability structures. On the other hand, according to Disyatat (2010), a policy tightening may actually influence more those banks that are dependent on market financing than banks relying on deposit financing. We can test the applicability of these theories to the Chinese data by using this particular variable.

Both of our time series on banks are normalised over time and over the mean of all bank groups by the following method

[8] We follow here partly Ascraft's (2006) indicator for the 'bank finance mix', defined as the ratio of insured deposits to the total of deposits and net federal fund borrowing.

$$Cap_{it} = C_{it} / A_{it} - 1/T \sum_{t=1}^{T} \left(1/N \sum_{i=1}^{N} C_{it} / A_{it} \right)$$

$$Dep_{it} = D_{it} / A_{it} - 1/T \sum_{t=1}^{T} \left(1/N \sum_{i=1}^{N} D_{it} / A_{it} \right)$$

where A denotes total assets/liabilities, C capitalisation (paid-in-capital as % of total assets) and D the share of deposits in banks' in total liabilities.

Table 1. **Descriptive statistics for banking groups in 1Q02–4Q/09, period averages.**

Variable	SOCB	JSBC	UCB	UCC	FFB	RCC
real y-o-y loan growth, %	9.86	24.41	23.46	-9.40	21.51	9.69
total assets at end-2009, % of sector's total	57.75	23.20	8.52	0.06	2.13	8.33
paid-in-capital, % of total assets	3.39	1.81	3.07	3.06	9.47	3.81
deposits as % of total liabilities	75.28	69.32	77.95	86.53	16.28	87.28

Source: CEIC.
Note: SOCB = state-owned commercial banks, JSCB = joint-stock commercial banks, UCB = urban commercial banks, UCC = urban credit cooperatives, FFB = foreign-funded banks, RCC = rural credit cooperatives.

As sees from Table 1, there are significant differences between bank groups. While the level of capitalisation of Chinese banks has traditionally been rather low, the foreign owned banks are clearly outliers in this respect. The foreign banks differ considerably from their Chinese counterparts also in terms of deposit shares. In the foreign banks, more than 80% of total liabilities are from sources other than deposits; at the other end, the rural and urban credit cooperatives are highly dependent on deposits. The other Chinese bank groups have somewhat more differentiated structures of liabilities.

4.1 TSLS estimations with pooled data

As mentioned above, we use quarterly data on six bank groups for 2002–2009, so that $T > N$, which means that (unlike most of the earlier papers using micro-level data) we cannot rely on panel data

estimation methods. Furthermore, due to the fact that we have a lagged dependent variable on the right hand side of equation (1), OLS estimation may produce spurious results. To avoid this problem, we employ an instrumental method of two-stage least squares for pooled data. In the first stage, an OLS regression estima-tion is carried out for each variable in the model using the instrument set; and in the second stage, the original equation is estimated with the variables replaced by their fitted values from the first-stage re-gressions.

In choosing the instruments, we need to take into account the constraint that the minimum number of in-struments is the number of estimated coefficients. On the other hand, we try to avoid the problem of over-identification by keeping the structure of the instruments relatively simple. We thus introduce as instruments all the explanatory variables that are considered exogenous as well as the second lags of credit growth and the bank variable; their first lags presumably being correlated with the error term in (1).

The results from the TSLS estimations are presented in Tables 2–4. We introduce at most four lags in all specifications to capture delays in the monetary policy transmission mechanism. However, where not statistically significant[9] we shortened the string of lags.

According to our results, credit growth is highly persistent in that the coefficient of lagged credit growth is found to be 0.8–1.2 in each specification. Somewhat surprisingly, reactions to all the other explanatory variables remain rather weak. For example, the positive reaction of credit growth to a rise in economic growth rate measured by industrial output growth dies out in some specifications. We assume that the weak link between economic development and credit growth is due to banks' occasionally more political than financial-intermediary role in the economy. The weak and even negative link from economic growth to credit growth was also found by Koivu (2009).

[9] In a few cases we also report marginally insignificant coefficients if leaving them out leads to much lower R^2.

Table 2 **Results for pooled TSLS using reserve money with 7-day repo rate as monetary policy indicator and loan growth as dependent variable**

	Basic model		Banking sector variable			
			Level of capital		Dependence on deposits	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
ΔL_{t-1}	1.037***	0.109	1.045***	0.107	1.026***	0.107
Δy_{t-1}	–0.699	0.489	–0.124	0.298	–0.117	0.299
Δy_{t-2}	0.338	0.381	0.270	0.284	0.287	0.291
Δy_{t-3}	–0.724	0.483	–0.873**	0.336	–0.817**	0.364
Δy_{t-4}	0.984**	0.487	0.661**	0.282	0.678**	0.289
Δinterest rate$_{t-1}$	0.024	0.021	0.016	0.011	0.044	0.030
Δinterest rate$_{t-2}$	–0.039**	0.019				
Δinterest rate$_{t-3}$	0.045*	0.027				
Δinterest rate$_{t-4}$						
Banking sector variable			0.000	0.002	–0.003	0.012
Δint. rate$_{t-1}$·Banking sector variable$_{t-1}$			–0.002	0.004	–0.029	0.028
Δint. rate$_{t-2}$·Banking sector variable$_{t-2}$						
Δint. rate$_{t-3}$·Banking sector variable$_{t-3}$						
Δint. rate$_{t-4}$·Banking sector variable$_{t-4}$						
Adj. R^2	.26		.31		.32	

Table 3 **Results for pooled TSLS using reserve money with reserve ratio as monetary policy indicator and loan growth as dependent variable**

	Basic model		Banking sector variable			
			Level of capital		Dependence on deposits	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
ΔL_{t-1}	1.057***	0.100	1.120***	0.0111	0.937***	0.102
Δy_{t-1}	–0.550	0.591	–0.604	0.608	–0.135	0.330
Δy_{t-2}	–0.605	0.367	–0.631*	0.377	0.328	0.281
Δy_{t-3}	0.318	0.553	0.351	0.568	–0.521*	0.288
Δy_{t-4}	0.755***	0.284	0.751**	0.751	0.681**	0.280
Δres. req_{t-1}	–0.006	0.007	–0.005	0.007	–0.006	0.015
Δres. req_{t-2}	0.027***	0.007	0.028***	0.007		
Δres. req_{t-3}	–0.021*	0.011	–0.023*	0.012		
Δres. req_{t-4}						
Banking sector variable			0.001	0.002	–0.011	-0.011
Δres. $req._{t-1}$·Banking sector $variable_{t-1}$			–0.001	0.002	0.003	0.003
Δres. $req._{t-2}$·Banking sector $variable_{t-2}$			0.001	0.002		
Δres. $req._{t-3}$·Banking sector $variable_{t-3}$			–0.005**	0.002		
Δres. $req._{t-4}$·Banking sector $variable_{t-4}$						
R^2	.35		.32		.37	

Table 4 **Results for pooled TSLS using reserve money with HKMA value indicator as monetary policy indicator and loan growth as dependent variable**

	Basic model		Banking sector variable			
			Level of capital		Dependence on deposits	
	Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
ΔL_{t-1}	0.901***	0.081	0.960***	0.083	0.927***	0.084
Δy_{t-1}	0.726**	0.316	0.729**	0.307	0.794**	0.354
Δy_{t-2}	–0.720**	0.325	–0.764**	0.316	–0.672*	0.361
Δy_{t-3}						
Δy_{t-4}						
ΔMP value indicator$_{t-1}$	–0.006*	0.003	–0.006*	0.003	0.016	0.010
ΔMP value indicatort$_{t-2}$	–0.011***	0.004	–0.011***	0.004	–0.013	0.010
ΔMP value indicatort$_{t-3}$	0.018***	0.004	0.019***	0.004	0.018*	0.010
ΔMP value indicatort$_{t-4}$	–0.006**	0.003	–0.007**	0.003	–0.016*	0.009
Banking sector variable			0.001	0.001	–0.005	0.011
$\Delta MPVA_{t-1}$·Banking sector variable$_{t-1}$			0.004***	0.001	–0.022**	0.010
$\Delta MPVA_{t-2}$·Banking sector variable$_{t-2}$			–0.000	0.001	0.001	0.010
$\Delta MPVA_{t-3}$·Banking sector variable$_{t-3}$			0.001	0.001	0.001	0.009
$\Delta MPVA_{t-4}$·Banking sector variable$_{t-4}$			–0.004***	0.001	0.009	0.009
R^2	.46		.49		.45	

Neither of the banking sector characteristics alone has a significant impact on credit growth. The positive coefficient of the level of capital in all specifications is as expected but never statistically significant. The coefficient of banks' dependence on deposits is negative, which means credit growth is slower for banks whose liability structure is more concentrated on deposits. However, the link is not statistically significant.

