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Tuuli Koivu

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 rate to the real economy is still weak.

JEL classification: E52, P24

Keywords: China, monetary policy

[1]Tuuli Koivu is affiliated with the Bank of Finland Institute for Economies in Transition (BOFIT). She can be reached at tuuli.koivu@bof.fi. The opinions expressed in this article are the author's and not necessarily those of the Bank of Finland. Useful comments have been received at the conference on the Chinese economy organised by the CERDI in Clermont-Ferrand in October 2007, at the BOFIT workshop in December 2007 as well as from Iikka Korhonen and Aaron Mehrotra. Remaining errors are obviously the author's.

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Tiivistelmä

Kiinan rahapolitiikan välineistö on aiemmin nojannut pitkälti hallinnollisiin määräyksiin ja koroilla on ollut talouspolitiikassa melko vähäinen merkitys. Myös aiempien tieteellisten tutkimusten mukaan korkotason vaikuttavuus Kiinan taloudessa on ollut heikko. Viimeisen vuosikymmenen aikana Kiina on kuitenkin uudistanut talouden rakenteitaan monin eri tavoin ja lukuisia esteitä on raivattu siltä, että korot voivat toimia tehokkaana rahapolitiikan välineenä. Korkojen merkitystä Kiinassa on tärkeää tarkastella myös maan tulevan rahapolitiikan kannalta, sillä talousuudistukset ovat vääjäämättä merkinneet hallinnollisten toimien käyttömahdollisuuksien supistumista, kun yksityisesti ja ulkomaisesti omistettujen yritysten osuus taloudesta on lisääntynyt. Tässä keskustelualoitteessa tutkitaan yhteisintegroituvuusmenetelmien avulla, onko korkojen vaikuttavuus rahapolitiikan välineenä Kiinassa parantunut. Tulosten mukaan luottojen kysynnän riippuvuus korkotasosta on lisääntynyt, mutta korkojen vaikuttavuus reaalitaloudessa on edelleen heikko.

Asiasanat: Kiina, rahapolitiikka

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".[2] Overall, according to several studies, the effectiveness of interest rates as a policy tool has been modest (see eg Laurens and Maino 2007 and Mehrotra 2007a).

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 more importantly, the economy has gradually shifted from state-owned enterprises to 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 China's monetary policy will face substantial challenges in the coming years and 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. Already since summer 2003, expanding capital inflows have increased liquidity in China's

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

financial markets and have made the conduct of domestic monetary policy more complicated.

We will analyse the effectiveness of interest rates in the credit demand framework. While several studies have been done on the dynamics of 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. Although studies on advanced economies have often found the impact of monetary policy via the lending channel on the real economy to be rather weak, the Chinese economy might work slightly differently (see eg Walsh, 2003 for a survey of earlier studies). 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 et al., 1993), this may not happen in China where the other modes of financing are underdeveloped. In this light, the lending channel could even be more effective in China, where the banking sector has been the dominant source of external funding, than in countries with well-developed financial markets.

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 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 in Section 4. Section 5 concludes.

2 Literature review

There are already a number of empirical studies on the transmission channels of Chinese monetary policy in China. While many earlier studies have focused on the links between the money supply and the real economy[3], 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 re-

[3] See eg Sun and Ma (2004), Xie (2004) and Mehrotra (2007b).

acting 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 one year lag. Unfortunately, the authors do not report the confidence intervals on their results.

Mehrotra (2007a) compares the exchange rate and interest rate channels in Japan, Hong Kong and China. For China (1996 M1- 2004 M8), 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 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 confirm the positive link from interest rates to economic activity that was found earlier by Qin, Quising, He and Liu (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, evidence on this issue is statistically rather weak and 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 eg 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 has nothing to do with the price mechanism but instead contains pure quantitative restrictions on bank lending and hence considerably reduces the price sensitivity of banks' activities - is still actively used by the PBC. Thus we would conclude that administrative tools, although diminished, 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 at the same 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 at least somewhat. Among the smaller banks, reforms have advanced at widely varying speeds. One of the best indicators for measuring the progress in the banking reform from this point of view could be the amount of non-performing loans (NPL). While the NPL ratio was estimated still to be around 30% in 2001 (eg OECD, 2005), by September 2007 the official figure had dropped to 6%. In addition, the introduction of the new main target for the banks - meeting the capital adequacy requirement - by the supervisory authorities target should lead to more sustainable developments in the sector. 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 eg 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.[4] There have also been legislative changes that have encouraged private entrepreneurship in China.[5] 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

