BOFIT Discussion Papers
19 • 2007

Aaron Mehrotra, Tuomas Peltonen
and Alvaro Santos Rivera

Modelling inflation in China – a regional perspective

SUOMEN PANKKI • FINLANDS BANK
EUROJÄRJESTELMÄ
EUROSYSTEMET

Bank of Finland, BOFIT
Institute for Economies in Transition

BOFIT Discussion Papers
Editor-in-Chief Iikka Korhonen

BOFIT Discussion Papers 19/2007
30.8.2007

Aaron Mehrotra, Tuomas Peltonen and Alvaro Santos Rivera:
Modelling inflation in China – a regional perspective

ISBN 978-952-462-885-3
ISSN 1456-5889
(online)

Suomen Pankki
Helsinki 2007

Contents

Aaron Mehrotra[a],Tuomas Peltonen[b] and Alvaro Santos Rivera[b*]

Modelling inflation in China – a regional perspective◊

Abstract

We model provincial inflation in China during the reform period. In particular, we are interested in the ability of the hybrid New Keynesian Phillips Curve (NKPC) to capture the inflation process at the provincial level. The study highlights differences in inflation formation and shows that the NKPC provides a reasonable description of the inflation process only for the coastal provinces. A probit analysis suggests that the forward-looking inflation component and the output gap are important inflation drivers in provinces that have advanced most in marketisation of the economy and have most likely experienced excess demand pressures. These results have implications for the relative effectiveness of monetary policy across the Chinese provinces.

Keywords: China, inflation, regional, New Keynesian Philips Curve, GMM
JEL Classification: E31, C22

* Corresponding author: Aaron Mehrotra, Bank of Finland, BOFIT, PO Box 160, 00101 Helsinki, Finland. Email: aaron.mehrotra@bof.fi

◊ All the views expressed in the paper are personal and do not necessarily reflect those of the Bank of Finland or the European Central Bank. We are grateful to Menzie Chinn, Ettore Dorrucci, Philipp Engler, Marcel Fratzscher, Alicia Garcia-Herrero, Tuuli Koivu, Iikka Korhonen, Yue Ma, Jouko Rautava, Christian Thimann, seminar participants at the ACE Conference in Hong Kong, the Pacific Rim Conference in Beijing, and the European Central Bank for helpful comments and suggestions.

Aaron Mehrotra,Tuomas Peltonen and Alvaro Santos Rivera

Modelling inflation in China – a regional perspective

Tiivistelmä

Tutkimuksessa mallinnetaan Kiinan maakuntien inflaatiota talousuudistusten aikana käyttäen uuskeynesiläistä Phillips-käyrää (NKPC). Tulosten mukaan inflaation muodostuksessa on eroja maakuntien välillä, ja uuskeynesiläinen Phillips-käyrä kuvaa inflaatioprosessia suhteellisen hyvin vain Kiinan rannikon maakunnissa. Probit-analyysin mukaan inflaatiodynamiikka on ennakoivaa ja riippuu tuotantokuilusta vain niissä maakunnissa, joissa markkinatalouskehitys on edennyt pisimmälle ja joissa on mahdollisesti ollut kysyntäpaineita. Tuloksilla on merkitystä rahapolitiikan suhteellisen tehokkuuden kannalta Kiinan eri maakunnissa.

Asiasanat: Kiina, inflaatio, alueellinen, uuskeynesiläinen Phillips-käyrä, GMM

1 Introduction

China's rapid growth and ever-increasing economic importance imply a need to understand its inflation developments. While some papers have recorded the ability of the New Keynesian Phillips Curve (NKPC) to capture the inflation process in the Mainland, less attention has been paid to differences across China's provinces. This is important, as aggregate figures mask significant differences in economic performance and different degrees of market development across regions, and institutional differences between provinces may impact the link between output growth and inflation. Table 1 in the Appendix presents some key economic statistics for China and its provinces for 2005.[1] Moreover, the effectiveness of monetary policy depends on the role of inflation expectations in determining inflation, which is of importance for conducting policy in a major economy with regional differences such as China.

One of the stated aims of China's gradual transition towards a more flexible exchange rate regime is to develop and implement an independent monetary policy framework effectively, which could in the future also evolve towards adoption of some form of price stability objective. In this regard, differences in the inflation formation process across Chinese provinces matter because they will directly hinge on the effectiveness of monetary policy. Furthermore, inflation differentials between provinces may reflect price adjustment processes between regions which are necessary and desirable from a regional convergence perspective. However, if differences in inflation formation processes are persistent, this might be a reflection of persistent structural rigidities that reduce some region's capacity, relative to others, to adjust to shocks. Previous literature has reported evidence of substantial trade barriers between the different provinces in China in the past (see Young, 2000). Such measures may prevent price arbitrage between the provinces. Moreover, if regional inflation developments are unrelated to the output gap and marginal costs, then there is little room for monetary policies to anchor inflationary expectations and provide a favourable environment for inter-regional economic growth convergence. Structural policies that target regions where the inflationary process is less responsive to variables that respond to monetary policy might then be called for.

[1] Some provinces are bigger than individual euro area countries in terms of GDP. Measured at USD exchange rates in 2005, Jiangsu, Shandong and Guangdong are all larger than Finland or Ireland, for example.

In our paper, we use a hybrid New Keynesian Phillips Curve (NKPC) to model provincial inflation developments in Mainland China. While the NKPC links inflation developments to expected inflation and marginal cost, a hybrid version takes into account inflation persistence by including lagged inflation rates. In a transition economy where wealth is mostly held in cash or bank deposits, expected inflation may be an important determinant of macroeconomic and social stability, as there is little possibility of hedging against inflation pressures. Consequently, China's macroeconomic development in the reform period may make a standard Phillips curve less valid for modelling inflation. Whereas overheating of the economy in the early 1990s drove consumer price inflation to 25%, the recent pickup after the Asian crisis has been accompanied by both outright deflation and very low positive inflation rates.

Using annual data for 29 provinces for the reform period 1978-2004, our analysis highlights the varying importance of the output gap and inflation expectations for inflation formation across provinces. In particular, we find that the forward-looking inflation component is significant in 22 of the 29 provinces, highlighting the importance of forward-looking behaviour in inflation formation. Nevertheless, there are only 9 provinces where both the forward-looking inflation component and the output gap are statistically significant, suggesting that there are important differences in the inflation process across provinces. Using probit analysis, we provide the first attempt to explain some of these differences. The forward-looking inflation component and the output gap are found to be important in provinces that have advanced most in the marketisation of the economy and have most likely experienced excess demand pressures. These results have implications for the relative effectiveness of monetary policy across the Chinese provinces.

This paper is structured as follows. Section 2 describes the previous literature relevant to our research question. Section 3 presents the theoretical framework, while Section 4 discusses some prominent data issues in the context of the transitional nature of the Chinese economy. Results from the estimations are presented in Section 5, while Section 6 discusses the robustness of the results. Section 7 concludes.

2 Existing literature on NKPC for mainland China

There are a number of recent studies seeking to model inflation dynamics in Mainland China with standard Phillips Curves (PC) and New Keynesian Phillips Curves (NKPC) using various output gap measures.

Gerlach and Peng (2006) estimate output gaps for China using three methods (HP filtering, residuals from a regression of output on a polynomial in time, and an unobservable components model) with annual data for 1982-2003. The three methods produce estimates that are similar and appear to co-move with inflation. Standard PC, however, does not fit the data well. They modify their PC model by including an unobserved variable that obeys a second-order AR process, to control for the omission of potentially important variables (e.g. price deregulation, trade liberalisation, and changes in the exchange rate regime) and obtain a much better fit.

Using annual data for the period 1982-02, Funke (2006) finds that a hybrid NKPC incorporating inflation expectations, lagged inflation and real marginal costs (measured as the output gap) does a good job of modelling inflation dynamics. However, he also finds that while the coefficients of lead and lag inflation are robust, the significance of the output gap (obtained from a band-pass filter) is fragile. In order to control for problems of endogeneity, lagged inflation rates and output gaps, the real oil price and the REER are used as instrumental variables.

Scheibe and Vines (2005), using quarterly data for 1988-02, also find that a hybrid forward-looking NKPC gives a better fit than a backward-looking Phillips curve. However, the authors also find that output gap measures derived from production functions (the best measure was a sector-based production function) explain inflation better than those derived from statistical filters. They use survey data and instrumental variables to proxy for inflationary expectations. As instruments, they use lags of inflation, output gap, and changes in the exchange rate and in oil prices. Scheibe and Vines also impose the restriction that the long-run Phillips curve be vertical (and successfully tested the validity of the assumption) and introduce changes in the nominal effective exchange rate (NEER) as an exogenous variable. They control for episodes of price liberalisation in 1993 and 1994 by using double impulse dummy variables to incorporate the vertical long-run Phillips curve assumption. Interestingly, the authors find that the effect of the exchange rate on inflation declines over time despite the move towards a more open economy. They interpret this as evidence of the growing importance of "pricing to market".

Kojima, Nakamura and Ohyama (2005) find that the fitted values of a Phillips curve estimated using an output gap proxied by electricity consumption per unit of capital (which is assumed to follow a linear trend), and a measure obtained from the band-pass filter, match up best with the actual inflation dynamics. They also find that wage growth, raw material prices and the money gap are important determinants of inflation.

Gerlach-Kristen (2005) finds evidence of business and inflation cycle synchronisation across most Chinese provinces in 1962-03. Applying factor analysis, she also finds a strong common component for business cycles from the mid-1980s onwards and a similar development for inflation already in the 1960s. A second important finding of this paper is that, while business cycle fluctuations became smaller, the amplitude of the inflation cycle increased during the period studied. This seems to suggest that prices play a larger stabilising role in a market-driven than in a centrally planned economy.

Similarly to other studies, Ha, Fan and Shu (2003) find that the NKPC accounted better for inflation dynamics in China in 1989-02 than did the conventional PC. They construct their marginal cost variable in the NKPC model using a linear combination of trade-weighted world prices in renminbi terms, the NEER, and unit labour costs. These variables are all found to have a significant long-run effect on CPI inflation. They also estimate a wage equation and find that excess labour supply prevented Balassa-Samuelson effects from playing a significant role in China. According to their findings, deflation, or low inflation, during these years reflected rapid productivity growth, an appreciation of the effective exchange rate in the wake of the Asian financial crisis, and moderating inflation in China's trading partners.

In sum, while various studies have used different specifications of Phillips curves for the aggregate Chinese economy, little evidence exists regarding their relevance for the individual Chinese provinces. This is of importance, given the institutional differences and varying growth experiences of Chinese provinces, and the challenge of conducting a single monetary policy for such a large economy. We next set out the theoretical framework for our study.