Our results for banks' reactions to monetary policy confirm the earlier result that the role of interest rates is still small in the Chinese economy (see eg Koivu, 2009). In both specifications with two separate banking sector indicators, a rise in the interest rate would actually lead to an increase in credit growth, although the result is not statistically significant. The result for banks' reactions to a rise in the reserve ratio is not much more encouraging from the viewpoint of policy-makers. By summing up the significant coefficients on notes that the accumulated impact of a rise in the reserve ratio on credit growth is actually positive. Thus, a simple rise in the reserve ratio seems not to be sufficient to lower the growth rate. Part of the explanation behind the weak result may lie in the time period studied, which coincides with strong currency inflows to China, and the hikes in the reserve ratio probably sterilised only partly the impacts of the continuous currency market interventions. This implies that the growth of liquidity and credit have continued apace, even in the face of increases in the reserve requirement. Finally, our last monetary policy indicator is the value indicator developed by Shu and Ng (2010). As expected, a rise in this index leads to a slowdown in credit growth. However, the impact turns positive and less significant in the specification with banks' dependence on deposits.

To study the existence of a bank lending channel in China we follow the earlier literature and use an interaction term between the indicators for monetary policy and banking sector characteristics. Based on the earlier literature, a decrease in credit growth caused by a tightening of monetary policy is expected to be partly offset by a high level of capital. Thus, in a standard case where a rise either in the interest rate, reserve ratio or the monetary policy value indicator leads to slower credit growth, the interaction term is expected to be positive. Expectations for the interaction term with banks' dependence on deposit are ambiguous. According to the theory by Bernanke and Blinder (1988), a bank which is less dependent on deposit financing may suffer less from a tightening and thus the interaction term would be positive. On the other hand, Disyatat (2010) assumes that banks relying on larger market-based shares of financing are in a more vulnerable position, so that the impacts of monetary tightening on

their balance sheet and lending might actually be more extensive. This would imply a positive coefficient of the interaction term.

In China's case, the interpretation of the coefficients of the interaction terms is complicated by the weak re-sults obtained on the impacts of monetary policy on credit growth. Furthermore, only few interaction terms are statistically significant. When using the HKMA value indicator to measure the stance of monetary policy, we obtain only weak signs that a high level of capital makes a bank slightly less vulnerable to monetary policy. Even this effect is reversed later on. In addition, it seems that a monetary tightening, as measured by the value indicator, actually leads to a slightly smaller decrease in lending for banks that are highly dependent on deposits, thus providing slight support for the Disyatat (2010) view.

In sum, the results for pooled data on six bank groups do not clarify the mixed picture presented by the earlier study by Gunji and Yuan (2010) as regards the bank lending channel in China. If anything, our results cannot be seen as strong evidence of a bank lending channel in China similar in form to those found in a number of advanced economies. We look next at the results for individual bank groups, to determine whether data pooling hides the trends in the data that we are interested in.

4.2 Studying the behaviour of each banking group separately

So far, we know very little about how individual bank groups in China react to changes in monetary policy. In reality, their reactions can be rather heterogeneous, depending eg on their ownership and customer structure and operating area. To illuminate the reactions of each individual banking group to monetary policy, we estimate a separate dynamic equation for each banking group's loan growth. We use the Generalized Method of Moment (GMM), because of the lagged dependent variable on the right hand side of the estimation equation

$$\Delta L_t = a\Delta L_{t-1} + \sum_{j=1}^{4} b_j \Delta y_{t-j} + \sum_{j=1}^{4} c_j \Delta MP_{t-j} + \varepsilon_t \qquad (2)$$

where ΔL_t denotes the real growth rate of bank loans in period t and y is the proxy for economic activity, measured by industrial output. MP_t is an indicator of monetary policy and ε is the error term. As regards measuring the monetary policy stance, we use the same three

indicators as above: 7-day repo rate, banking group specific reserve requirement and the value indicator developed by Shu and Ng (2010). To avoid the problem of endogeneity, we lagged all the explanatory variables. As instruments, we use all the exogenous variables in our equation and the second lag of the dependent variable. Due to the small sample size, we try to keep the number of estimated coefficients and instruments as small as possible. To test the validity of the instruments, we apply the Hansen test and report the J-statistics together with the results in Table 5–7.

The results indeed reveal significant differences between the bank groups' lending behaviour. As noted in using the pooled data, lending growth is a relatively persistent phenomenon although the coefficients of lagged credit growth now vary more than earlier, between 0.2 and 1.0. Bank groups' reactions to economic growth vary considerably. Urban credit cooperatives, which have been reformed and whose lending has been decreasing in recent years, actually react negatively to positive economic developments. All the other bank groups react positively to economic growth, although the size of the impact varies greatly. The strongest reaction can be seen in lending by the joint-stock commercial banks; the reactions of state-owned banks and rural credit cooperatives are considerably smaller. This result is not surprising taking into account the large banks' role in carrying out very politically oriented functions and the concentration of rural credit cooperatives on lending projects in the countryside and in agriculture, in particular. Demand for these projects is not well captured by our indicator for macroeconomic conditions, industrial output growth.

Note the definite differences also in banks' sensitivity to monetary policy. The earlier result, that the role of interest rates as a monetary policy tool is still limited, is confirmed again. None of the bank groups reacts to a rise in the interbank rate by decreasing their lending, as one would expect. Actually, some of the bank groups react positively to higher interest rates. The immediate impact of a hike in the reserve requirement on lending is negative in most bank groups. However, the impact turns rapidly positive and the accumulated impact one year after the hike is positive, except for lending by joint-stock banks and urban credit cooperatives. Confirming our results for TSLS, the value indicator for monetary policy stance developed by Shu and Ng (2010) has the most permanent effect on banks' lending. When monetary policy is tightened, as measured by this indicator, lending decreases by all banks other than the rural credit cooperatives and foreign-funded banks.

Table 5 **Results for GMM estimations on each banking group with 7-day repo as monetary policy indicator and loan growth as dependent variable**

	SOCB		JSCB		UCB		FFB		UCC		RCC	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**
ΔL_{t-1}	0.910***	0.136	0.894***	0.125	0.782***	0.044	0.932***	0.204	1.054***	0.027	0.586***	0.037
Δy_{t-1}	–1.199***	0.295	–0.955***	0.325	–0.646***	0.076	0.641***	0.191	–0.545***	0.085	0.577***	0.055
Δy_{t-2}	0.615***	0.120	–0.294**	0.133	-0.150**	0.069	–0.147	0.208	2.648***	0.046	–0.484***	0.036
Δy_{t-3}	0.649**	0.237	0.890**	0.383	0.416***	0.416	–0.608***	0.093	–4.503***	0.074		
Δy_{t-4}			0.512*	0.302	0.635***	0.635			2.154***	0.103		
ΔIR_{t-1}	–0.011	0.012	0.019	0.020			–0.005	0.010				
ΔIR_{t-2}	–0.006	0.008	–0.036**	0.015			0.019**	0.009				
ΔIR_{t-3}	0.023*	0.013	0.053***	0.016								
ΔIR_{t-4}												
D_Q408											0.077**	0.028
R^2	.31		.22		.27		.39		.81		.60	
J-stat.	3.229		1.216		6.565		4.275		1.150		2.569	

Table 6 **Results for GMM estimations on each banking group with reserve ratio as monetary policy indicator and loan growth as dependent variable**

	SOCB		JSCB		UCB		FFB		UCC		RCC	
	Coeff.	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**	**Coeff.**	**Std. err.**
ΔL_{t-1}	0.771***	0.098	0.334**	0.138	0.665***	0.130	0.423**	0.181	1.008***	0.047	0.746***	0.084
Δy_{t-1}	0.078	0.135	0.992***	0.327	0.997**	0.432	−1.228*	0.598	−1.415*	0.763	1.588***	0.449
Δy_{t-2}					0.107	0.255	−0.567	0.478	1.511**	0.685	−1.506***	0.441
Δy_{t-3}					−0.778*	0.445	0.665	0.670	−2.552***	0.759		
Δy_{t-4}							1.930***	0.501	2.323***	0.138		
ΔRR_{t-1}	−0.018***	0.004	-0.034***	0.007	−0.019***	0.005	0.025***	0.007	−0.006	0.011	−0.016*	
	0.008											
ΔRR_{t-2}	0.013***	0.003	0.005	0.006	−0.003	0.006	0.003	0.010	0.023	0.014	0.026**	0.12
ΔRR_{t-3}	0.010***	0.002	0.004	0.004	0.025**	0.011	−0.018	0.013	−0.035**	0.013	0.007**	0.003
ΔRR_{t-4}			0.022***	0.005	0.011***	0.003	−0.022**	0.009				
R^2	.45		.52		.26		.75		.82		.31	
J-stat.	5.793		2.648		0.326		5.34		3.351		4.441	