[4] According to OECD (2005), the private-sector share in the non-farming business sector increased from 43% in 1998 to 57% in 2003.
[5] Most recently, the property law was approved by the People's Congress in March 2007.

found credit demand in the euro area to be a function of total output and the lending rate.[6] 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 and Gertler, 1995) Thus, there is not clear consensus among economists in which way output growth affects lending.

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 practically impossible until late-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

[6] They found that credit stock reacts positively to output and negatively to interest rates in the euro area.

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 channels of external financing have been very limited. Until the last few years, stock-exchange listing or issuing corporate bonds was basically possible for only a few large state-owned companies. According to the OECD (2005), about three-quarters of external funds raised by non-financial corporations in China was covered by bank loans in both 1998 and 2003. The second important channel was foreign direct investment, whereas the combined share of bonds and shares was only about 6%. 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. As a result, an increase in the credit stock can also impact the inflation rate and the central bank may react to a change in commercial bank lending practices and change the interest rate. 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.

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:

$$credit_t = \beta_1 y_t + \beta_2 \text{int}_t + \text{ec}_t. \quad (4.1)$$

We use monthly data for 1998 M1– 2007 M5. 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 eg Holz 2007).

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.

Graph A1 in the Appendix illustrates the dynamics of the variables in the model. As we can see from Graph 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 and 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 Graph 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.

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 A1 in the Appendix, 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 A4 in the Appendix). Graphical observation suggests the inclusion of a deterministic trend in the cointegration

[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.

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

As an estimation approach, we use a vector error correction model which allows us to estimate the long-run equation and also the short-run dynamics in our system. When we estimate the the equation (4.1) for the credit demand, our results from the Johansen maximum likelihood method yield the following long-run relationship:

$$credit_t = \underset{(.071)}{0.207} y_t - \underset{(.006)}{0.006} int_t + \underset{(.001)}{0.005} t + ec_t \qquad (4.3)$$

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.

In its entirety, the vector error correction model can be written in matrix form (Lütkepohl, 2004) as

$$\Delta x_t = \Pi x_{t-1} + \Gamma_1 \Delta x_{t-1} + ... + \Gamma_{p-1} \Delta x_{t-p+1} + CD_t + u_t \qquad (4.2)$$

where x_t=*(credit$_t$ y_t, int$_t$)'*. CD is a vector of deterministic terms, i.e. constant and trend; u is the error term; Πx_{t-1} contains the long-run 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 x p) matrices that contain the so-called loading coefficients and cointegration coefficients. K is the number of variables.

We now include into our estimation the short-run dynamics. We introduce 8 lags into the system 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. The obtained 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 A7. 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 Graph A5 in the Appendix. 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.

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

4.3.1 Credit demand equation for 1998 M1-2001 M9

For the first subperiod, obvious weakness is that we have slightly less than four 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 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 A2), and we obtain evidence of at least one cointegration vector among our variables (Table A5). 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:

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

We again introduce the trend variable into our model as it is statistically is 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 willingness to decrease the financing costs was probably supported by the relatively high level of real interest rates during the first subperiod.

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

[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.

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 A8). 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:

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

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 A3 and A6). 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:

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

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 A9 in the Appendix). Again the only test that we have problems in passing with is 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:

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

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.