3 Theoretical framework

The attractiveness of the NKPC as a theory of inflation is largely based on its robust theoretical foundations. Woodford (2003) derives the aggregate supply relation by assuming a certain profit function for the supplier of an individual good. Prices are set as in Calvo (1983), where a fraction α (0 < α < 1) of goods prices remain fixed every period, and each price has an equal probability of being changed every period. Those firms that adjust their price choose the same optimal price p*t. The aggregate price level is determined as a convex combination of the lagged price level and the new optimal price:

$$p_t = \alpha p_{t-1} + (1-\alpha) p_t^* . \quad (1)$$

Profits are discounted by a stochastic discount factor averaging β (0 < β < 1). y_t* denotes the output gap, which is the difference between actual and natural rates of output – the latter varying in response to real disturbances, such as changes in preferences and productivity shocks. It can be shown that the aggregate supply relation between the aggregate inflation rate π_t and aggregate output at time t is of the form:

$$\pi_t = \kappa y_t^* + \beta E_t \pi_{t+1} , \quad (2)$$

where

$$\kappa = \frac{(1-\alpha)(1-\alpha\beta)}{\alpha}\zeta > 0 . \quad (3)$$

For any given inflationary expectations, the short-run Phillips curve is the flatter, the smaller the value of ζ, which in the theoretical model measures the degree of strategic complementarity in price setting (Woodford, 2003). The short-run Phillips curve is steeper when α is smaller, i.e. when the average time interval between price changes becomes shorter. When inflation is a forward-looking phenomenon, current expectations of future inflation are able to shift the NKPC. Therefore, a credible commitment by the central bank to disinflate may come about at zero cost in terms of economic output, as the monetary authority can credibly set to zero the path of future output gaps.

However, observed inflation behaviour does not correspond well with models of purely forward-looking inflation. In particular, the NKPC does not capture the empirical observation that inflation is highly persistent (see Fuhrer and Moore, 1995). Galí and Gertler (1999) provide a theoretical framework for the hybrid model by dividing firms into two categories. The first group of firms, a fraction 1-ω, is forward-looking and behaves according to the previously-described specification by Calvo (1983), setting a price p_t^f. The other group is backward-looking, and sets its price p_t^b equal to the average price set in the most recent round of price adjustments corrected for inflation. These firms thereby follow a rule based on the recent pricing behaviour of its competitors. The index for newly set prices is now written as

$$\overline{p_t}^* = (1-\omega) p_t^f + \omega p_t^b \quad (4)$$

and the aggregate price level evolves according to

$$p_t = \alpha p_{t-1} + (1-\alpha)\overline{p_t}^* . \quad (5)$$

A hybrid specification of NKPC that captures inflation persistence can be written as

$$\pi_t = \kappa y_t^* + \beta E_t \pi_{t+1} + \mu \pi_{t-1} . \quad (6)$$

In our paper we consider such a hybrid specification for Mainland China, similarly to Funke (2006). We use a GMM-procedure to estimate the parameters κ, β, and μ in Eq. (6).

While the previous framework allows us to identify differences between China's provinces in terms of the inflation process, it does not address the reasons for these differences. In particular, it does not shed light on why inflation expectations and a measure of economic slack should be statistically significant in some provinces and possibly insignificant in others. In order to address this question we adopt a prior that, while China has moved from command towards market economy, there are significant differences in structural adjustments of the individual provinces.

Given that the NKPC assumes that wages and prices are set optimally according to prevailing information in an environment of monopolistic competition among the suppliers of different goods, it may not be representative of the inflation process in provinces where the transition towards a market economy is less advanced. Prices in a command economy do not properly reflect costs or relative scarcity. In such an environment, it is unlikely that excess demand, entering the NKPC relation in the form of the real marginal cost variable, has a statistically significant link with the inflation rate.[2]

The assumption of the NKPC model might also not hold in provinces where the underdevelopment of the local economy simply hinders the emergence of the conditions necessary for a market system based on competition, equal access to resources and information to work efficiently. Indeed, there seems to be a positive relationship between GDP per capita of different regions in China and the weight of the private sector in these regions. In the Eastern provinces, which account for around 65% of GDP and where GDP per capita on average exceeds USD 3,000, the private sector accounts for 63% of value added for the local economy. In the eleven provinces that comprise China's western region, GDP per capita averages USD 1,200 and the private sector accounts for only 32% of the economy.[3]

Finally, due to the fragmentation of Chinese domestic markets, as reported by Young (2000), price arbitrage between provinces may not hold. Young's argument is based on the nature of the reform process in China, where incremental reforms created rent-seeking opportunities. These were subsequently used by local officials, who sought to protect local industries. It is reasonable to assume that fragmentation of markets may create persistent divergences in the inflation processes of the various provinces. In fact, there is some indication that business cycles have become more synchronised over time across Chinese regions. This is true especially for estimated output gaps, while the support for regional inflation convergence is less evident.[4] Table 2 and Figure 1 in the Appendix present some measures of inflation and output gap dispersion for 1978-2004.

In order to operationalise the idea of explaining the performance of NKPC by province-specific variables linked to the level of transition towards a market-based economy, we use a probit-model. For the dependent variable in the probit framework, we construct a dummy variable that takes the value one when both output gap and forward-looking infla-

[2] We acknowledge that empirical support for NKPC varies even between industrial countries, depending on the exact specification and the variables used to proxy marginal costs, among other things. However, we defend the use of transition-linked variables by the fact that NKPC provides a reasonable description of inflation dynamics for some Chinese provinces and a relatively poor one for others. This suggests that structural differences between provinces may be a reason for the differences.

[3] See OECD Economic Survey of China 2005.

[4] In contrast, Fan and Wei (2006) find that prices of most goods and services analysed in their study converged to the law of one price in China. Their data set consists of 93 products and services in 36 cities over a maximum of 156 months. The authors find that the price convergence of China is comparable to that of the US, Canada and European countries.

tion component are statistically significant at least at the 10% level in estimations of the hybrid NKPC. Otherwise, the dummy takes the value zero.

The choices for the independent variables are as follows. As a proxy for the level of marketisation of the province, we use the ratio of output by state-owned and state-controlled enterprises to total output. Chen and Feng (2000) argue that state-owned enterprises are poorly adapted to market mechanisms reflected in prices. It is likely that a higher share of private sector firms in the economy implies a larger number of firms that are operating under hard budget constraints. Our approach is similar to Biggeri (2003), who finds that the level of output in each Chinese province is negatively influenced by the number of state-owned enterprises.5 Hoff and Stiglitz (2004) note the emergence of private ownership as one of the important features in a transition from command towards market economy.

The development of the financial system is also likely to be of relevance to the ability of a market-based inflation model to capture inflation developments in a transition economy. As Gros and Steinherr (2004) point out, under central planning the demand for funds for investment is almost unlimited, and there is no price mechanism to allocate them. The distribution of financial resources is decided by the government based on political priorities. During transition, the importance of the financial system for allocating savings to investment increases, and the distribution of financial resources is increasingly based on efficiency concerns. We capture financial depth of the provinces with the ratio of loans to Gross Regional Product (GRP), following Hasan et al. (2006). The amount of credit extended to the private sector may capture financial development better than the aggregate measure considered in our study. However, we are constrained in the Chinese case by data limitations. In fully integrated financial markets, firms and consumers should be able to borrow from anywhere in the economy, so there should not be any supply-side constraints arising from the availability of funding. However, the degree of inter-provincial capital mobility is low in China, as Boyreau-Debray (2003) points out. This justifies our use of provincial variables to gauge financial conditions.

We include labour productivity as one explanatory variable in the probit model, defined as real GRP growth less employment growth. When economic growth accelerates, the upward impact on inflation created by the closing of the output gap may be dampened by a parallel increase in labour productivity. Therefore, the relation between detrended output and inflation in the NKPC may be less robust. On the other hand, as outlined by Balassa (1964) and Samuelson (1964), increased labour productivity in the traded goods sector could also boost overall inflationary pressures by driving up the prices of goods in the non-traded sector of the economy where productivity growth is likely to be more moderate. The inclusion of average GRP growth rates and migration rates in the probit model is also related to the importance of economic slack for inflation, as capacity constraints could prove more binding in provinces with higher average GRP growth and less migration. Migrants provide an important contribution to provincial labour supply, they help to raise potential output, and increase the degree of labour market slack, thus dampening any upward pressure on inflation that may arise from rising wages during periods when growth is accelerating.

Another explanatory variable in the probit model is the share of industry in GRP. In addition to reflecting the level of provincial development, it may capture labour productivity in the province, given that labour productivity in Chinese industry is much higher than in agriculture. Moreover, a large part of agricultural production in China is still influenced by government policies aimed at food self-sufficiency. These policies run against the market price mechanism. Thus, the relationship between output and prices in the NKPC may be less robust for provinces with large shares of agricultural production, particularly grain output, in GRP.

Finally, we include in our model the sum of international imports and exports to GRP, to measure the openness of the province. The effects of increased openness on the suitability of the market-based inflation model are ambiguous. On the one hand, increased openness could yield possibilities to take advantage of economies of scale through technology imports and weaken the impact of the output gap on the inflation rate, simply because capacity constraints become less binding. This is important because of historical barriers to trade, even between Chinese provinces, as described in Young (2000). On the other hand, to the extent that increased openness leads to closer links with international markets, the market-based inflation model is likely to be a better proxy for the provincial inflation process. Moreover, for the more open provinces, expected inflation may be important, as economic agents are aware that inflation pressure abroad and exchange rate changes have a lagged impact on local prices. Next, we discuss some data and estimation issues.

[5] Hasan et al. (2006) use the ratio of private investment to total investment to capture the prominence of the private sector in each of China's provinces.

4 About the data

In our analysis, we use data for 29 Chinese provinces provided by the National Bureau of Statistics (NBS) in their Compendium of Statistics. Chongqing and Tibet are omitted due to data availability. The periodicity of the data is annual, starting in 1978. Chinese economic reforms were initiated at that time in the rural areas, when price and output decisions were liberalised in agricultural markets. Foreign trade and investment were also allowed by the new "open door" policy in 1978 although these were strongly encouraged only in the 1990s, when current account transactions were made fully convertible and tariffs on imported inputs were reduced. We acknowledge the fact that there have been structural changes in the economy during the reform period, which may pose a problem for the parameter stability of an aggregate supply relation. Nevertheless, including observations from 1978 onwards is imperative in order to have adequate observations for empirical analysis, and high-frequency price data for Chinese provinces is either non-existent or notably volatile. Finally, we tackle the stability issue by examining recursive estimates of coefficients for the output gap and inflation rate.

For prices, we use the inflation rate based on the retail price index (RPI), mainly based on considerations of data availability. In many provinces, CPI data are only available from the mid-1980s or 1990s onward.[6] Using data on annual inflation rates, we construct a retail price index for China. The inflation rates are then defined in the conventional manner as $\pi_t \equiv p_t - p_{t-1}$, where p_t denotes the price index in logarithmic form. For a transition economy, the use of retail prices is attractive since it limits the impact of price regulations on inflation developments.[7] Price regulations have been non-negligible in China, especially for services included in the CPI but not in the RPI. However, OECD (2005) reports that the share of retail sales transacted at market prices was 69% already in 1991, which corresponds roughly to the mid-point of our estimation sample. State-guided prices corresponded to 10% of transactions at the time, with state-fixed prices in place for the remaining 21%. In 2003, over 96% of retail sales transactions were already conducted at market

[6] These provinces are Anhui, Guangdong, Hebei, Inner Mongolia, Jiangxi, Liaoning, Qinghai, Sichuan, and Zhejiang.