Table 7 **Results for GMM estimations on each banking group with value indicator as monetary policy indicator and loan growth as dependent variable**

	SOCB		JSCB		UCB		FFB		UCC		RCC	
	Coeff.	**Std. error**	**Coeff.**	**Std. error**	**Coeff.**	**Std. error**	**Coeff.**	**Std. error**	**Coeff.**	**Std. error**	**Coeff.**	**Std. error**
ΔL_{t-1}	0.431***	0.047	0.223	0.152	0.882***	0.036	0.179*	0.094	1.019***	0.067	0.730***	0.130
Δy_{t-1}	0.189*	0.092	1.148**	0.431	–0.519***	0.100	0.535	0.341	0.601*	0.348	1.232***	0.248
Δy_{t-2}			–0.793***	0.125	0.017	0.062	0.901***	0.170	2.977***	0.167	–1.375***	0.325
Δy_{t-3}			0.499***	0.102	0.702***	0.083	0.891***	0.267	–3.716***	0.205	0.224*	0.114
Δy_{t-4}							–1.051*	0.599				
$\Delta MPVI_{t-1}$	–0.010***	0.003	–0.021***	0.004	–0.011***	0.003	0.006**	0.003	–0.003	0.005	–0.001	0.007
$\Delta MPVI_{t-2}$	–0.018***	0.002	–0.029***	0.009			0.008*	0.004	–0.012*	0.007	–0.006	0.003
$\Delta MPVI_{t-3}$											0.013**	0.005
$\Delta MPVI_{t-4}$												
D_Q408											0.080***	0.032
R^2	.78		.67		.32		.69		.79		.75	
J-stat.	5.548		.183		3.674		3.827		3.681		.901	

It seems that the lending by these two groups is difficult to control by the monetary policy. This is not surprising given the special role of rural cooperatives in financing projects particularly in the rural areas and agriculture, which often have political backing and thus may be less affected by monetary policy actions. The operations of foreign funded banks have been restrained by strict rules that have limited their access to retail level business in domestic currency terms, even after banking regulation was harmonised by end-2006 in connection with the WTO membership agreement. Thus the gradual liberalisation of these restrictions, which is missing in our estimations, has probably affected foreign banks' lending much more than the shifts in monetary policy.

The most sensitive bank groups in terms of monetary policy are the big state-owned banks and joint-stock commercial banks, ie the biggest banks in China. Lending by these banks decreases when the reserve requirement is increased or generally when monetary policy is tightened, as indicated by the value indicator. There may be many reasons for their sensitivity. First, these banks, particularly the big state-owned banks, have close ties to Chinese decision making and the government. Second, the banks may also be watched more carefully by the authorities simply because of their size. These two groups cover about three fourths of the whole sector and thus have major impacts also on developments in the real economy.

Finally, we try to determine whether there are factors internal to the banks that might explain the differences in sensitivity across the bank groups or in other words evidence of a bank lending channel. It is difficult to see how the sensitivity would be linked to banks' dependence on deposits for financing. The large state-owned banks and joint stock commercial banks actually have rather diversified liabilities in their balance sheet compared to many other bank groups (Table 1). The result thus enhances slightly our earlier result that market-based finance makes banks more vulnerable to monetary policy, as argued by Disyatat (2010). On the other hand, the level of capital has been particularly low in the joint-stock banks while the bank groups immune to monetary policy – rural credit cooperatives and foreign funded banks – are among the banks with highest capital levels. This then confirms our result that a higher level of capital makes a bank respond less dramatically to shifts in monetary policy. However, one should bear in mind the caveats, such as the small sample size of this study, and so interpret the results with caution. Moreover, the results for individual bank groups assume that banks' lending growth does not react differently to a shift in monetary policy eg because of a difference in customer composition.

5 Conclusions

This paper has studied the monetary policy transmission mechanism in China. More specifically, we have been interested in finding out whether commercial banks enhance the impacts of monetary policy by adjusting their credit supply to shifts in monetary policy stance. Most of the earlier studies on a number of ad-vanced and emerging economies have found evidence of a bank lending channel meaning in that loan supply, and not only loan demand, is affected by monetary policy. In particular, highly capitalised, liquid and large banks have been found to reduce their lending less than other banks in response to a monetary policy contraction. There are, however, differences among the countries eg with respect to bank characteristics that are important in terms of the bank lending channel.

To our knowledge, there is only one earlier paper that studies econometrically the existence of a bank lending channel in China, and the results from that paper by Gunji and Yuan (2010) are quite inconclusive. This paper aims to deepen our knowledge of the bank lending channel in China by using quarterly data on six bank groups in 2002–2009 in estimation exercises using both TSLS and GMM.

Our first finding is related to the use of various monetary policy tools in China. The results clearly indicate that the interest rate still plays very minor role in the Chinese economy and that it alone is not a sufficiently effective tool to enable the Chinese authorities to control credit growth. This finding confirms the earlier results on China's monetary policy transmission mechanism and justifies the Chinese monetary authorities' conduct of monetary policy via several quantity- and price-based measures.

Following the earlier literature, we study the bank lending channel using an interaction term between the monetary policy indicator and a banking sector characteristic. The logic behind this is that some bank characteristics – eg a high level of capitalisation – can compensate partly for the effects of monetary policy on credit growth. For example, a bank with abundant capital may reduce its credit supply less than a bank with a lower level of capitalisation in response to a monetary policy tightening.

For China, interpretation of the results for the interaction term and thus the bank lending channel is complicated by the generally weak response of credit growth to shifts in the stance of monetary policy. As mentioned above, the interest rate does not seem to be effective in guiding credit growth in the Chinese economy, and even the response of banks to a hike in the reserve requirement seems to be short-lived.

Finally, by using a monetary policy value indicator developed by Shu and Ng (2010) we obtain more robust responses of banks to changes in monetary policy. Finally, we find weak evidence that a higher level of capitalisation makes a bank less responsive to shifts in monetary policy also in China. The impact of our second banking sector characteristic – banks' dependence on deposits for financing – on bank lending is even more obscure but suggests that banks whose financing is more market based are more strongly affected by monetary policy. This result would be consistent with Disyatat's (2010) view that monetary policy is more likely to have an impact on banks' loan supply via its impact on asset prices and hence on banks' balance sheets than by the traditional channel, which assumes that bank lending depends on deposits.

We acknowledge that the relatively small size of our data sample may give rise to problems, so that caution is advised in interpreting the results. Our data covers bank groups, not on individual banks, and it is possible that very heterogeneous banks are grouped together. Furthermore, when studying the banks group separately the question rises whether there are also differences among bank groups in their credit demand. If the differ-ent reactions of bank groups to a shift in monetary policy stance are due to differences in the banks' credit demand, this will inevitably lower the reliability of the results.