4.4 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 statistically always 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 equations 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. 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

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

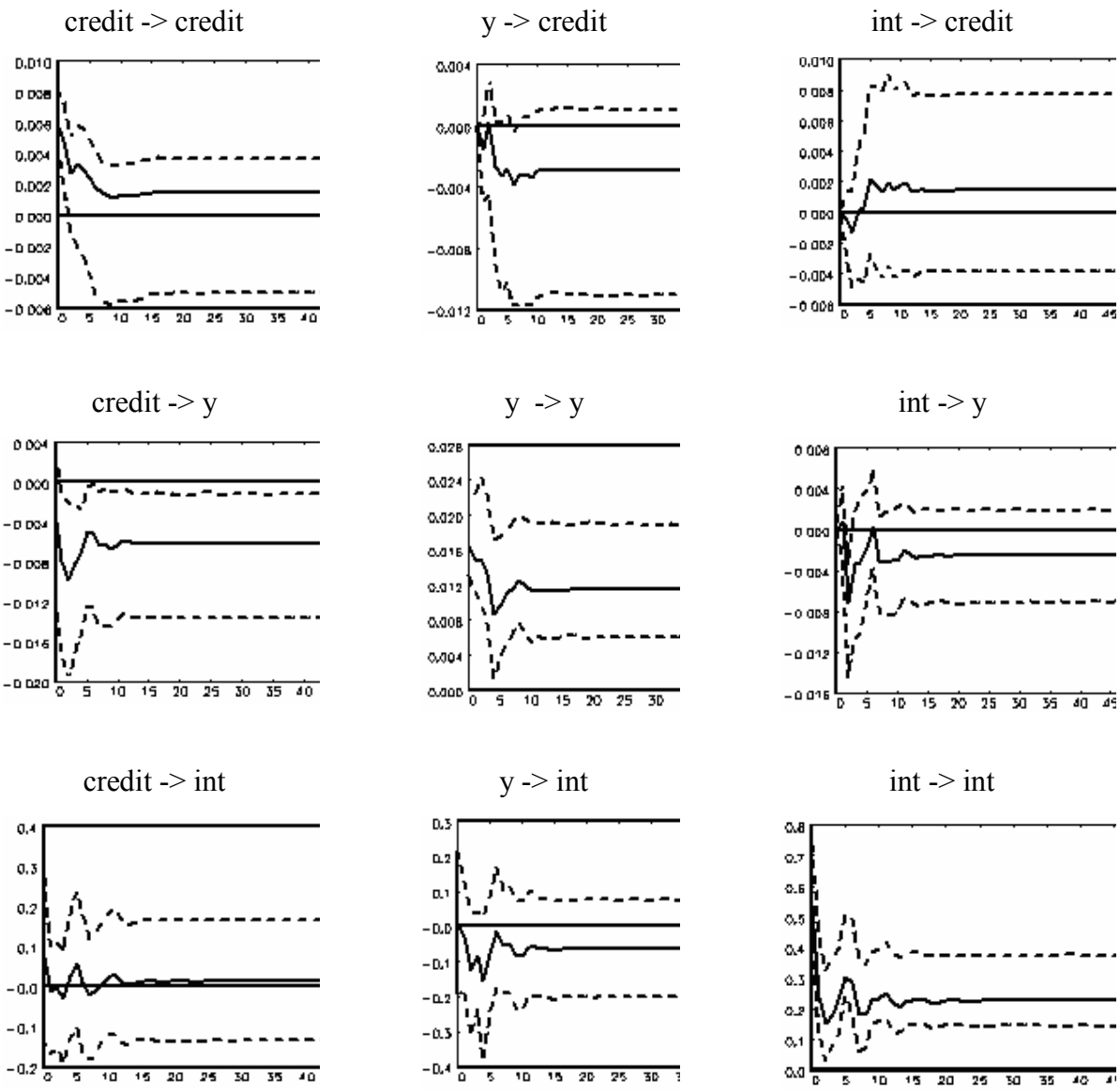
where the asterisks denote unrestricted elements. This means that a shock to credit can have an instantaneous impact on both of the other variables, i.e. economic output and lending rate. A shock to output, however, cannot have an immediate impact on credit stock, whereas the lending rate could react 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 500. We present system responses to a shock of one standard deviation in Graphs 1 and 2 for the periods 1998 M1-2001 M9 and 2001 M10-2007 M5 respectively.

As we see from Graph 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. However, the response to an interest rate shock is not statistically significant. Neither is the negative response of output to an interest rate hike. The decrease of credit stock after an increase in economic output supports our results from the long-run analysis.