[7] The use of retail prices does not weaken the policy relevance of our study, since movements in retail prices in China are highly correlated with consumer prices. As an example, the coefficient of contemporaneous correlation between the annual growth rates of the two series was 99.5% for 1986-2004. China sets an annual target for CPI growth among its targets for economic and social development (see e.g. PBoC, 2005).

prices. We account for episodes of important price deregulation by means of impulse dummy variables. These take the value of one for years when important liberalisation measures where in place, namely in 1985, 1989, and in 1994.

Because the output gap is not directly observable to the policymaker, one needs a satisfactory proxy. We are sympathetic to the argument by Woodford (2003) that de-trended output is a problematic choice, as the natural rate of output should vary in response to real disturbances, and these may not be well described by smooth time series. However, using a measure such as labour share to proxy marginal costs is not attractive in the Chinese case due to data limitations; hence our choice is the output gap. We use the Baxter-King (1999) band-pass (BP) filter in order to isolate the cyclical component in the data. This is a linear filter that takes a two-sided weighted moving average, given a fixed number of lead and lag terms (three lags in our case). The BP filter isolates the component of GDP that lies between 2 and 8 years. As this method entails a loss of observations, we proceed as follows. We calculate 4 forecasted observations using an optimal ARIMA model for GDP and data for 1952-2004. [8] We then transform the entire series into logarithms and apply the BP-filter, losing only observations before 1978 (start of our actual sample) and after 2003 (end of available data without the forecasted values).

Finally, to evaluate the time series properties of the inflation and the output gap measures, we perform standard unit root tests. In order to increase the power of the unit root tests[9], we apply panel unit root tests by Im, Pesaran and Shin (2003) and Levin, Lin and Chu (2002). [10] In both cases, individual constants and linear trends are included as exogenous variables, as well as different lag lengths from 1 to 3. In all cases, regarding the inflation and output gap measures, both panel unit root tests reject the null hypothesis of a unit root at the 1% level of statistical significance. Therefore, we treat the inflation and output gap measures as stationary variables in the analysis.

[8] The optimal ARIMA model was estimated using TRAMO (Time Series Regression with ARIMA Noise, Missing Observations, and Outliers) by Victor Gomez and Agustin Maravall programmed in EViews 6.0.
[9] See Maddala and Wu (1999, 631).
[10] The main difference between the two panel unit root tests is that the Levin, Lin and Chu (2002) test assumes a common unit root process across cross-sections, whereas the Im, Pesaran and Shin (2003) test assumes individual unit root processes.

5 Empirical analysis

We begin the empirical evidence with a description of two main variables of our estimation framework, the inflation rate and the output gap. Figure 1 displays RPI inflation rates for the 29 provinces of our study, defined as previously using the constructed price index in logarithmic form. For most provinces, two instances of increased inflation pressure are prominent. These occur first in the late 1980s, when administered prices were adjusted and supply-side bottlenecks emerged in certain industrial sectors. The second pick-up in inflation coincides with strong demand pressure in the Chinese economy and the accompanying credit growth in the early 1990s. During 1978-2003, average annual inflation was highest in Hainan province (6.1%). Inflation volatility - measured by the standard deviation - was also most pronounced in Hainan. The highest one-year inflation rate for all Chinese provinces was in Guangdong, where RPI inflation hit 26.4% in 1988. The lowest average inflation was recorded for Henan province (4.2%) and the lowest one-year inflation rate for Shanghai (-5.0%) in 1998 during the Asian financial crisis.

As regards the output gap, our band-pass filter estimates differ more across provinces than the RPI inflation rates, as illustrated in Figure 2. The largest output gaps were estimated for Jilin province (9.3% in 1988), and for Hainan (9.0% in 1990), which posted the highest average inflation rate. The smallest output gap was estimated for Anhui province (-10.1% in 1991). It is interesting that our estimated provincial output gaps sometimes obtain considerably higher magnitudes than the aggregate measure reported by Funke (2006), thus revealing differences across regions.

Figure 1 Provincial RPI inflation rates

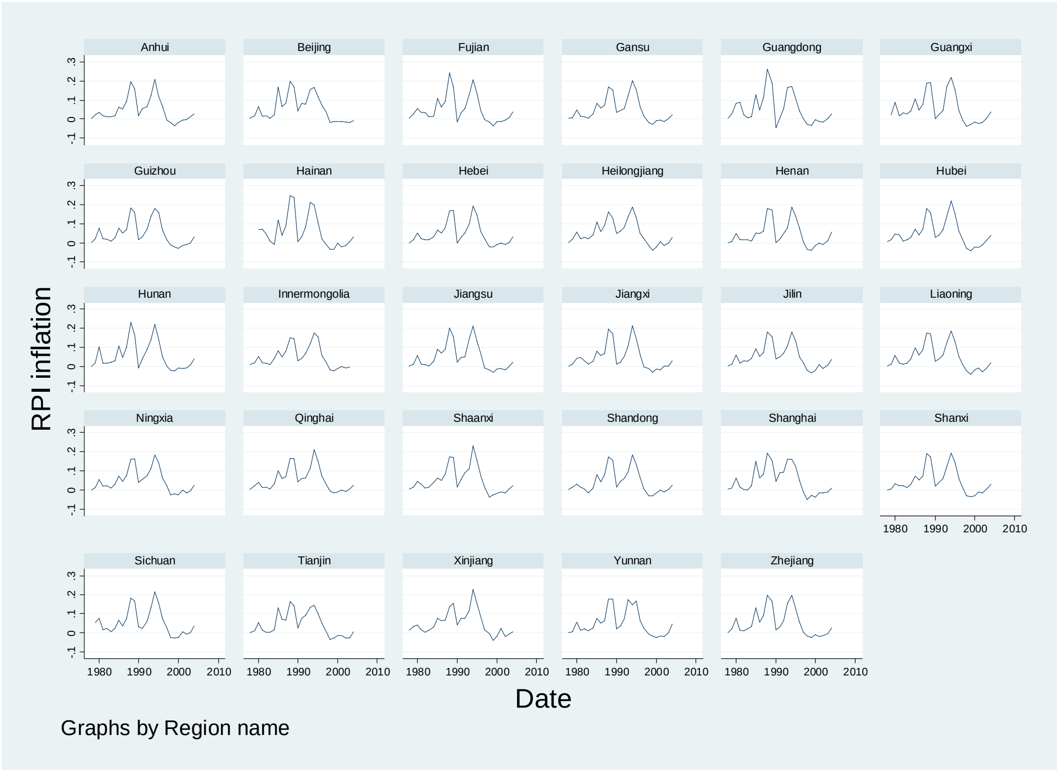


Figure 2 Provincial output gaps

Table 1 provides estimates for the hybrid NKPC for the 29 provinces included in our study. As forward-looking inflation is endogenous in the system, the estimation is conducted using GMM.[11] As instruments, we include the second and third lags of inflation (levels), and the first, second and third lags of output gap, real oil price (nominal oil price deflated by US CPI), and the NEER. The overidentifying restrictions for this instrument set can be rejected for only 2 of the 29 provinces at the 5% significance level.[12]

The results in Table 1 suggest that the hybrid NKPC provides a satisfactory framework for analysing inflation developments in China at the provincial level. The forward-looking inflation component is statistically significant at the 5% level in 22 of the 29 provinces in the sample. These significant coefficient estimates fall between 0.31 (Shandong) and 0.85 (Ningxia), while pooling all the provinces together results in an estimate of 0.35. It is of interest that using aggregate Chinese annual data for 1982-2002 and a similar instrument set, Funke (2006) estimates the forward-looking coefficient at 0.45-0.48, depending on the estimation method. Those coefficients for future inflation that are not statistically significant are estimated to be positive for all but 2 provinces. These results emphasize the importance of the forward-looking inflation component for price determination at provincial level, even though the coefficients are somewhat smaller in magnitude than in previous studies using aggregate Chinese data.

The significance of the lagged inflation rate is not surprising given the observed persistence in inflation. Lagged inflation is found to be significant at the 5% level for 26 of the estimated 29 provinces, with coefficient estimates varying between 0.25 (Hunan) and 0.75 (Xinjiang).[13] The pooled estimate for all the provinces was 0.37, again falling below the magnitudes of 0.52-0.56 reported in Funke (2006) for aggregate Chinese data.

[11] The two-step efficient GMM estimation was done with the Stata 9.2. program using the command IV-REG2. See Baum et al. (2007) for details.

[12] The overidentifying restrictions are also rejected for the model where all regions are pooled together. However, the focus of the analysis is on the provincial models. While a pooled estimation would greatly increase the efficiency of our estimation, we would loose information provided by estimating the provincial models separately.

[13] The reported coefficients for backward-looking inflation reported in Benigno and Lopez-Salido (2006) for France, Italy, Spain and the Netherlands fall between our estimates for Chinese provinces.