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Appendix

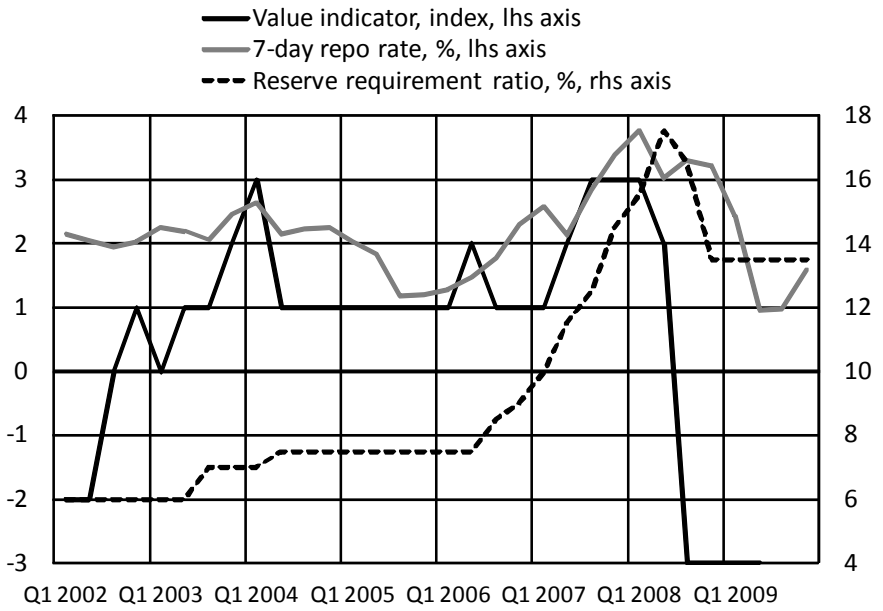
Table A1 **Definitions of data**

Variable	Explanations
ΔlogL	Quarterly changes in claims on non-financial sector that are in logs and deflated by the consumer goods price index (CGPI) and seasonally adjusteda.
Δy	Quarterly changes in the real and seasonally adjusteda industrial value-added in logs.
ΔRR	Changes in commercial banks' reserve ratio in percentage points. Since 2003, separate ratios for each banking group published in PBC's China Monetary Policy Report.
ΔInt Rate	Changes in 7-day repo interest rate, in percentage points
ΔHong Kong	Changes in China's monetary policy stance as indicated by the 7-value monetary stance indicator developed by Shu and and Ng (2010).
Banks' liquidity	Claims on government, cash, excess reserves and central bank bonds as % of total assets, seasonally adjusteda and normalized.
Banks' capitalisation	Paid-in-capital as % of total assets, normalised.
Dependence of deposits	Other liabilities than deposits on banks' balance sheets as a share of total liabilities, normalised.

Note: All series except for reserve money are from the CEIC. Reserve money data are from the IFS database.

[a] The author has seasonally adjusted the specified time series using X11 Arima.

Figure A1 **Monetary policy variables**



Source: CEIC.

Chapter 6

An analysis of Chinese money and prices using a McCallum-type rule

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An analysis of Chinese money and prices using a McCallum-type rule

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This paper evaluates the usefulness of a McCallum-type monetary policy rule based on money supply for maintaining price stability in mainland China. We examine whether excess money relative to rule-based values provides information that improves the forecasting of price developments. The results suggest that our monetary variable helps in predicting both consumer and corporate goods price inflation, but the results for consumer prices depend on the forecasting period. Moreover, results using a structural vector autoregression suggest that our measure of excess money supply could be used to identify monetary policy shocks in the Chinese economy.

Keywords: McCallum rule; monetary policy; China

JEL Classifications: E52; E31

1. Introduction

The literature on monetary policy rules is related to the formal analysis of rules versus discretion by Kydland and Prescott (1977), and there is now ample literature on evaluating monetary policy by estimating simple policy rules. One should not assume that all aspects of policy could be summarized by such a rule or that the central bank could mechanically follow a rule. Nevertheless, use of a rule in evaluating monetary policy may render it easier to communicate to the general public, who will in turn be better able to judge the central bank's performance vis-à-vis its objectives. The literature on estimating monetary policy rules has focused predominantly on advanced economies, especially via the estimation of Taylor-type interest-rate feedback rules (see Taylor 1993). In contrast, little such work has been done on developing or emerging economies.

In this paper, we analyse monetary policy and its impacts on inflation in the biggest emerging economy – China. Clearly, such analysis must take into account the specific features of the country. From the viewpoint of this paper, the dominant characteristic of China's monetary policy is the prominent role of the money supply. According to the People's Bank of China (PBC), an appropriate supply of money would promote 'economic growth positively and contribute to preventing both inflation and deflation' (PBC 2005). Moreover, the monetary authority specifies

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annual targets for money growth, most prominently for the broad money supply, M2.[1] As interest rates have not yet assumed a key role in the monetary transmission mechanism, the modelling of policy using a Taylor rule emphasizing short-term interest rates would hardly seem appropriate for China. In contrast, a monetary policy rule based on control of money supply, such as the one proposed by McCallum (e.g. McCallum 1988, 2003), would seem a viable alternative. While the 30 years of economic reform have embraced the Chinese financial sector and for example led to the abolishment of credit plans during our research period, lending guidelines to commercial banks and other quantitative monetary measures have still been prominent.

We examine whether the deviations from a McCallum-type rule would help in predicting inflation in China. This rule specifies money growth as a function of targeted nominal GDP growth, corrected for changes in the velocity of money. The fit of this rule for China has been recently investigated by Burdekin and Siklos (2008) and Liu and Zhang (2007). In addition to analysing the fit of the rule, the latter authors also include a quantity rule for money in their model, which was developed for analysing monetary policy in China. Our emphasis is rather different; we focus here on the issue of whether the McCallum rule could provide important information for the central bank in its attempt to maintain price stability in China. In particular, we examine whether the deviations of money supply from the rule-based values provide any information on price movements in consumer and corporate goods. Given the discussion about the role of asset prices in fomulating monetary policy more generally, we also briefly explore the possibility that excess money supply can be used for forecasting share or land price developments in China. Finally, we investigate, within a structural vector autoregressive framework, whether the McCallum rule could be used to identify monetary policy shocks in China.

We find that the deviation of monetary growth from the values indicated by the McCallum rule improves consumer and corporate goods price inflation forecasts, compared with simple autoregressive inflation processes. Nevertheless, the results for consumer prices are dependent on the forecasting period. Moreover, we find little evidence that excess money supply would help predict asset price inflation. Finally, expansionary monetary policy shocks in a structural vector autoregressive framework lead to increases in nominal GDP. Our results provide support for the PBC's focus on monetary aggregates in pursuing macroeconomic stabilization.

This paper is structured as follows. The next section provides a short description of Chinese monetary policy after 1994. Section 3 presents the McCallum rule for monetary policy. In section 4, we conduct forecasting experiments for prices of consumer and corporate goods, as well as for assets, using our measure of excess money. Section 5 considers use of the McCallum rule for identifying monetary policy shocks in China and section 6 concludes with policy implications.

2. Short description of China's monetary policy

Because there are several extensive descriptions of China's recent monetary policy in existence (see for example Xie 2004; Laurens and Maino 2007; Geiger 2008), we provide here just a brief summary of the main features.

The stated objective of PBC monetary policy is 'to maintain stability of the value of the currency and thereby promote economic growth'.[2] As summarized by Geiger (2008), the authorities use various instruments to achieve the objectives. During our sample period, monetary policy operated within the framework of a fixed or managed exchange rate and strict controls on capital flows. The latter have enabled an independent monetary policy, at least to some degree, despite the fixed exchange rate regime (Ma and McCauley 2008).

Many studies note the absence of a major role for interest rates in the Chinese economy, as compared to the advanced economies (see for example Laurens and Maino 2007; Mehrotra 2007; Koivu 2009). Even though the authorities actually set several interest rates (central bank lending rate, rediscount rate and benchmark rates for different maturities of deposits and loans), the interest rate channel has been ineffective for various reasons. For example, the liberalisation of interest rates has advanced rather slowly, the banking sector has traditionally not been profit-oriented and companies generally relegate interest costs to a minor role in their investment decisions.[3]

Furthermore, Chinese authorities have generally been reluctant to use interest rates as a major policy tool. For example, during the 18 months from the beginning of 2007 until the end of June 2008, when inflationary pressures increased considerably, the benchmark interest rate for one year credit was lifted relatively little, from 6.12 to 7.47%. Instead, the authorities set annual intermediate targets for money supply growth (M1 and M2) and in recent years, the central bank has also announced a target for credit growth. The authorities have then controlled the money supply by setting the reserve requirement ratio and deciding on central bank lending, which used to be a significant part of commercial banks' financing. The PBC has also controlled market liquidity via open-market operations in treasury bonds, and since 2003 by selling central bank bills to commercial banks.

The authorities have also used administrative policy tools to guide financial sector developments in China. Until the start of 1998, credit plans formed the basis of bank lending. Even after the abolishment of credit plans, the authorities have continued to issue lending guidelines for commercial banks (window guidance policy). This policy, which includes the issuance of direct guidelines and orders to the commercial banks, was intensified due to rapid credit growth in 2003 and again in 2007.

As suggested by Geiger (2008), the PBC has often missed the exact targets for monetary growth. However, actual monetary developments have closely tracked the major trends in central bank targets, and monetary policy has played an important role in achieving the ultimate policy targets – low inflation and rapid growth – since the mid-1990s.