For the latter subperiod, 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 leads to a decline in the credit stock. The decline takes place a few months after an interest rate rise and lasts (with statistical significance) for about two years. Despite the decline in the credit stock, the impact of an interest rate hike on industry value-added is very weak. The industrial value-added increases temporarily with a rise in the interest rate, which could well reflect the expectations content of interest rate policy: the boom is still in progress for some time after the interest rate hike. The positive link, however disappears after a few months time and we can not identify any negative impact from interest rate on the level of economic output in our system.

Graph 1 Impulse responses for 1998 M1-2001 M9



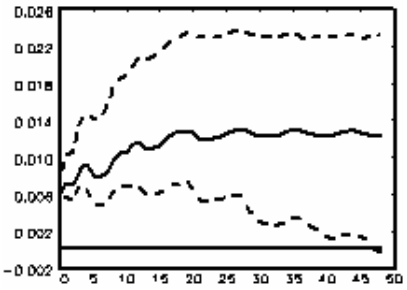
Despite the fact that the link from the interest rate to economic activity is still found weak, there are signs that the functioning of the Chinese banking sector has become more market-oriented during the research period. For example, in contrast to the first subperiod, a positive shock to the credit stock now boosts economic output and may indicate an improved efficiency of credit allocation. Although we found the long-run positive link between the economic output and credit stock, it seems that in the short-run, an increase in economic activity actually leads to a drop in the credit stock. However, the impact remains statistically significant for less than one year.

The interest rate setting also follows now more closely development of the two other variables in the model than in the first period. For example, a positive shock to credit stock is followed by higher interest rates. This result reflects China's monetary policy during the research period. The authorities used to set explicit targets for money and credit growth in the beginning of a year and when for example the credit target was exceeded, authorities tightened monetary policy, in this case raised interest rates. Thus, our finding that a credit shock leads to higher interest rates is not surprising. However, after about a half a year, the impact of a credit shock on the real interest rate turns negative. This is probably not due to changes in the nominal benchmark lending rate but reflects the increased inflationary pressures in the economy.

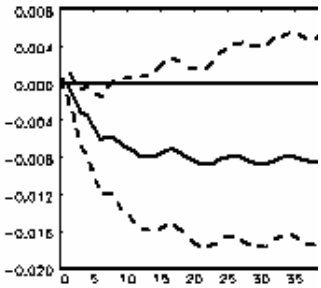
In addition, a positive output shock raises the real lending rate. There are two possible explanations for this again reflecting the specific character of real lending rate in our system. First, higher rate can be due to the fact that the authorities respond to higher economic output growth with higher interest rates. Secondly, a productivity shock can cause a decrease in inflation and thus increases the level of real interest rate if nominal rate is kept constant.