Table 1 Estimates of hybrid NKPC

	All regions	Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation	0.3519***	0.4454***	0.268	0.5461***	0.5574***	0.4234***
	[0.0355]	[0.0538]	[0.1655]	[0.0699]	[0.1350]	[0.0758]
L. CPI inflation	0.3674***	0.4631***	0.4804***	0.3309***	0.3699***	0.2592***
	[0.0215]	[0.1020]	[0.1500]	[0.0742]	[0.0675]	[0.0935]
Output gap	0.0062***	0.0005	0.0047	0.0103*	0.0004	0.0165***
	[0.0011]	[0.0012]	[0.0044]	[0.0054]	[0.0021]	[0.0046]
Price dummies	0.0732***	0.0674***	0.0716***	0.0668**	0.0679***	0.1026***
	[0.0045]	[0.0151]	[0.0259]	[0.0268]	[0.0108]	[0.0244]
Constant	0.0059***	-0.0036	0.0024	-0.0055	-0.0059	0.0036
	[0.0021]	[0.0033]	[0.0083]	[0.0056]	[0.0074]	[0.0075]
	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.3750***	0.9503***	0.3409***	0.4400***	-0.0081	0.2679
	[0.1171]	[0.3542]	[0.0935]	[0.0618]	[0.2758]	[0.2805]
L. CPI inflation	0.3910***	0.2817**	0.4094***	0.3559***	0.5373***	0.3410*
	[0.0995]	[0.1170]	[0.1161]	[0.0826]	[0.1808]	[0.1784]
Output gap	0.0135**	0.0005	0.0071***	0.0028	-0.0006	0.0193
	[0.0061]	[0.0065]	[0.0024]	[0.0033]	[0.0020]	[0.0208]
Price dummies	0.0883***	0.0597***	0.1171***	0.0808***	0.0748***	0.0547
	[0.0258]	[0.0210]	[0.0233]	[0.0184]	[0.0094]	[0.0398]
Constant	0.003	-0.0197	-0.0008	0.0019	0.0125	0.0151
	[0.0092]	[0.0176]	[0.0073]	[0.0049]	[0.0085]	[0.0185]
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.3685***	0.3574**	0.2653	0.4078***	0.4065***	0.3645***
	[0.0762]	[0.1515]	[0.1912]	[0.0615]	[0.0829]	[0.1346]
L. CPI inflation	0.3539***	0.2491**	0.4138***	0.4448***	0.2698***	0.3538***
	[0.0636]	[0.1006]	[0.1348]	[0.0789]	[0.0966]	[0.0618]
Output gap	0.0009	0.01	0.001	0.0105***	0.0011	0.0083***
	[0.0049]	[0.0077]	[0.0051]	[0.0028]	[0.0034]	[0.0029]
Price dummies	0.0775***	0.1018***	0.0587***	0.0454***	0.0949***	0.0698***
	[0.0144]	[0.0212]	[0.0136]	[0.0132]	[0.0175]	[0.0089]
Constant	0.0039	0.0072	0.0021	0.0033	0.0033	0.0061
	[0.0052]	[0.0131]	[0.0108]	[0.0035]	[0.0077]	[0.0076]
	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.4175***	0.8536***	0.2757	0.3884***	0.3063***	0.5894***
	[0.1058]	[0.2157]	[0.1912]	[0.1169]	[0.0973]	[0.0998]
L. CPI inflation	0.3949***	0.3422***	0.4172***	0.3896***	0.3914***	0.3438***
	[0.0782]	[0.1325]	[0.0721]	[0.0752]	[0.0500]	[0.0658]
Output gap	0.0038	-0.0025	0.0023	0.0059	0.0093***	0.0093
	[0.0032]	[0.0048]	[0.0032]	[0.0063]	[0.0035]	[0.0087]
Price dummies	0.0660***	0.0665***	0.0819***	0.0733***	0.0685***	0.0577**
	[0.0129]	[0.0152]	[0.0089]	[0.0269]	[0.0137]	[0.0245]
Constant	0.0034	-0.0203*	0.0042	0.0055	0.0086	-0.0004
	[0.0074]	[0.0110]	[0.0097]	[0.0099]	[0.0056]	[0.0052]
	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.7977**	0.4485***	0.5444***	-0.248	0.162	0.4539***
	[0.3749]	[0.0858]	[0.2054]	[0.3740]	[0.2241]	[0.1172]
L. CPI inflation	0.4265***	0.4697***	0.2161*	0.7545***	0.3384	0.3490***
	[0.1620]	[0.0763]	[0.1268]	[0.1821]	[0.2436]	[0.0578]
Output gap	-0.0036	0.0007	0.0080***	0.0124	0.0282	0.0062***
	[0.0028]	[0.0017]	[0.0027]	[0.0095]	[0.0207]	[0.0018]
Price dummies	0.0645***	0.0721***	0.0741***	0.0835***	0.0286	0.0822***
	[0.0240]	[0.0148]	[0.0121]	[0.0243]	[0.0413]	[0.0103]
Constant	-0.0242	-0.008	0.0048	0.021	0.0216	-0.001
	[0.0175]	[0.0076]	[0.0058]	[0.0166]	[0.0220]	[0.0065]

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are in brackets.

Regarding the coefficient for the output gap, we obtain correctly signed significant coefficients at the 5% level for 9 provinces. Using pooled data, the output gap is statistically significant even at the 1% level. The significant (5% level) estimates for the output gap vary between 0.006 (Zhejiang) and 0.017 (Guangdong). These results, especially the differences in the significance of the output gap, suggest that pooling the data or using aggregate Chinese data may hide considerable differences across provinces. For three provinces the coefficient for the output gap is negative, but for none of them are the coefficient estimates statistically significant.[14]

For Hainan, where inflation volatility in our sample was highest, the hybrid NKPC Phillips curve fits the data well, with the coefficients for future and lagged inflation and the output gap all correctly signed and statistically significant, even at the 1% level. A similarly good fit is observed for Guangdong, Jilin, Jiangsu, Shandong and Zhejiang. All the aforementioned coefficients are significant at the 5% level for Guangxi. But for some provinces the NKPC provides a relatively poor fit. For Beijing, Heilongjiang, Inner Mongolia, Qinghai, Xinjiang and Yunnan, the coefficients for both forward-looking inflation and the output gap are not statistically significant.

Table 2 Results of probit estimation

	1	2	3
Real Gross Regional Product (GRP) growth	163.4599**		
	[71.4299]		
Share of State Controlled Enterprises' output of Gross Industrial Output		-3.3385**	
		[1.3717]	
Ratio of industry output to GRP			0.0018***
			[0.0003]
Ratio of trade to GRP	7.6896**	0.6781	4.0804***
	[3.4718]	[0.4588]	[0.7957]
Ratio of loans to GRP	5.4484**	1.5669**	0.1101
	[2.4032]	[0.6794]	[1.0654]
Migration rate	-137.0365**	-22.8023**	-16.3604*
	[64.4123]	[11.4839]	[9.2418]
Labour productivity	-59.9920*	-3.8636	45.9830**
	[36.2697]	[5.9653]	[21.3472]
Observations	27	27	27

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are in brackets. Trade is the sum of foreign exports and imports to GRP; Loans is total loan stock in the province to GRP; Migration rate is the share of migrants in employment; Labour productivity is real GRP growth less employment growth. All variables are measured as averages for 1978-2004 where data is available. Data source: China Compendium of Statistics, CEIC.

[14] Our results are similar to those of Jondeau and Le Bihan (2001), who find that the driving variable is largely insignificant for the US and euro area. In the hybrid NKPC specification for the US by Neiss and Nelson (2005), their theory-based output gap obtains a higher coefficient (0.05) than in our provincial estimates for China. In a specification with the unit labour cost term, however, the variable gets a coefficient of 0.016 and is statistically insignificant. The estimates for the real marginal cost variable in Benigno and Lopez-Salido (2006) for five euro area countries vary between 0.002 (France) and 0.135 (Germany).

While the analysis above reveals differences in the ability of the hybrid NKPC to model inflation at the provincial level, the reasons for the divergences in inflation formation are not explained. In the following, we utilise a probit model to investigate the differences in the inflation process. Table 2 displays results from the probit estimation. Interestingly, the share of state controlled enterprises' output in total output is statistically significant with a negative sign. This suggests that the NKPC fits the data best for those provinces where the importance of the private sector for total output is largest, which is a reasonable result for a market-based inflation model.[15] Furthermore, openness, defined as the ratio of foreign trade to GRP, enters two of the three specifications with a positive statistically significant coefficient. Interestingly, all the provinces where both forward-looking inflation and output gap are statistically significant, are situated on the coast. The importance of openness may reflect the fact that most of these coastal provinces are characterised by the highest degree of market liberalisation and the largest share for the private sector. Price adjustments in these provinces are thus more likely to be influenced by changes in marginal costs and the output gap. Also, increasing financial deepening in the provinces is positively correlated with the ability of NKPC to explain inflation developments for the provinces, as the loans-to-GRP ratio is statistically significant and positive in two of three specifications. This is expected, as financial deepening is one of the key features of any economy in transition to a more market-based structure.[16]

Average GRP growth in the provinces also explains the differences in inflation formation processes in a statistically significant way. Capacity constraints are likely to prove most binding in provinces with the fastest growth in output, leading to inflation pressures. Higher levels of migration can alleviate those capacity constraints by increasing the labour supply, as suggested by the negative coefficient for the migration rate in Table 2. Labour productivity also contributes to increasing potential output, as suggested by the negative coefficient in the first column of the table. The negative coefficient in the third specification can be explained by the omission of provincial growth rates from this equation, or alternatively, potentially important Balassa-Samuelson effects in the provinces. Given that a large part of agricultural production in China is influenced by non-market

[15] Chen and Feng (2000) find that greater presence of state-owned enterprises reduces provincial growth.
[16] Our finding can be seen to run counter of the results by Hao (2006), Boyreau-Debray (2003) and Park and Sehrt (2001), where a higher provincial loan expansion is generally associated with lower economic growth. However, these results relate financial deepening to provincial economic growth, not the inflation process as described by the NKPC.

policies aimed at food self-sufficiency, it is not surprising that the NKPC proves to be a more robust model for inflation in those provinces where the share of industry in GRP is highest.

6 Robustness of the results

To ensure robustness of the results, we conducted several robustness tests. First, due to record-high growth rates in China that have occurred in the presence of considerable structural change in the economy, an investigation of coefficient stability is of interest. As our sample is relatively short, we examine the stability issue with recursive estimates of the hybrid NKPC, in particular the coefficient estimates for the forward-looking inflation component and the output gap, for 1999-2003. These are displayed in the Appendix in Figures 2-3, and Tables 4-8. We display the point estimates, together with the confidence bands to illustrate parameter uncertainty, for only those 9 provinces where both coefficients were found to be statistically significant for the benchmark sample 1978-2003. The recursive estimates do not raise major concerns about the stability of the estimated coefficients for forward-looking inflation and the output gap.

To further evaluate the robustness of the results, we construct an alternative output gap measure using the Hodrick-Prescott (HP) filter with a standard lambda value of 100. The estimation results are shown in Table 3 in the Appendix. When estimating the models using output gaps constructed with the HP filter, we found 7 provinces[17] where both the forward-looking inflation component and the output gap measure are statistically significant at least at the 5% level. In all cases, the estimated output gap coefficients have similar signs, but the estimated coefficients are generally smaller than those obtained using the output gap measure constructed with the BP filter. Overall, we find that the results are quite robust to the choice of detrended output measure. In contrast, when we estimate the models using a labour share variable as a proxy for marginal costs, the NKPC does not fit the data well.[18] In particular, even when the forward-looking and lagged inflation rates are statistically significant, the output gap is rarely significant and usually obtains the wrong sign.

[17] Fujian, Guangdong, Guangxi, Hainan, Shanghai, Tianjin, Zhejiang.
[18] The labour share is proxied by the total number of employed persons times the average wage of staff and workers, divided by GRP.

This result may partly reflect limitations in wage and employment data for the Chinese economy.[19]

Finally, as regards robustness of the probit model, we display three different specifications of the models, which are estimated using heteroscedasticity robust standard errors. Overall, the estimates are found to be quite robust, albeit the small sample size prevents proper evaluation of model stability. However, we find that potential multicollinearity problems arise when the following variables are jointly included: real Gross Regional Product (GRP) growth, share of State Controlled Enterprises' (SCE) output of Gross Industrial Output, and ratio of industry output to GRP.

All in all, we find the first stage estimation results to be robust to different sample lengths and choice of filter used to construct the output gap measure. Similarly, we find that the second stage estimation results are robust to different specifications, i.e. inclusion and exclusion of variables. However, we also find that using labour share as a proxy for marginal cost in the first stage does not lead to plausible results. Similarly, potential multicollinearity problems arise when certain variables are included jointly in the second stage regression.