3. Simulating a McCallum-type monetary policy rule for China

The limited role of interest rates in PBC monetary policy suggests that a policy rule for the nominal interest rate may not accurately reflect actual policy. In several contributions, McCallum (1988, 2003) has proposed a rule for the monetary base, which can be written as:

$$\Delta m_t = \Delta x^* - \Delta v_t^a + 0.5(\Delta x^* - \Delta x_{t-1}) \quad (1)$$

In Equation (1), m and x denote the monetary aggregate and nominal GDP, and Δv_t^a is the average rate of money velocity growth over four quarters.[4] The rule includes a prominent role for the target growth rate of nominal GDP, Δx^*, which of course must be pre-defined. It also corrects for expansionary money demand due to declining velocity – captured by the term Δv.

At least two earlier papers have studied China's monetary policy in the McCallum rule framework. Burdekin and Siklos (2008) apply the rule, first using the coefficients specified by McCallum, and then by allowing the data to determine the coefficient estimates. They use simulated values for the target nominal GDP growth, Δx^*. Liu and Zhang (2007) use graphical analysis to compare the fit of the McCallum rule with actual outcomes for money supply.[5]

In this paper, we calculate the McCallum-rule based values for China's money supply. McCallum (1988) specifies the rule in terms of the monetary base because this variable is controllable by the monetary authority, and this is also our benchmark approach. One could obviously argue that the rather high level of excess reserves may have decreased the controllability of reserve money during the first years of the research period. However, the amount of the excess reserves as a share of total deposits has decreased significantly during the last decade and they amounted only to 3.5% of total deposits at the end of 2007.

Different from the original rule (e.g. McCallum 2003), we use the average money velocity growth over the previous four quarters (including quarter t), instead of over four years.[6] We do this modification due to the limited data sample. Like Liu and Zhang (2007), we derive the target for nominal GDP from the targets for real GDP and CPI specified in the Chinese government's social and economic development goals (see for example PBC 2006, page 74).[7]

Unfortunately, the target for the GDP deflator – needed to calculate the nominal GDP target – is not defined. However, as shown in Figure A1 in the Appendix, the annual growth rates for CPI and GDP deflators are highly correlated (correlation coefficient 0.98 for 1994Q1–2007Q2). Growth of the GDP deflator slightly exceeds the annual changes in the CPI since 2000. Therefore, we add the difference between the GDP deflator and consumer price inflation to the announced CPI target to derive the target rate for nominal GDP. We argue that our approach may be better able to capture the nominal GDP target of the Chinese authorities than is possible with simulated values.

Our analysis starts with 1994, which has been considered the starting year for the so-called third phase of Chinese reforms and was particularly important from the monetary policy perspective. The official and market exchange rates were unified, and current account transactions were liberalised. In addition, banking reform advanced to the establishment of three policy banks, importantly separating policy finance from the more commercially-oriented activities. At the same time, the PBC began to publish target values for monetary aggregates M1 and M2.

Figure 1 displays the estimated McCallum rule for China's monetary base, together with the actual outcomes.[8] Actual movements in the monetary base have quite closely tracked the values implied by the McCallum rule. During the first years of the research period, money supply has been somewhat lower than suggested by the McCallum rule but, since 2003, the growth of base money has been very close to the specified rule. During the last few quarters of the period studied, monetary growth

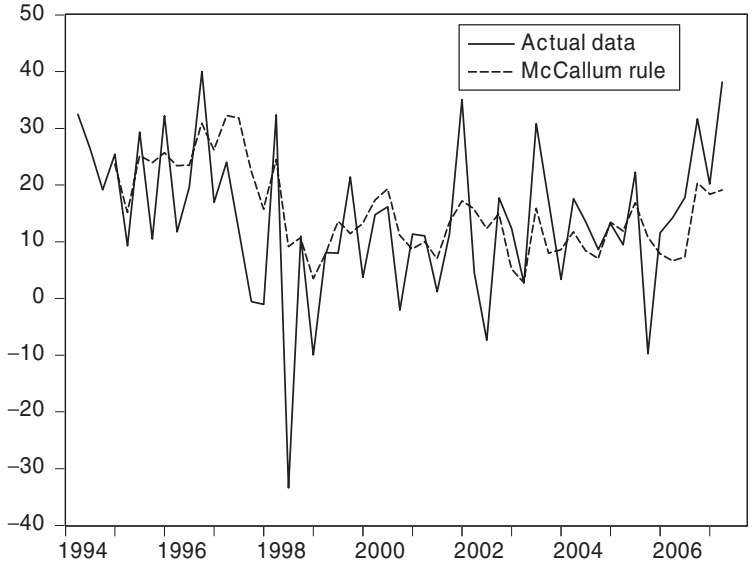

Figure 1. Outcome for monetary base and McCallum rule, % change y-o-y.

increased faster than the McCallum rule prescription, partly due to hikes in reserve requirement ratios that expanded the monetary base.[9] Figure A2 in the Appendix displays developments over time in the growth of base money velocity.

Interestingly, the deviations of money supply from the McCallum rule are reflected in fluctuations of consumer price inflation during the period studied. After hitting a record high of over 25% at the beginning of our sample period, annual inflation slowed down quickly and was even followed by two deflationary periods, 1998–2000 and 2001–2002. This decline in inflation, which corresponds closely with the period when the actual money supply was below the level suggested by the McCallum rule, is shown in Figure 2. Since 2003, inflation has generally remained low, except for the one-time hike, due mainly to increases in grain prices in 2004 and higher inflation after the end of 2006. GDP growth remained strong throughout our sample period although the growth rates dropped from over 13% in 1994 to 7.6% in 1999. Since 2001, GDP growth has picked up again, to exceed 11% in 2007. Although there are a number of factors behind the developments of both inflation and economic growth along the 1990s, we confirm the link between policy (defined by the McCallum rule) and GDP growth and inflation within a more formal framework later in this paper.

We also simulate the McCallum rule for M2 in China. While the use of M2 is justified by its role as a major intermediate target for China's monetary policy (there are no announced annual targets for the monetary base), broad money does not serve as an operating target for the monetary authority. Nevertheless, it should be emphasized that M2 assumes the role of an indicator variable only. Even in China, where practically all banks are majority state-owned, the authorities do not have complete control over commercial banks' activities nor thus over M2.

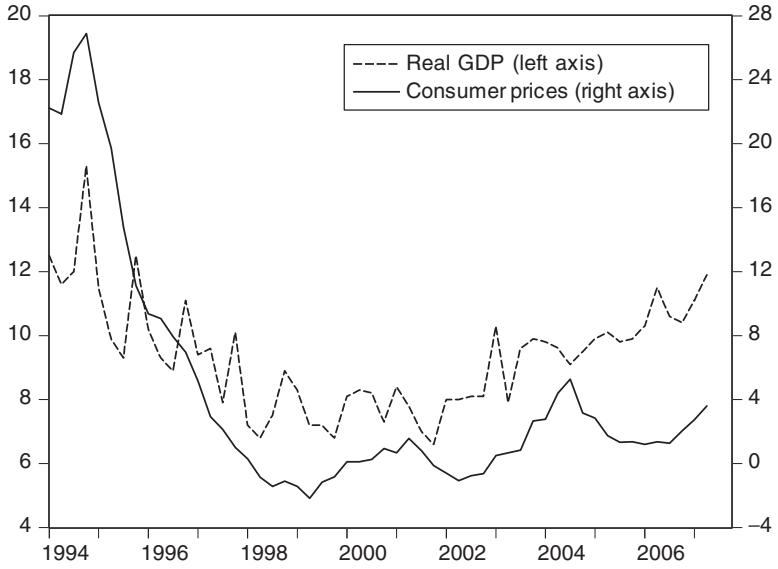

Figure 2. Consumer good prices and real GDP, % change y-o-y.