Graph 2 Impulse responses for 2001 M10-2007 M5

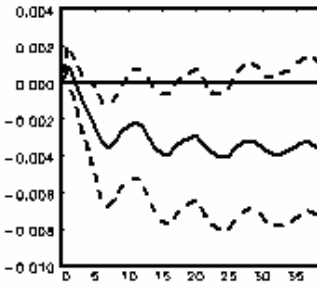
credit -> credit



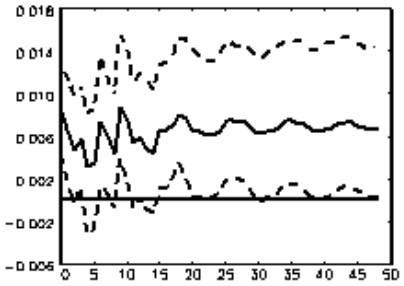
y -> credit



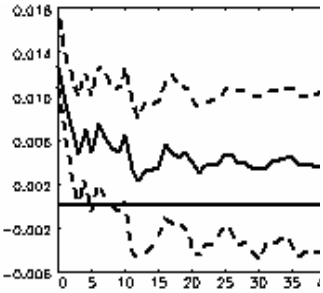
int -> credit



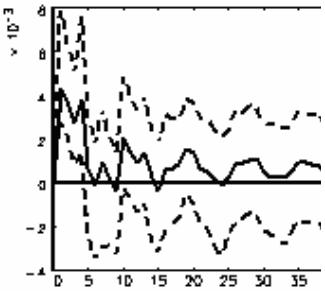
credit -> y



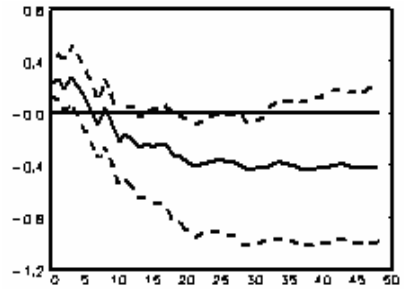
y -> y



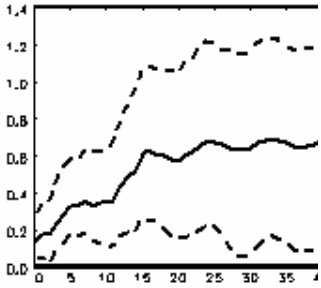
int -> y



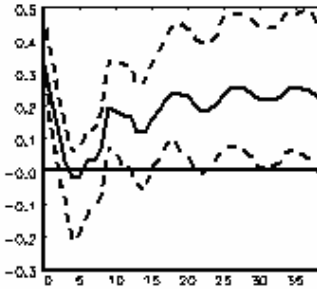
credit -> int



y -> int



int -> int



To briefly sum up our results from the impulse response analysis, 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 setting – a familiar result in earlier studies of China. It thus seems that, even though the credit allocation now follows economic conditions, and particularly interest rate setting, more closely, the effectiveness of the interest rate as a monetary policy tool is still rather low.

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.

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 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 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 although very weak. Overall, however, we need to be very cautious when interpreting our results for the first subperiod because 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. The result is not unexpected in light of earlier findings on rather weak lending channels also on many other countries (see eg Walsh 2003). However, while the weak lending channel in eg 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 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 will probably mine the influence of these measures in the coming years and the authorities should be able to rely on more market-oriented tools, such as interest rate setting.

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

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the official benchmark rate for a one-year credit was 5.6% while the prevailing black market lending rate was 12%.

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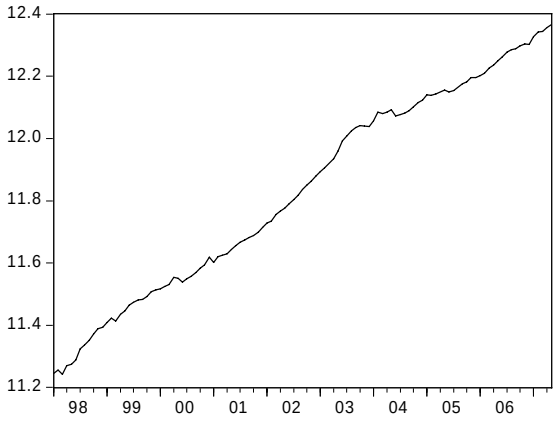
Graph A1 Series used in structural VAR estimations

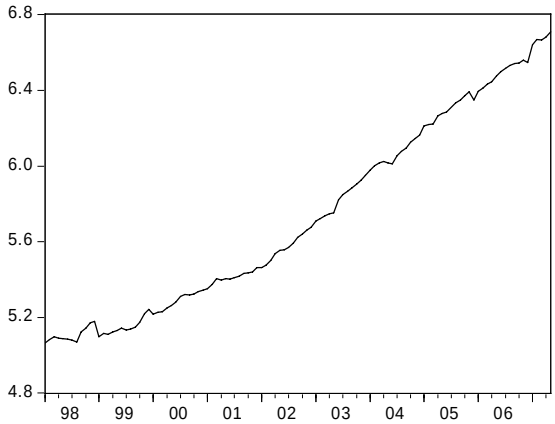
Data Sources

We obtained the credit stock from the IFS database and the value added for industrial value-added and lending rate from the CEIC database.