7 Conclusion

In our study, a hybrid New Keynesian Phillips Curve (NKPC) was employed to model provincial inflation developments in Mainland China. Using annual data for 29 provinces for the reform period 1978-2004, our analysis highlights the varying importance of the output gap and inflation expectations for inflation formation across provinces. We find that the forward-looking inflation component is statistically significant in 22 of the 29 provinces, highlighting the importance of this variable for the inflation formation process in China. Nevertheless, the varying degree of statistical significance of the estimated coefficients, especially for the output gap, suggests that there are also important differences in the inflation process across provinces.

Notably, all the provinces where both the forward-looking inflation component and the output gap are statistically significant, are situated on China's coastline. These prov-

[19] Rudd and Whelan (2005) find that the labour share measure of the output gap does not improve the fit of the NKPC for the US economy.

inces share some common characteristics: they are more open to international trade; they have the lowest share of state-controlled enterprises in their total output; they have experienced high rates of economic and labour productivity growth; and they have attracted large net inflows of immigrants from other provinces. Our probit analysis shows that the most significant variables for explaining the relevance of the NKPC model across Chinese provinces are precisely those that capture the degree of development of the market system (share of state-controlled sector in total output, openness to trade, financial deepening) and the relative exposure to excess demand pressures (GDP growth rates, labour productivity, level of industrialisation, migration).

Differences in the inflation processes and mechanisms across provinces have important implications for the conduct of monetary policy in China. Some researchers (e.g. Goodfriend and Prasad, 2006) have recommended that China move from money growth and credit targets to a framework where the inflation objective provides the anchor for policy. Under inflation targeting, a high level of forward-looking inflation expectations enhances the effectiveness of monetary policy, as a credible commitment by the central bank increases the probability that the target will actually be achieved. Secondly, in a low inflation environment agents' forward-looking behaviour generates additional benefits. When nominal interest rates are close to zero, a credible commitment to higher inflation lowers the real *ex ante* interest rate, even without any change in the nominal policy rate, and can thus provide a stimulus to the economy (see Svensson, 2003). Our results can be seen as evidence that forward-looking inflation expectations are already in place in most of the provinces in China. However, our findings also suggest that excess demand pressures, proxied by the output gap, have had a statistically significant impact on inflation formation only in some provinces, suggesting that market-based inflation mechanisms are fully in place only in the most advanced provinces along the Mainland’s coastline.

While our paper represents a first attempt to use a hybrid NKPC to account for the inflation process in the Chinese provinces, and to explain some of the observed differences across provinces, it leaves open some interesting research questions. For instance, as openness, defined as the ratio of trade to regional product, exerts a notable impact on the importance of the output gap and forward-looking inflation, it is possible that an open-economy NKPC could provide a good framework for analysing inflation formation in some of the provinces. This is left for future research.

References

Balassa, B., 1964. The purchasing-power parity doctrine: a reappraisal. *Journal of Political Economy* 72 (6), 584–596.

Baum, C.F., Schaffer, M.E., Stillman, S., 2007. ivreg2: Stata module for extended instrumental variables/2SLS, GMM and AC/HAC, LIML and k-class regression. http://ideas.repec.org/c/boc/bocode/s425401.html.

Baxter, M., King, R. G., 1999. Measuring business cycles: Approximate band-pass filters for economic time series. *Review of Economics and Statistics* 81, 575-593.

Benigno, P., Lopez-Salido, J. D., 2006. Inflation persistence and optimal monetary policy in the euro area. *Journal of Money, Credit, and Banking* 38 (3), 587-614.

Biggeri, M., 2003. Key factors of recent Chinese provincial economic growth. *Journal of Chinese Economic and Business Studies* 1 (2), 159-183.

Boyreau-Debray, G., 2003. Financial intermediation and growth: Chinese style. Policy Research Working Paper 3027. World Bank, Washington, D.C.

Calvo, G., 1983. Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics* 12, 383-398.

Chen, B., Feng, Y., 2000. Determinants of economic growth in China: Private enterprise, education and openness. *China Economic Review* 11, 1-15.

Fan, C. S., Wei, X., 2006. The law of one price: Evidence from the transitional economy of China. *The Review of Economics and Statistics* 88 (4), 682-697.

Fuhrer, J. C., Moore, G. A., 1995. Inflation persistence. *Quarterly Journal of Economics* 100, 127-159.

Funke, M., 2006. Inflation in mainland China – modelling a roller coaster ride. *Pacific Economic Review* 11 (4), 413-429.

Galí, J., Gertler, M., 1999. Inflation dynamics: A structural econometric analysis. *Journal of Monetary Economics* 44, 195-222.

Gerlach, S., Peng, W., 2006. Output gaps and inflation in Mainland China. *China Economic Review* 17 (2), 210-225.

Gerlach-Kristen, P., 2005. Business cycle and inflation synchronisation in Mainland China and Hong Kong. Working paper, University of Basel.

Goodfriend, M., Prasad, E., 2006. A framework for independent monetary policy in China. IMF Working paper no. 06/111. International Monetary Fund, Washington, DC.

Gros, D., Steinherr, A., 2004. Economic transition in Central and Eastern Europe: Planting the seeds. Cambridge University Press, Cambridge.

Ha, J., Fa, K., Shu, C., 2003. The causes of inflation and deflation in Mainland China, *Hong Kong Monetary Authority Quarterly Bulletin*, September, 23-31.

Hasan, I., Wachtel, P., Zhou, M., 2006. Institutional development, financial deepening and economic growth: Evidence from China. BOFIT Discussion paper no. 12/2006. Bank of Finland, Helsinki.

Hao, C., 2006. Development of financial intermediation and economic growth: The Chinese experience. *China Economic Review* 17, 347-362.

Hoff, K., Stiglitz, J. E., 2004. After the big bang? Obstacles to the emergence of the rule of law in post-communist societies. *The American Economic Review* 94 (3), 753-763.

Im, K. S., M. H. Pesaran, Y. Shin, 2003. Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics* 115, 53-74.

Jondeau, E., Le Bihan, H., 2001. Testing for a Forward-Looking Phillips Curve. Additional Evidence from European and US Data. Banque de France, Notes d'Etudes et de Recherche #86.

Kojima, R., Nakamura, S., Ohyama, S., 2005. Inflation dynamics in China. Bank of Japan Working Paper No. 05-E-9.

Levin, A., C. F. Lin, C. S. Chu, 2002. Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics* 108, 1-24.

Maddala, G. S., Wu, S., 1999. A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics*, Special Issue, 631-652.

Neiss, K. S., Nelson, E., 2005. Inflation Dynamics, Marginal Cost, and the Output Gap: Evidence from Three Countries. *Journal of Money, Credit, and Banking* 37 (6), 1019-1045.

OECD, 2005. *OECD Economic Surveys China 2005*. OECD Publications.

Park, A., Sehrt, K., 2001. Tests of Financial Intermediation and Banking Reform in China. *Journal of Comparative Economics* 29, 608-644.

PBoC, 2005. China Monetary Policy Report. Quarter Four, 2005. Monetary Policy Analysis Group of the People's Bank of China.

Rudd, J., Whelan, K., 2005. Does labor's share drive inflation? *Journal of Money, Credit, and Banking* 37 (2), 297-312.

Samuelson, P. A., 1964. Theoretical notes on trade problems. *Review of Economics and Statistics* 46 (2), 145–154.

Scheibe, J., Vines, D., 2005. A Phillips curve for China. CEPR Discussion Paper No. 4957.

Svensson, L. E. O., 2003. Escaping from a liquidity trap and deflation: The foolproof way and others. *Journal of Economic Perspectives* 17 (4), 145-166.

Woodford, M., 2003. Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton University Press, Princeton.

Young, A., 2000. The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China. *The Quarterly Journal of Economics* 115 (4), 1091-2235.

Appendix

Table 1 Economic statistics for China and its provinces, 2005

2005 values	GDP RMB bn	Real GDP % y/y	Employment mn	Openness % GDP	Primary ind. % GDP	Tertiary ind. % GDP	Productivity % y/y
China	18,308.5	10.2	758.3	62.6	12.6	39.9	3.3
Anhui	537.5	11.8	34.8	13.9	18.0	40.7	4.3
Beijing	688.6	11.8	9.2	63.0	1.4	69.1	1.6
Chongqing	307.0	11.5	17.2	11.1	15.1	43.9	9.7
Fujian	656.9	11.6	18.7	69.8	12.8	38.5	5.0
Gansu	193.4	11.8	13.5	12.1	15.9	40.7	6.8
Guangdong	2,236.7	13.8	47.0	158.6	6.4	42.9	-1.7
Guangxi	407.6	13.2	27.0	11.4	22.4	40.5	1.5
Guizhou	197.9	11.6	22.2	8.3	18.6	39.6	2.3
Hainan	89.5	10.2	3.8	18.6	33.6	41.8	2.6
Hebei	1,009.6	13.4	34.7	15.5	14.9	33.3	4.6
Heilongjiang	551.2	11.6	16.3	15.3	12.4	33.7	6.1
Henan	1,058.7	14.2	56.6	6.9	17.9	30.0	3.1
Hubei	652.0	12.1	26.8	12.3	16.6	40.3	1.1
Hunan	651.1	11.6	36.6	8.6	19.6	40.6	2.0
Inner Mongolia	389.6	23.8	10.4	11.0	15.1	39.3	0.5
Jiangsu	1,830.6	14.5	38.8	105.1	8.0	35.4	-1.7
Jiangxi	405.7	12.8	21.1	9.9	17.9	34.8	2.8
Jilin	362.0	12.1	11.0	16.2	17.3	39.1	-1.0
Liaoning	800.9	12.3	19.8	47.4	11.0	39.6	1.7
Ningxia	60.6	10.9	3.0	15.7	11.9	41.7	7.2
Qinghai	54.3	12.2	2.7	7.4	12.0	39.3	-0.5
Shaanxi	367.6	12.6	18.8	13.5	11.9	37.8	3.4
Shandong	1,851.7	15.2	51.1	38.9	10.6	32.0	0.5
Shanghai	915.4	11.1	8.6	160.0	0.9	50.5	-2.4
Shanxi	418.0	12.6	14.8	17.7	6.3	37.4	5.1
Sichuan	738.5	12.6	46.0	8.4	20.1	38.4	0.4
Tianjin	369.8	14.7	4.3	119.5	3.0	41.5	0.4
Tibet	25.1	12.1	1.4	4.2	19.1	55.6	8.0
Xinjiang	260.4	10.9	7.6	25.7	19.6	35.7	3.2
Yunnan	347.3	9.0	24.6	11.6	19.3	39.5	3.3
Zhejiang	1,343.8	12.8	32.0	74.4	6.6	40.0	-4.2

Notes. Openness is calculated as the share of trade (imports by consumer + exports by producer) to GRP for the provinces, and as the share of external trade (imports + exports) to GDP for the country. Productivity is calculated as the difference between real GDP growth and employment growth. Data source: CEIC.