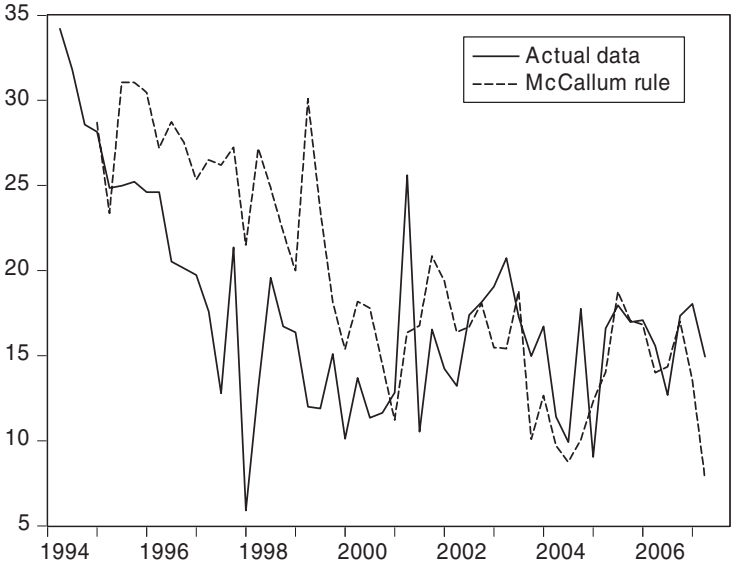

Figure 3. Outcome for M2 and McCallum rule, % change y-o-y.

Developments in actual M2 vis-à-vis the values derived by the McCallum rule are quite similar to what we saw in regard to base money. In the first half of the sample period, the actual broad money supply (M2) increased at a lower rate than that specified by the McCallum rule, as shown in Figure 3. Since 2001, actual developments have been more in line with the policy rule.

Table 1. Outcome from McCallum rule and PBC annual target for M2.

	McCallum rule, %	PBC target*, %
1995	28.5	23–25
1996	28.5	25
1997	26.3	23
1998	24.0	16–18
1999	23.0	14–15
2000	16.5	14–15
2001	16.3	14
2002	17.6	13
2003	15.0	16
2004	10.3	17
2005	15.5	15
2006	15.5	16

*Source: PBC Annual Reports and China Monetary Policy Reports, various issues.

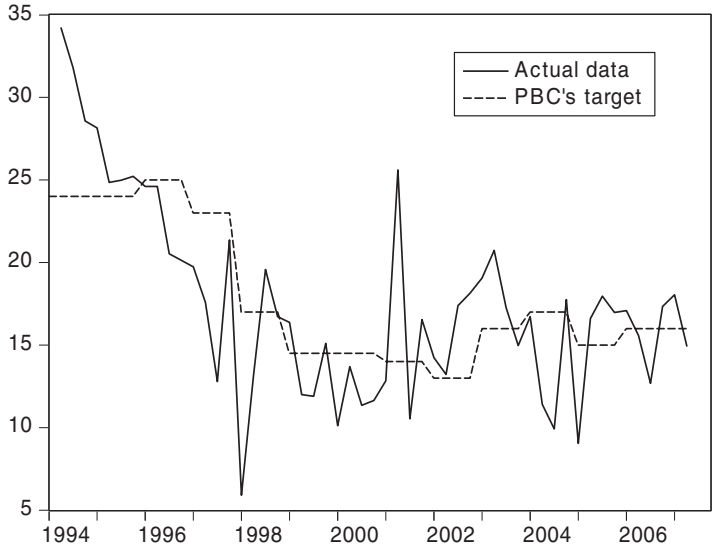

Figure 4. Outcome for M2 and PBC target, % change y-o-y.

The status of M2 as an intermediate target further enables a comparison of PBC announced targets and values generated by the McCallum rule. As displayed in Table 1, values implied by the rule exceeded the central bank's target growth rate for M2 every year up to 2003. In the last few years, the McCallum rule and the PBC target have followed growth rates very close to each other. Furthermore, and keeping in mind the caveat that M2 cannot be used as an operating target, China's realized monetary policy was previously even more contractionary than what the target would have suggested (Figure 4). After inflation was brought down by 1996, the M2 growth rate remained below the central bank's target most of the time until 2001. Since then, actual monetary growth has been quite close to the target.

4. McCallum rule and inflation forecasting

In this section, we use our measure of excess money supply – deviation of actual money supply growth from the value specified by the McCallum rule – for inflation forecasting. For this purpose, we estimate a reduced form bivariate vector autoregressive model, employing lags of an inflation measure and excess money supply. The model is estimated for 1995Q1–2006Q2, and *h*-step-ahead out-of-sample forecasts are generated for 2006Q3–2007Q2.[10] Omitting the deterministic terms, a reduced form model can be expressed as:

$$x_t = A_1 x_{t-1} + \cdots + A_p x_{t-p} + u_t \tag{2}$$

Here, x_t is a $(K \times 1)$ vector of endogenous variables. The A_i are fixed $(K \times K)$ coefficient matrices and the u_t is assumed to follow a K-dimensional white noise process with $\mathrm{E}(u_t) = 0$. Regarding model specification, we follow the Akaike information criterion for optimal lag length, with a maximum of six lags. In the case where misspecification tests provide evidence against this lag length, we generally include three lags, which is appropriate for a first-differenced series of quarterly data. All the estimated bivariate models pass the Portmanteau (at 16 lags) and LM tests (at 5, 4 and 1 lags) for autocorrelation, and the ARCH-LM test (at 16 lags) for model residuals. The Schmidt–Phillips test for unit roots suggests that both excess money supply and the different measures of inflation are stationary, as the null hypothesis of a unit root is rejected at the 5% level. These results are available from the authors upon request.

In order to evaluate the forecasting performance of these models, we need a benchmark for comparing with the forecasts. As is common in the literature, we compare the root mean squared forecast errors (RMSE) to those provided by a simple autoregressive (AR) process. The satisfactory forecasting performance of an AR process has been well documented in the literature for both the euro area and US economies (e.g. Marcellino, Stock, and Watson 2003; Banerjee and Marcellino 2006). For China, Mehrotra and Sánchez-Fung (2008) compare inflation forecasts obtained from 15 different models and find that only those incorporating many predictors via a principal component outperform the AR process. In addition to using consumer price index as a measure of prices, we also use the corporate goods price index (CGPI) published by the PBC (see Figure A3 in the Appendix). This measure covers prices of goods in inter-enterprise transactions, and it includes agricultural, mining and processed products, together with coal, oil and electricity. The results from this exercise are provided in Table 2. A figure of less than one indicates that including a monetary variable improves the forecast, as compared with a univariate AR-process.

It is clear that our measure of excess money supply (for both monetary base and M2) improves the forecasts of consumer and corporate goods prices, for all forecast horizons considered, as compared with an AR-process. It is also noteworthy that inclusion of the deviation from the PBC monetary growth target outperforms the univariate process. Therefore, all these measures have information value for future price pressures.

The role of asset prices in the formulation of monetary policy has been debated for years, and the discussion has often intensified at times of boom and slowdown in the stock and housing markets in the 1990s and 2000s. Theory generally suggests that

Table 2. Inflation forecasts, *h*-step-ahead.

	Monetary base, deviation from McCallum rule			M2, deviation from McCallum rule			M2, deviation from PBC target		
	h-step-ahead forecast			*h-step-ahead forecast*			*h-step-ahead forecast*		
Predictor	$h=1$	$h=2$	$h=4$	$h=1$	$h=2$	$h=4$	$h=1$	$h=2$	$h=4$
Consumer prices	0.26	0.91	0.92	0.91	0.91	0.91	0.65	0.93	0.94
Corporate goods prices	0.14	0.68	0.42	0.52	0.41	0.83	0.59	0.49	0.89

Note: RMSE relative to AR-process.

monetary policy should stabilize infrequently adjusted prices but not the highly flexible asset prices (see for example Woodford 2003). Concern has also been raised about the ability of the monetary authority to identify asset price bubbles. According to Svensson (2004), the monetary authority should react to asset prices only to the extent that they have an impact on output gap and inflation. Goodhart and Hofmann (2002), on the other hand, claim that ignoring asset price movements leads to suboptimal outcomes for the economy in terms of inflation and output gap variability. Without taking a stand on the exact role of asset prices in policy formulation, we focus on whether our measures of liquidity provide any information on asset price developments. In this regard, we repeat the exercise of Table 2 by including as price indicators a land price index as well as Shanghai and Shenzhen share prices.

Our results in Table 3 do not provide firm evidence in support of the forecasting ability of our measures of excess money supply for asset prices. In general, only for the very short run (one quarter) does the inclusion of excess liquidity measures produce better results than the AR-process. This could be due to the rapid movements in asset prices, or to the fact that in China asset prices are driven by their own shocks rather than excess liquidity.