Credit stock

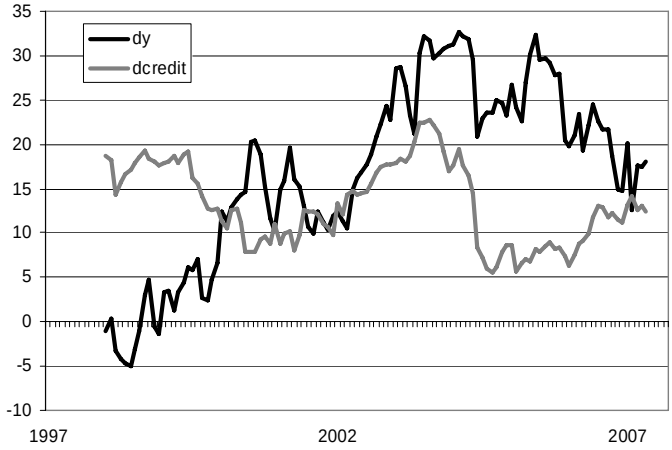


Industrial value-added

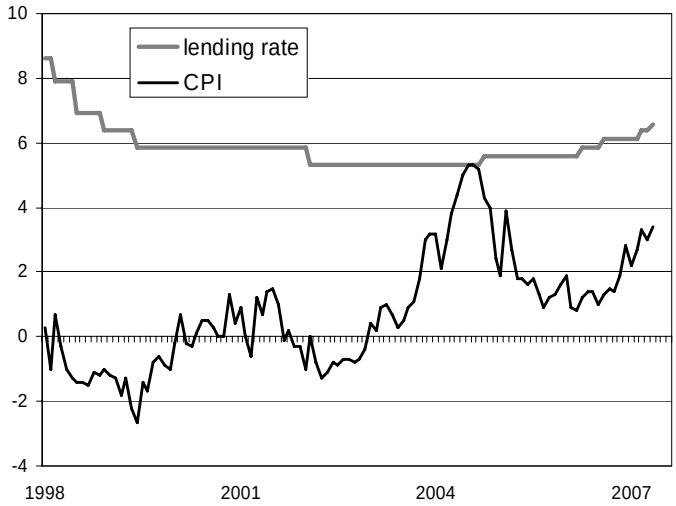


Lending rate

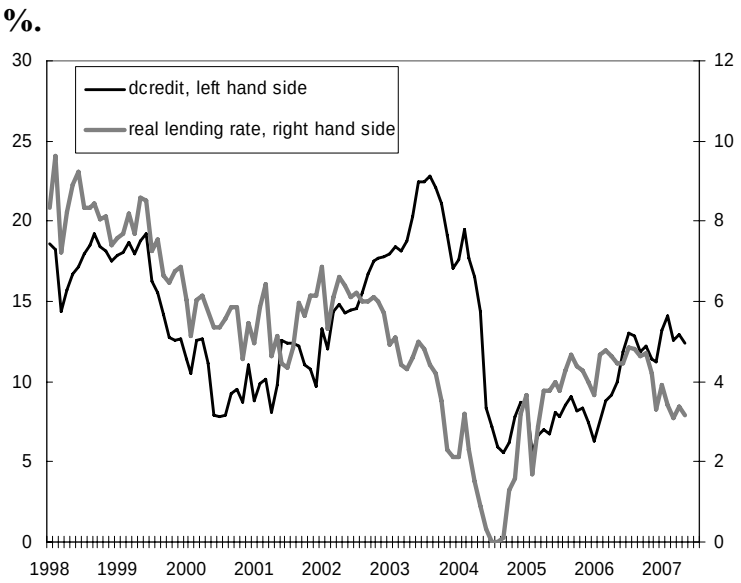
Graph A2 Annual changes in real credit stock and industry value added, 1998 M1-2007 M5, %.



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



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



Graph A5. Results from the Chow sample split test.