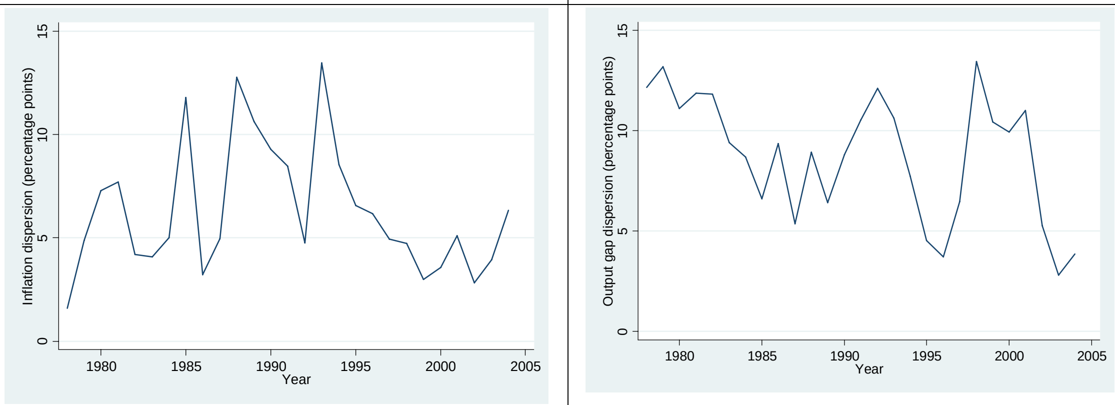
Table 2 Average regional dispersion (max-min, percentage points)

	Inflation (RPI)	Output gap (BPF)
1978-81	5.4	12.1
1982-85	6.3	9.1
1986-89	7.9	7.5
1990-93	9.0	10.5
1994-97	6.5	5.6
1998-01	4.1	11.2
2002-04	4.4	4.0

Notes. Inflation is measured as annual change in retail price index (RPI); output gap is calculated by subtracting actual output from Baxter and King (1999) band-pass filtered (BPF) trend.

Figure 1 Regional inflation and output gap synchronisation measures

Inflation (RPI) dispersion 1978-2004 (max-min, percentage points)	Output gap (BPF) dispersion 1978-2004 (max-min, percentage points)



Sources. National bureau of Statistics, authors' calculations.

Table 3. Estimates of hybrid NKPC with output gap measures constructed using Hodrick-Prescott (HP) filter

	All regions	Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation	0.4643***	0.4636***	0.3158**	0.6264***	0.5300***	0.4902***
	[0.0331]	[0.0608]	[0.1611]	[0.0820]	[0.1456]	[0.1031]
L. CPI inflation	0.3624***	0.4582***	0.5506***	0.2403***	0.3524***	0.1122
	[0.0230]	[0.0910]	[0.1696]	[0.0842]	[0.0640]	[0.1250]
Output gap	0.0011***	0.0001	0.001	0.0031**	0.0006	0.0074***
	[0.0003]	[0.0005]	[0.0025]	[0.0015]	[0.0008]	[0.0021]
Price dummies	0.0779***	0.0683***	0.0685***	0.0970***	0.0700***	0.1330***
	[0.0040]	[0.0134]	[0.0237]	[0.0228]	[0.0085]	[0.0366]
Constant	-0.0007	-0.0042	-0.0038	-0.0065	-0.0041	0.0043
	[0.0015]	[0.0040]	[0.0078]	[0.0063]	[0.0064]	[0.0097]

	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.5071***	0.9805***	0.3674***	0.4597***	0.2517*	0.4879***
	[0.0702]	[0.1801]	[0.0964]	[0.0496]	[0.1389]	[0.0963]
L. CPI inflation	0.3667***	0.2870**	0.2834***	0.3342***	0.3881***	0.3600***
	[0.0821]	[0.1242]	[0.0775]	[0.0813]	[0.1392]	[0.1145]
Output gap	0.0027***	-0.0012	0.0022***	0.0016	-0.0015	0.0006
	[0.0009]	[0.0020]	[0.0008]	[0.0015]	[0.0011]	[0.0015]
Price dummies	0.1009***	0.0596***	0.1392***	0.0846***	0.0726***	0.0819***
	[0.0214]	[0.0231]	[0.0282]	[0.0155]	[0.0081]	[0.0212]
Constant	-0.0054	-0.0232***	0.0006	0.0006	0.0071	-0.0032
	[0.0066]	[0.0084]	[0.0059]	[0.0043]	[0.0073]	[0.0051]

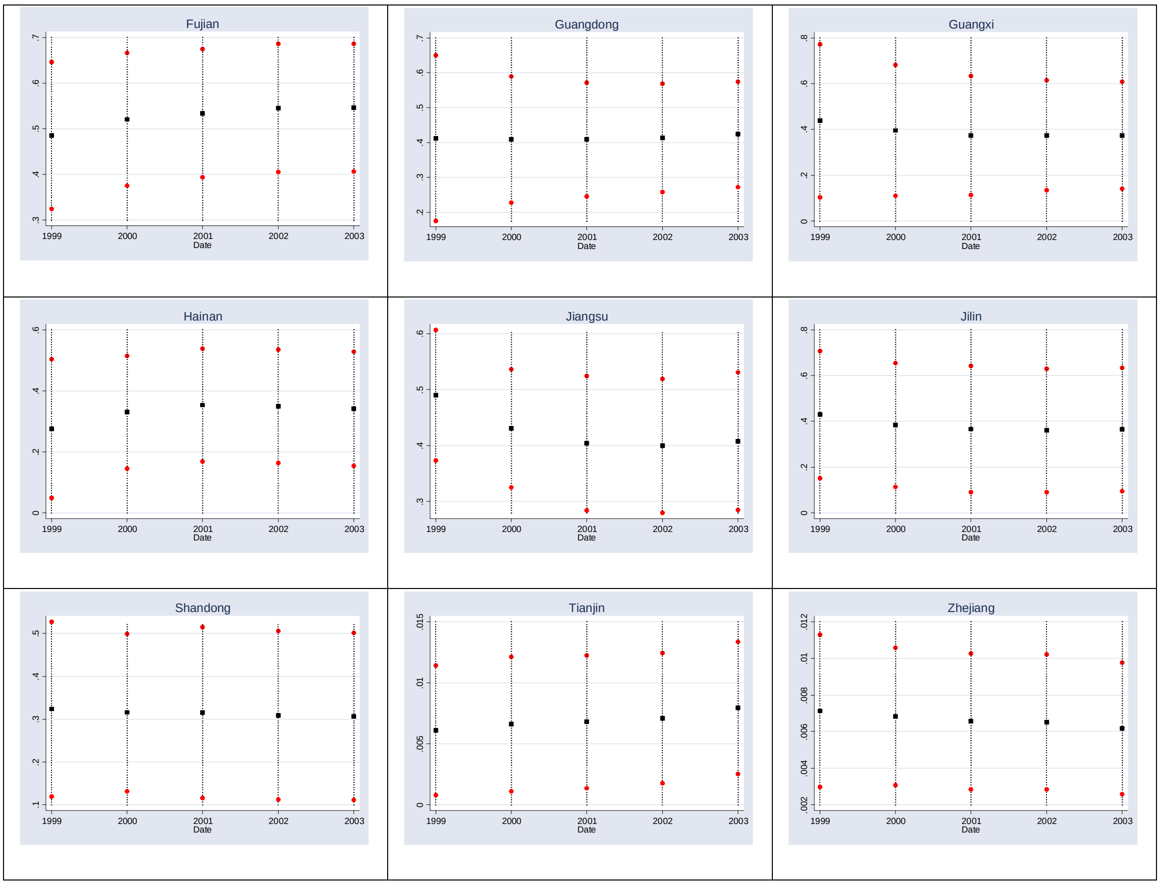
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.3565***	0.4759***	0.4362**	0.4900***	0.4781***	0.6489***
	[0.0774]	[0.1164]	[0.2219]	[0.0680]	[0.0657]	[0.1015]
L. CPI inflation	0.3745***	0.2951***	0.4428***	0.3891***	0.2618**	0.3145***
	[0.0630]	[0.1142]	[0.0845]	[0.0796]	[0.1058]	[0.0742]
Output gap	-0.0007	0.0022	-0.0016	0.0024	0.0012	0.0023
	[0.0014]	[0.0024]	[0.0014]	[0.0015]	[0.0014]	[0.0015]
Price dummies	0.0736***	0.0981***	0.0607***	0.0654***	0.0913***	0.0645***
	[0.0085]	[0.0171]	[0.0120]	[0.0117]	[0.0160]	[0.0115]
Constant	0.0033	-0.0025	-0.0065	-0.0018	0.0012	-0.0059
	[0.0044]	[0.0075]	[0.0114]	[0.0044]	[0.0056]	[0.0059]

	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.4999***	0.6803***	0.1211	0.4242***	0.4524***	0.2077**
	[0.0742]	[0.2507]	[0.2807]	[0.0955]	[0.0627]	[0.1010]
L. CPI inflation	0.3579***	0.3546***	0.4794***	0.4044***	0.3439***	0.5884***
	[0.0836]	[0.1301]	[0.0890]	[0.0849]	[0.0770]	[0.0830]
Output gap	0.0017	-0.0007	0.0007	-0.0004	0.002	-0.0043**
	[0.0014]	[0.0009]	[0.0015]	[0.0019]	[0.0014]	[0.0021]
Price dummies	0.0696***	0.0671***	0.0840***	0.0989***	0.0814***	0.0908***
	[0.0111]	[0.0114]	[0.0097]	[0.0270]	[0.0126]	[0.0267]
Constant	0.0002	-0.0128	0.0073	-0.0012	0.0009	-0.0058*
	[0.0066]	[0.0099]	[0.0121]	[0.0070]	[0.0044]	[0.0030]

	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.5847***	0.5188***	0.5944***	-0.3617	0.5234***	0.4259***
	[0.2177]	[0.0577]	[0.1846]	[0.5988]	[0.0663]	[0.1051]
L. CPI inflation	0.4384***	0.4162***	0.2382*	0.6996***	0.4550***	0.3329***
	[0.1397]	[0.0809]	[0.1234]	[0.2021]	[0.1713]	[0.0735]
Output gap	-0.0014	0.0008	0.0020**	0.0091	0.0003	0.0016**
	[0.0010]	[0.0006]	[0.0010]	[0.0073]	[0.0045]	[0.0008]
Price dummies	0.0656***	0.0735***	0.0794***	0.0810***	0.0436*	0.0912***
	[0.0191]	[0.0142]	[0.0101]	[0.0259]	[0.0232]	[0.0094]
Constant	-0.0121	-0.0069	-0.0041	0.0252	-0.01	-0.0014
	[0.0093]	[0.0055]	[0.0050]	[0.0255]	[0.0079]	[0.0048]