A final remark on the forecasting exercises concerns robustness of the results with respect to the estimation period. We have repeated the forecasting exercise of Table 2 using an estimation period of 1995M1–2004M2 and a corresponding forecasting period of 2004M3–2005M2. For corporate goods price inflation, the results generally remain robust, as the AR-process is beaten in seven of nine tested observations. Nonetheless, for consumer price inflation the results are less encouraging, as the AR process is outperformed in just two of nine observations. This suggests that the results for consumer price inflation in this section are dependent on the sample period, and information over and above monetary pressures should be considered carefully in evaluating price pressures in the Chinese economy.

5. Identifying policy shocks with the McCallum rule

In the final section of the paper, we utilize the McCallum rule to capture monetary policy shocks in the Chinese economy in a structural vector autoregressive framework. In particular, we are interested in the effects on China's nominal output of a deviation of monetary base from the value specified by the McCallum rule. While the previous analysis established the possibility of using the monetary policy rule for inflation forecasting, little was said about the dynamic impacts of monetary expansions/contractions over time. More generally, because thus far no consensus has been reached in the literature as regards the identification of Chinese monetary policy shocks, our approach provides a possible alternative.[11]

In order to identify monetary policy shocks using the McCallum rule, we proceed as follows. After estimation of a reduced form model (Equation (2)) and having obtained a congruent representation of the data, we proceed to specification of the structural form, which can be written as:

$$\mathbf{A}x_t = A_1^* x_{t-1} + \cdots + A_p^* x_{t-p} + \mathbf{B}\varepsilon_t \tag{3}$$

Table 3. Asset price forecasts, *h*-step-ahead.

	Monetary base, deviation from McCallum rule			M2, deviation from McCallum rule			M2, deviation from PBC target		
	h-step-ahead forecast			*h-step-ahead forecast*			*h-step-ahead forecast*		
Predictor	$h=1$	$h=2$	$h=4$	$h=1$	$h=2$	$h=4$	$h=1$	$h=2$	$h=4$
Land prices	0.34	0.58	0.87	0.53	0.96	1.07	1.16	1.10	1.05
Shanghai share prices	0.45	1.10	1.09	1.86	1.11	1.14	0.81	0.98	0.99
Shenzhen share prices	0.40	1.53	1.41	0.90	0.98	1.11	0.30	1.37	1.28

Note: RMSE relative to AR-process.

In Equation (3), the structural shocks, ε_t, are related to model residuals via linear relations. They are assumed to be uncorrelated and therefore orthogonal. The A_i^*s $(i=1,\ldots,p)$ are again $(K\times K)$ coefficient matrices, and **B** is a structural form parameter matrix. The reduced form model can be linked to the structural form simply via $u_t=\mathbf{A}^{-1}\mathbf{B}\,\varepsilon_t$. We specify the McCallum rule in the matrices **A** and **B**, and estimate the so-called AB-model by Amisano and Giannini (1997). The structural model is estimated by maximum likelihood, subject to the structural-form restrictions, and using the covariance–variance matrix of the reduced form VAR.

We commence our analysis by re-writing the McCallum rule (1) as:

$$\Delta m_t = 1.5\Delta x^* - \Delta v_t^a - 0.5\Delta x_{t-1} \tag{4}$$

To simplify matters, we specify the nominal GDP target, Δx_t^*, to be constant over time. Hence $1.5\Delta x_t^* - \Delta v_t^a$ reduces to a variable that is time-varying only to the extent that velocity changes over time. In the VAR estimation that follows, this variable is labelled the (adjusted) change in velocity. In order to calculate the constant nominal GDP target, we focus on the estimation period 1997Q1–2007Q2 and take the average of nominal GDP targets over that time. This yields a nominal GDP target of 12.3%.[12]

We estimate the reduced form VAR model with the following three variables: change in monetary base (Δm_t), change in nominal GDP lagged by one period (Δx_{t-1}) and the adjusted change in velocity ($1.5\Delta x_t^* - \Delta v_t^a$). Utilizing four lags and including a constant as a deterministic term, we estimate this model for the period 1997Q1–2007Q2. Then, in order to remove the most statistically insignificant coefficients, we sequentially eliminate those with the lowest *t*-values until all remaining coefficients have *t*-values of at least 1.00. The resulting model appears to be a valid representation of the data. In particular, the adjusted Portmanteau test (at 16 lags, *p*-value 0.47), the LM-test (four lags, *p*-value 0.34) and the multivariate VARCH-LM test (five lags, *p*-value 0.38) do not provide evidence against the model specification.

Proceeding to the structural-form specification, the AB-model is written as:

$$\begin{bmatrix} 1 & 0 & a_{13} \\ 0.5 & 1 & -1 \\ a_{31} & a_{32} & 1 \end{bmatrix} u_t = \begin{bmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{bmatrix} \varepsilon_t \tag{5}$$

The McCallum rule is specified in the second row of Equation (5), so that monetary policy shocks are captured as the row's structural shocks. Regarding the other rows, our identification scheme is close to a recursive system where adjusted velocity reacts immediately to any shock hitting the system and nominal GDP responds sluggishly to shocks. The sluggishness of GDP obtains despite the fact that we allow it to react immediately to a shock to (adjusted) velocity in order to attain a just-identified model. We then examine the dynamics of the monetary policy shock over time via impulse response analysis over 20 quarters, as shown in Figure 5. Parameter uncertainty is taken into account through the use of 90% Hall percentile confidence intervals, obtained by bootstrapping with 1000 replications. The impacts on nominal GDP and monetary base are accumulated over time in order to focus on the levels of these variables.

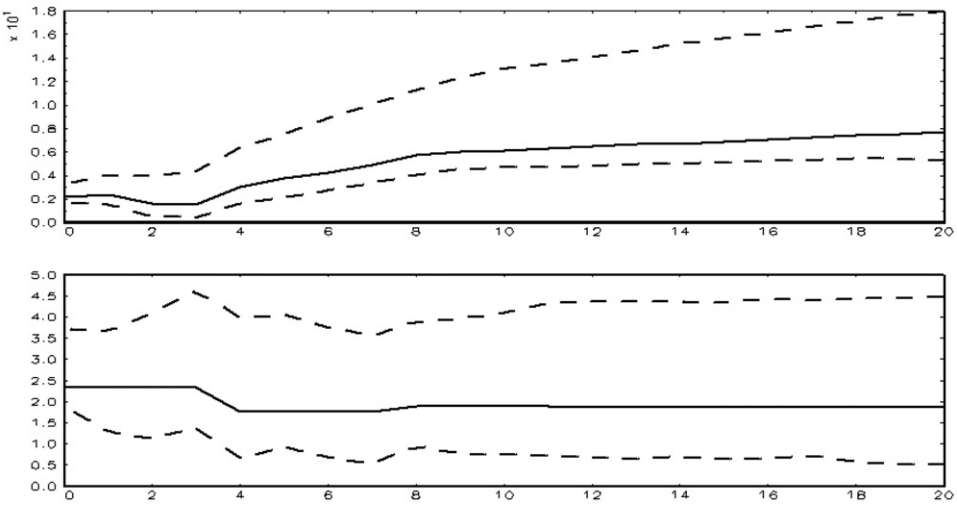

Figure 5. Impact of a monetary policy shock on nominal GDP (top) and monetary base (below).

According to the impulse responses, an expansionary monetary policy shock – relative to the McCallum rule – leads to an immediate increase in the level of base money. The impact on money is permanent, and the increase in the level of nominal GDP is long lasting and statistically significant. It stabilizes only after the fifth year following the shock. While it is generally assumed that money is neutral in the long run (in that there is no impact on *real* output) a permanent impact on prices and hence on the level of *nominal* GDP is in line with theory.[13] These results provide support for the PBC's focus on the money stock in order to maintain price stability. Together with the finding that realized base money growth has closely tracked the McCallum rule, they suggest that the rule might well be used to capture monetary policy shocks in the Chinese economy.

6. Conclusions

In this paper, we have examined whether changes in China's money supply measured by deviations from the McCallum rule help us forecast inflationary pressures in the country. While earlier studies have emphasized the modest role of interest rates in the Chinese economy, the quantity-based McCallum rule may provide a more plausible framework for analysing China's monetary policy compared, for example, to the Taylor rule. Moreover, the quantitative targets set by the People's Bank of China for money supply growth support this argument.

According to our analysis, the simulated McCallum rule accords quite well with actual growth of the base money since 1994. During the early years of the period studied (the mid-1990s) the realised money supply has grown at a lower rate than that prescribed by the McCallum rule. It appears that in the 2000s, the actual money growth has been very close to the values determined by the rule.