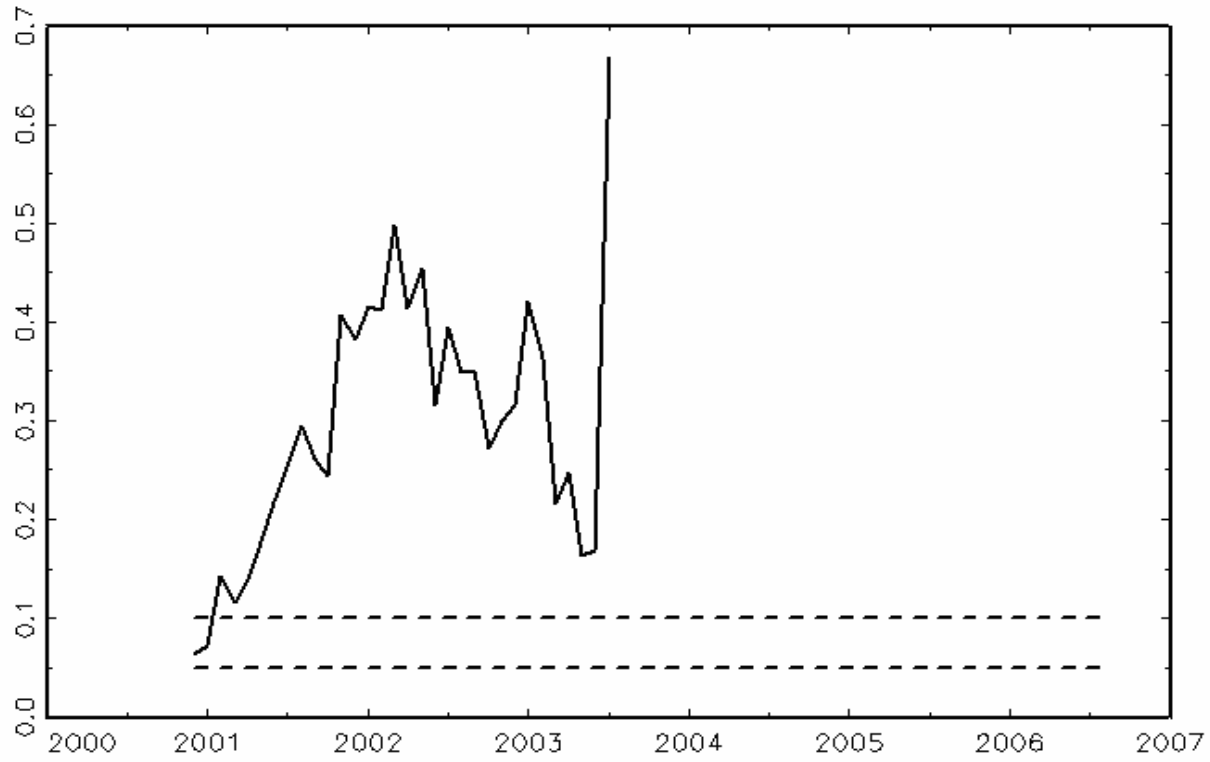


Table A1 Results from Augmented Dickey-Fuller tests, 1998 M1-2007 M5

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 A2. 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 A3. 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***

* 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 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 A5. 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 1 2	197.80*** 83.99*** 21.79***	39.44*** 16.80 4.39
y, credit, int	Constant, trend	10 (AIC, HQ, SC)	0 1 2	447.13*** 120.47*** 56.74***	89.43*** 24.09* 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-kp)/T](trace statistics) suggested by Ahn and Reinsel (1990).

Table A6. 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 1 2	119.73*** 26.76*** 9.66
y, credit, int	Constant	1 (HQ, SC)	0 1 2	125.24*** 22.46** 9.35**
y, credit, int	Constant, trend	12 (AIC)	0 1 2	145.53*** 48.79*** 8.65
y, credit, int	Constant, trend	1 (HQ, SC)	0 1 2	57.44*** 25.69* 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 A7. 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 A8. 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. 1,2,3)	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 A9. 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 A10. 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		$-0.146[credit_{t-1} - 0.759y_{t-1} + 0.013int_{t-1} + 0.005t_{t-11}]$
10/01-5/07	4		$(0.107)[credit_{t-1} - 1.252y_{t-1} + 0.017int_{t-} + 0.015t_{t-111}]$
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 parenthesis () are statistically insignificant.

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Bank of Finland
BOFIT – Institute for Economies in Transition
PO Box 160
FIN-00101 Helsinki

☎ + 358 10 831 2268
bofit@bof.fi
http://www.bof.fi/bofit