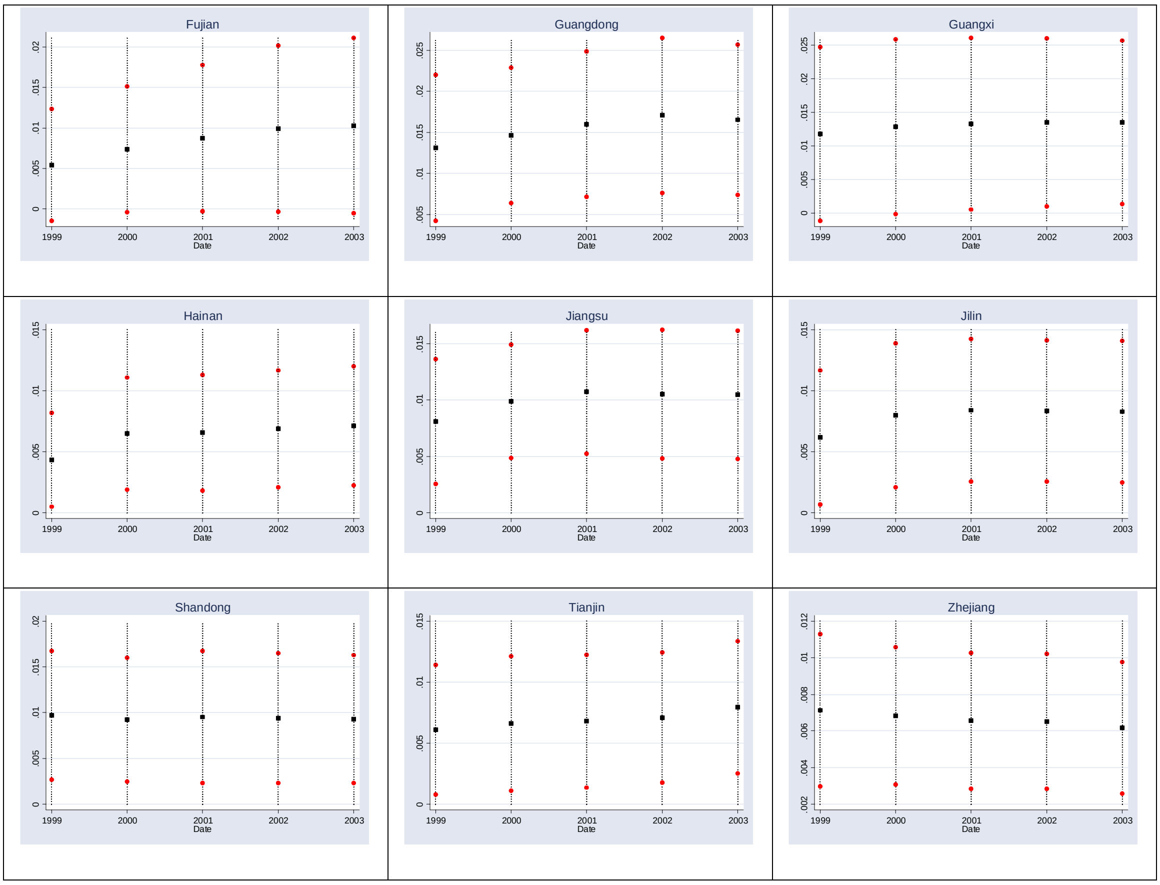
Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% level, respectively. Robust standard errors are in brackets.

Figure 2 Recursive point estimates of forward-looking inflation



Notes. Point estimates with their confidence bands with +/-2 standard errors displayed.

Figure 3. Recursive point estimates of output gap



Notes. Point estimates with their confidence bands with +/-2 standard errors displayed.

Table 4 Recursive estimates of the models, 1978-1999

		Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation		0.4939***	0.0423	0.4852***	0.5938***	0.4121***
		[0.0709]	[0.2744]	[0.0802]	[0.1168]	[0.1188]
L. CPI inflation		0.5678***	0.3468*	0.3078**	0.5050***	0.2705**
		[0.1279]	[0.1979]	[0.1348]	[0.1041]	[0.1105]
Output gap		-0.0012	0.0073	0.0054	0.0012	0.0131***
		[0.0013]	[0.0060]	[0.0034]	[0.0013]	[0.0044]
Price dummies		0.0604***	0.0798***	0.0807***	0.0592***	0.0966***
		[0.0141]	[0.0225]	[0.0241]	[0.0112]	[0.0197]
Constant		-0.0142*	0.0321	0.0018	-0.0170*	0.0011
		[0.0085]	[0.0301]	[0.0133]	[0.0101]	[0.0151]
	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.4378***	0.7959***	0.2763**	0.5008***	0.5059***	0.2469
	[0.1668]	[0.1488]	[0.1134]	[0.0806]	[0.0698]	[0.2994]
L. CPI inflation	0.4505***	0.3588**	0.2445*	0.4397***	0.4758***	0.3597*
	[0.1403]	[0.1494]	[0.1470]	[0.1110]	[0.1009]	[0.2038]
Output gap	0.0118*	0.0032	0.0043**	0.0013	-0.0017	0.0186
	[0.0065]	[0.0037]	[0.0019]	[0.0036]	[0.0015]	[0.0201]
Price dummies	0.0801***	0.0534**	0.1085***	0.0780***	0.0601***	0.0554
	[0.0234]	[0.0216]	[0.0301]	[0.0177]	[0.0081]	[0.0366]
Constant	-0.0083	-0.0176	0.0183	-0.0065	-0.0093*	0.0163
	[0.0201]	[0.0125]	[0.0219]	[0.0072]	[0.0055]	[0.0248]
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.5449***	0.5753***	0.6086***	0.4900***	0.5568***	0.4299***
	[0.0594]	[0.1170]	[0.1590]	[0.0585]	[0.1108]	[0.1390]
L. CPI inflation	0.4346***	0.3254**	0.5734***	0.5018***	0.3399***	0.3264***
	[0.1144]	[0.1370]	[0.1265]	[0.0790]	[0.1004]	[0.1058]
Output gap	0.0048	0.0044	0.0129***	0.0081***	0.0027	0.0062**
	[0.0046]	[0.0052]	[0.0044]	[0.0028]	[0.0040]	[0.0027]
Price dummies	0.0616***	0.0966***	0.0256	0.0494***	0.0870***	0.0683***
	[0.0165]	[0.0183]	[0.0190]	[0.0107]	[0.0209]	[0.0093]
Constant	-0.0079	-0.01	-0.0174	-0.0096	-0.0077	0.0042
	[0.0093]	[0.0158]	[0.0110]	[0.0075]	[0.0119]	[0.0143]
	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.5725***	0.8676***	0.5035***	0.4829***	0.3234***	0.5901***
	[0.0821]	[0.2627]	[0.0929]	[0.1220]	[0.1018]	[0.0954]
L. CPI inflation	0.4473***	0.4281***	0.5015***	0.3944***	0.3991***	0.3575***
	[0.1107]	[0.1306]	[0.1049]	[0.1221]	[0.0721]	[0.0912]
Output gap	0.0016	-0.001	0.0017	0.0035	0.0097***	0.0147*
	[0.0030]	[0.0024]	[0.0016]	[0.0072]	[0.0035]	[0.0078]
Price dummies	0.0674***	0.0586***	0.0742***	0.0798***	0.0690***	0.0454**
	[0.0117]	[0.0099]	[0.0081]	[0.0287]	[0.0134]	[0.0219]
Constant	-0.0104	-0.0289**	-0.0122	-0.0012	0.0066	0.0016
	[0.0110]	[0.0127]	[0.0099]	[0.0187]	[0.0111]	[0.0086]
	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.7330***	0.4936***	0.4470**	0.3043*	0.1856	0.3352
	[0.2173]	[0.0230]	[0.1910]	[0.1844]	[0.1757]	[0.2275]
L. CPI inflation	0.5123***	0.5534***	0.2049	0.6230***	0.3704	0.2741**
	[0.1278]	[0.0475]	[0.1765]	[0.1060]	[0.2389]	[0.1116]
Output gap	-0.002	0.0069**	0.0061**	0.0008	0.0229	0.0071***
	[0.0014]	[0.0029]	[0.0027]	[0.0028]	[0.0143]	[0.0021]
Price dummies	0.0584***	0.0670***	0.0785***	0.0856***	0.0321	0.0865***
	[0.0192]	[0.0111]	[0.0136]	[0.0166]	[0.0390]	[0.0119]
Constant	-0.0253**	-0.0177**	0.0086	-0.01	0.0194	0.0133
	[0.0126]	[0.0074]	[0.0116]	[0.0114]	[0.0187]	[0.0227]

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% level, respectively. Robust standard errors are in brackets.

Table 5. Recursive estimates of the models, 1978-2000

		Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation		0.4609***	0.1693	0.5206***	0.6312***	0.4086***
		[0.0636]	[0.2189]	[0.0726]	[0.1376]	[0.0904]
L. CPI inflation		0.5250***	0.4139**	0.3535***	0.4381***	0.2547***
		[0.1150]	[0.1680]	[0.1013]	[0.0964]	[0.0918]
Output gap		-0.0001	0.0075	0.0074*	0.0003	0.0147***
		[0.0010]	[0.0054]	[0.0039]	[0.0018]	[0.0041]
Price dummies		0.0616***	0.0737***	0.0726***	0.0645***	0.0979***
		[0.0152]	[0.0237]	[0.0252]	[0.0113]	[0.0215]
Constant		-0.0084	0.0164	-0.0055	-0.0161	0.0039
		[0.0052]	[0.0193]	[0.0099]	[0.0117]	[0.0098]
	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.3959***	0.8827***	0.3305***	0.4720***	0.4908***	0.2534
	[0.1430]	[0.2385]	[0.0924]	[0.0695]	[0.0711]	[0.2778]
L. CPI inflation	0.4073***	0.3404**	0.3220**	0.3765***	0.3823***	0.3560*
	[0.1204]	[0.1355]	[0.1416]	[0.0942]	[0.1058]	[0.1959]
Output gap	0.0129**	0.0014	0.0065***	0.0024	-0.0011	0.0204
	[0.0065]	[0.0048]	[0.0023]	[0.0036]	[0.0013]	[0.0205]
Price dummies	0.0880***	0.0562***	0.1126***	0.0830***	0.0633***	0.0549
	[0.0252]	[0.0208]	[0.0279]	[0.0169]	[0.0082]	[0.0378]
Constant	0.0006	-0.0209	0.0087	-0.0012	-0.0031	0.0137
	[0.0143]	[0.0155]	[0.0131]	[0.0055]	[0.0045]	[0.0156]
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.4784***	0.4837***	0.5131***	0.4310***	0.4519***	0.3840***
	[0.0750]	[0.1460]	[0.1324]	[0.0527]	[0.1021]	[0.1355]
L. CPI inflation	0.2921***	0.2004*	0.3708***	0.4838***	0.2499**	0.3675***
	[0.0925]	[0.1071]	[0.1091]	[0.0823]	[0.0974]	[0.0813]
Output gap	0.0057	0.0075	0.0093	0.0099***	0.0014	0.0080***
	[0.0048]	[0.0079]	[0.0057]	[0.0025]	[0.0036]	[0.0029]
Price dummies	0.0701***	0.1051***	0.0495***	0.0448***	0.0969***	0.0690***
	[0.0174]	[0.0207]	[0.0185]	[0.0117]	[0.0188]	[0.0089]
Constant	0.0044	0.0059	-0.0027	-0.0022	0.0038	0.0039
	[0.0082]	[0.0155]	[0.0095]	[0.0044]	[0.0110]	[0.0111]
	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.4944***	0.9701***	0.4785***	0.4035***	0.3156***	0.5905***
	[0.1093]	[0.2565]	[0.0830]	[0.1188]	[0.0919]	[0.0962]
L. CPI inflation	0.3538***	0.4064***	0.4436***	0.3814***	0.4109***	0.4002***
	[0.0796]	[0.1317]	[0.0774]	[0.0980]	[0.0566]	[0.0777]
Output gap	0.0035	-0.0049	0.0009	0.0066	0.0093***	0.0115
	[0.0034]	[0.0038]	[0.0022]	[0.0067]	[0.0034]	[0.0079]
Price dummies	0.0703***	0.0701***	0.0771***	0.0726***	0.0689***	0.0497**
	[0.0120]	[0.0128]	[0.0073]	[0.0272]	[0.0131]	[0.0239]
Constant	0.0025	-0.0370***	-0.0069	0.0063	0.0057	-0.0042
	[0.0106]	[0.0137]	[0.0097]	[0.0153]	[0.0070]	[0.0056]
	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.6749***	0.5241***	0.4628**	0.2441	0.1745	0.3823**
	[0.2256]	[0.0280]	[0.1902]	[0.2691]	[0.2234]	[0.1565]
L. CPI inflation	0.5008***	0.5793***	0.201	0.5881***	0.4105	0.2979***
	[0.1282]	[0.0560]	[0.1463]	[0.1025]	[0.2628]	[0.0836]
Output gap	-0.0024	0.0025	0.0066**	0.0019	0.0293	0.0068***
	[0.0018]	[0.0016]	[0.0028]	[0.0053]	[0.0232]	[0.0019]
Price dummies	0.0603***	0.0636***	0.0779***	0.0869***	0.0231	0.0854***
	[0.0196]	[0.0089]	[0.0123]	[0.0191]	[0.0469]	[0.0112]
Constant	-0.0204*	-0.0186***	0.009	-0.0016	0.0157	0.008
	[0.0123]	[0.0051]	[0.0080]	[0.0156]	[0.0232]	[0.0139]