We tested whether our measure of excess liquidity (deviation of actual money supply growth from that of the McCallum rule) helps to forecast consumer price and corporate goods price inflation. According to the results, using the deviation of monetary growth from the rule indeed improves inflation forecasts, as compared with simple autoregressive processes for inflation. However, the results for consumer prices depend on the forecasting sample. Finally, expansionary monetary policy shocks in a structural vector autoregressive framework, incorporating the McCallum rule, lead to increases in nominal GDP.

Our results suggest that the McCallum rule could be a useful tool for analysing monetary policy and for providing information about inflationary pressures in the Chinese economy. The results could also be seen to lend support for the PBC's focus on monetary aggregates as intermediate policy targets. While monetary policy has probably played a significant role in achieving the targets of stability of the value of the currency and fast economic growth since the mid-1990s, in the coming years China will face new challenges as economic reforms are pushed forward. Partial privatization of the financial sector, a more flexible exchange rate and gradual liberalization of capital flows may reduce the effectiveness of quantitative monetary policy tools in the economy. Interest rates are likely to assume a bigger role as major operating targets for the implementation of policy – as is the case in advanced economies.

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Notes

1. Monetary targeting was adopted in several advanced economies in the 1970s and it was widely considered successful in controlling inflation in Germany and Switzerland (see for example Mishkin 2001). However, the German Bundesbank missed its money growth targets quite frequently. Bernanke and Mihov (1997) argue that Bundesbank policy was actually better described as inflation targeting rather than money targeting.
2. http://www.pbc.gov.cn/english/huobizhengce/objective.asp on 8 February 2008.
3. In a former command economy, the lack of profit orientation is related to the concept of soft budget constraints, whereby an economic agent's budget does not pose a strict constraint on his spending (see Kornai 1992).
4. We use data on nominal GDP kindly provided by Li-gang Liu, Wenlang Zhang and Jimmy Shek from the Hong Kong Monetary Authority. The data on monetary aggregates and prices are from the CEIC and IFS databases.
5. Liu and Zhang (2007) also use a quantity-based rule in their New-Keynesian model to analyse China's monetary policy. However, the rule used in the model differs from the exact specification by McCallum.
6. In addition, when measuring the feedback adjustment term, we use the target for the current period instead of previous-period GDP. McCallum (1999) argues that the velocity term captures the component of velocity growth that is due to institutional change. Therefore, the exact period of average velocity calculation may be, in practice, less important, as long as it captures possible structural changes in the economy. Burdekin and Siklos (2008) similarly report using the average growth rate of velocity of period t, smoothed by taking a moving average.
7. For 1994–1997, the PBC used to specify targets only for retail price inflation and GDP.

8. We use the variable 'reserve money' reported in the People's Bank of China Quarterly Statistical Bulletin. This aggregate includes currency issue as well as deposits of financial institutions and non-financial corporations held at the central bank.
9. In this case, fast monetary growth may reflect tighter instead of looser monetary policy. As most of the frequent hikes in the reserve requirement ratio that took place in 2007 are outside our estimation sample, they do not pose a major problem for our analysis.
10. For land prices, the sample starts in 1998 due to data availability.
11. Dickinson and Liu (2007) identify monetary policy shocks in China by using the central bank lending rate and the quantity of credit. Mehrotra (2007) uses the central bank repo rate, while Chow and Shen (2005) capture Chinese monetary policy shocks by narrow money M1.
12. Such a nominal target for GDP growth appears reasonable, given that since 1997 the government's real GDP growth targets have remained at 7–8%, consumer price inflation targets between 1–5% and the rise in the GDP deflator has exceeded consumer price inflation after 1999.
13. An alternative approach would be to include real GDP and its deflator as separate variables in the estimated system, but this would require assumptions as to their weights in the policy rule – something not specified by the McCallum rule. Preliminary estimations using the same coefficient (−0.5) for both variables yield the persistent positive effects of an expansionary monetary policy shock, on both the level of real GDP and its deflator.

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Appendix

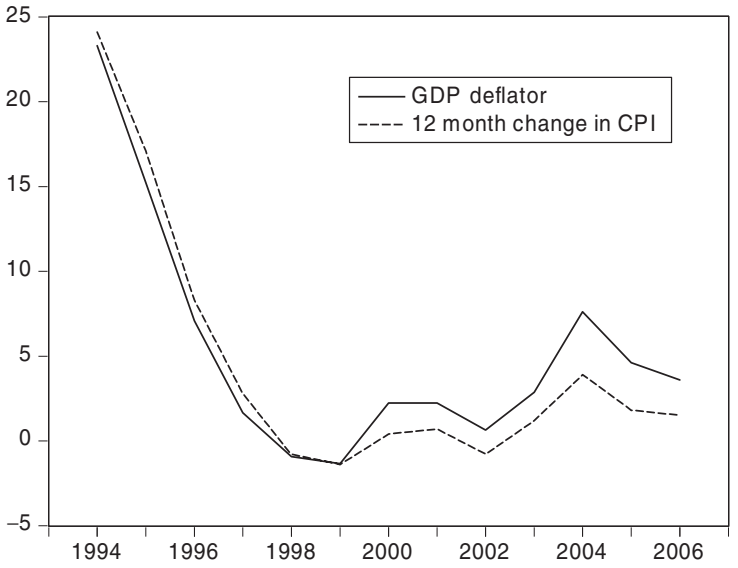

Figure A1. Annual GDP deflator and 12 month change in CPI, %.

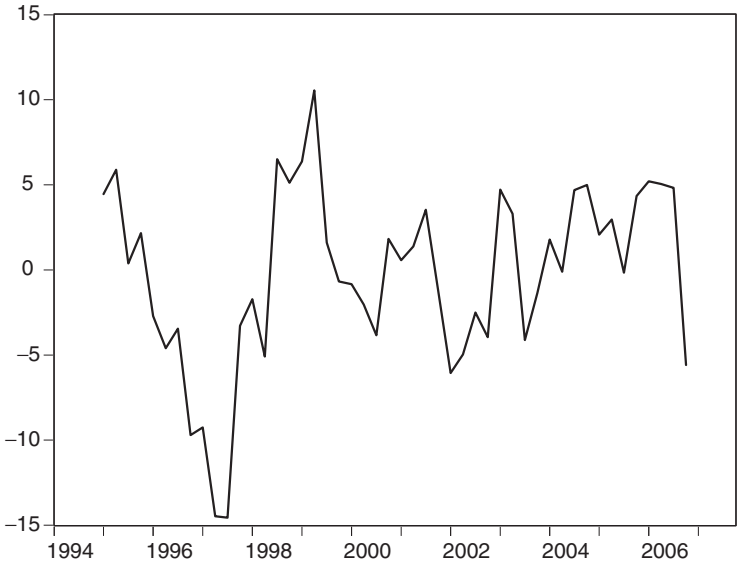

Figure A2. Monetary base velocity, % change y-o-y.

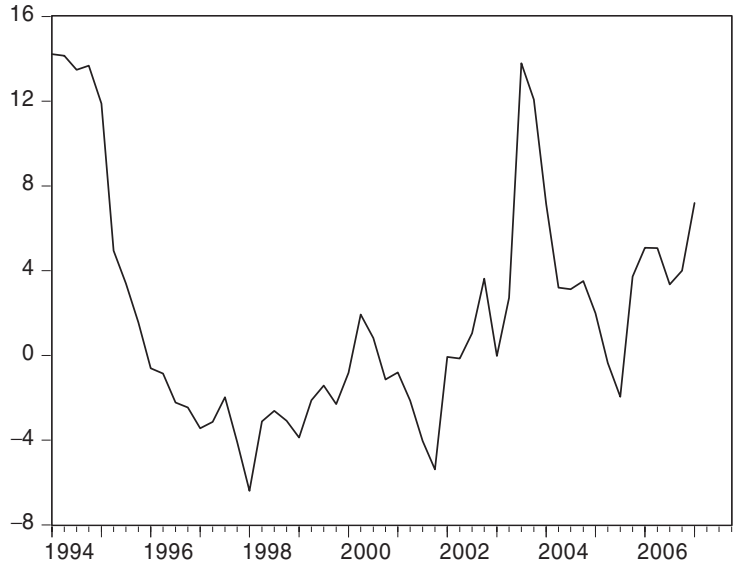

Figure A3. Corporate goods prices, % change y-o-y.

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