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% level, respectively. Robust standard errors are in brackets.

Table 6 Recursive estimates of the models, 1978-2001

		Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation		0.4528***	0.2309	0.5340***	0.6464***	0.4085***
		[0.0589]	[0.1841]	[0.0701]	[0.1337]	[0.0815]
L. CPI inflation		0.4923***	0.4567***	0.3456***	0.3826***	0.2459***
		[0.1114]	[0.1567]	[0.0863]	[0.0904]	[0.0952]
Output gap		0.0003	0.0054	0.0087*	0.0002	0.0160***
		[0.0012]	[0.0048]	[0.0045]	[0.0017]	[0.0044]
Price dummies		0.0636***	0.0729***	0.0700***	0.0671***	0.0999***
		[0.0159]	[0.0250]	[0.0260]	[0.0113]	[0.0235]
Constant		-0.0055	0.007	-0.0063	-0.0121	0.0055
		[0.0045]	[0.0128]	[0.0078]	[0.0098]	[0.0089]
	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.3737***	0.9702***	0.3533***	0.4602***	0.4751***	0.2508
	[0.1297]	[0.3248]	[0.0923]	[0.0650]	[0.0816]	[0.2824]
L. CPI inflation	0.3915***	0.3021**	0.3723***	0.3426***	0.3541***	0.3486*
	[0.1125]	[0.1272]	[0.1326]	[0.0894]	[0.1325]	[0.1930]
Output gap	0.0133**	0.0002	0.0066***	0.0027	-0.0016	0.0206
	[0.0064]	[0.0060]	[0.0024]	[0.0035]	[0.0017]	[0.0208]
Price dummies	0.0900***	0.0595***	0.1155***	0.0836***	0.0664***	0.0543
	[0.0259]	[0.0210]	[0.0256]	[0.0180]	[0.0086]	[0.0383]
Constant	0.0036	-0.0226	0.0014	0.002	-0.0015	0.0149
	[0.0121]	[0.0183]	[0.0103]	[0.0056]	[0.0068]	[0.0143]
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.3943***	0.3731**	0.4475***	0.4043***	0.4159***	0.3665***
	[0.0796]	[0.1529]	[0.1258]	[0.0600]	[0.0898]	[0.1382]
L. CPI inflation	0.3229***	0.2084*	0.3400***	0.4668***	0.2599***	0.3231***
	[0.0748]	[0.1092]	[0.1077]	[0.0813]	[0.0984]	[0.0718]
Output gap	0.0027	0.0109	0.0044	0.0107***	0.0007	0.0084***
	[0.0049]	[0.0079]	[0.0048]	[0.0027]	[0.0035]	[0.0029]
Price dummies	0.0748***	0.1028***	0.0581***	0.0432***	0.0960***	0.0702***
	[0.0153]	[0.0213]	[0.0150]	[0.0127]	[0.0178]	[0.0092]
Constant	0.0053	0.0113	0.0005	0.0021	0.0039	0.0088
	[0.0066]	[0.0149]	[0.0092]	[0.0047]	[0.0093]	[0.0096]
	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.4184***	0.9196***	0.4295**	0.3876***	0.3151***	0.5855***
	[0.1172]	[0.2542]	[0.1726]	[0.1273]	[0.0996]	[0.0978]
L. CPI inflation	0.3344***	0.3722***	0.3831***	0.3744***	0.3787***	0.3656***
	[0.0763]	[0.1360]	[0.0538]	[0.0853]	[0.0577]	[0.0695]
Output gap	0.0051	-0.0044	0.001	0.0069	0.0095***	0.0104
	[0.0034]	[0.0046]	[0.0030]	[0.0064]	[0.0036]	[0.0084]
Price dummies	0.0667***	0.0681***	0.0801***	0.0720***	0.0689***	0.0546**
	[0.0131]	[0.0147]	[0.0080]	[0.0272]	[0.0138]	[0.0238]
Constant	0.0106	-0.0294**	-0.0007	0.0082	0.0099	-0.0017
	[0.0095]	[0.0149]	[0.0122]	[0.0131]	[0.0067]	[0.0044]
	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.8828**	0.5073***	0.4805**	-0.0755	0.1652	0.4209***
	[0.3649]	[0.0480]	[0.1916]	[0.3246]	[0.2341]	[0.1289]
L. CPI inflation	0.4264***	0.3893***	0.1942	0.6884***	0.373	0.3221***
	[0.1607]	[0.1029]	[0.1372]	[0.1478]	[0.2619]	[0.0705]
Output gap	-0.0041	-0.0037	0.0068**	0.0078	0.0291	0.0066***
	[0.0027]	[0.0028]	[0.0027]	[0.0075]	[0.0235]	[0.0019]
Price dummies	0.0657***	0.0748***	0.0774***	0.0813***	0.0268	0.0840***
	[0.0241]	[0.0144]	[0.0121]	[0.0213]	[0.0460]	[0.0107]
Constant	-0.0310*	0.0004	0.0094	0.0151	0.019	0.0034
	[0.0187]	[0.0048]	[0.0065]	[0.0160]	[0.0236]	[0.0099]

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% level, respectively. Robust standard errors are in brackets.

Table 7 Recursive estimates of the models, 1978-2002

		Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation		0.4479***	0.2566	0.5454***	0.5883***	0.4134***
		[0.0539]	[0.1688]	[0.0701]	[0.1360]	[0.0777]
L. CPI inflation		0.4839***	0.4726***	0.3305***	0.3701***	0.2472**
		[0.1058]	[0.1530]	[0.0777]	[0.0700]	[0.1011]
Output gap		0.0003	0.0047	0.0099*	0.0001	0.0171***
		[0.0012]	[0.0045]	[0.0051]	[0.0020]	[0.0047]
Price dummies		0.0652***	0.0722***	0.0677**	0.0677***	0.1027***
		[0.0153]	[0.0255]	[0.0267]	[0.0108]	[0.0252]
Constant		-0.005	0.0039	-0.0054	-0.0078	0.0062
		[0.0038]	[0.0097]	[0.0065]	[0.0084]	[0.0085]
	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.3750***	0.9677***	0.3497***	0.4431***	-0.0036	0.255
	[0.1201]	[0.3530]	[0.0927]	[0.0643]	[0.2705]	[0.2759]
L. CPI inflation	0.3916***	0.2716**	0.3981***	0.3417***	0.5311***	0.3482*
	[0.1046]	[0.1211]	[0.1235]	[0.0851]	[0.1826]	[0.1915]
Output gap	0.0135**	0	0.0069***	0.0027	-0.0005	0.0202
	[0.0063]	[0.0064]	[0.0024]	[0.0034]	[0.0021]	[0.0209]
Price dummies	0.0886***	0.0611***	0.1165***	0.0831***	0.0742***	0.0544
	[0.0257]	[0.0209]	[0.0240]	[0.0183]	[0.0092]	[0.0389]
Constant	0.0031	-0.02	-0.0003	0.003	0.0129	0.0147
	[0.0102]	[0.0184]	[0.0086]	[0.0054]	[0.0080]	[0.0157]
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.3681***	0.3543**	0.2653	0.3997***	0.4011***	0.3612***
	[0.0780]	[0.1509]	[0.1912]	[0.0600]	[0.0837]	[0.1349]
L. CPI inflation	0.3539***	0.2370**	0.4138***	0.4566***	0.2500**	0.3480***
	[0.0705]	[0.1062]	[0.1348]	[0.0805]	[0.1034]	[0.0643]
Output gap	0.001	0.0102	0.001	0.0105***	0.0006	0.0084***
	[0.0050]	[0.0078]	[0.0051]	[0.0029]	[0.0035]	[0.0029]
Price dummies	0.0769***	0.1021***	0.0587***	0.0438***	0.0959***	0.0699***
	[0.0147]	[0.0214]	[0.0136]	[0.0130]	[0.0177]	[0.0089]
Constant	0.004	0.0087	0.0021	0.0034	0.0051	0.0068
	[0.0059]	[0.0137]	[0.0108]	[0.0041]	[0.0088]	[0.0080]
	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.4039***	0.8497***	0.235	0.3894***	0.3088***	0.5980***
	[0.1092]	[0.2251]	[0.2329]	[0.1242]	[0.0983]	[0.0993]
L. CPI inflation	0.3811***	0.3599***	0.4184***	0.3911***	0.3862***	0.3448***
	[0.0793]	[0.1313]	[0.0778]	[0.0785]	[0.0517]	[0.0692]
Output gap	0.0041	-0.0032	0.0028	0.006	0.0094***	0.0113
	[0.0032]	[0.0042]	[0.0035]	[0.0064]	[0.0035]	[0.0087]
Price dummies	0.0659***	0.0670***	0.0826***	0.0728***	0.0688***	0.0538**
	[0.0130]	[0.0143]	[0.0093]	[0.0270]	[0.0137]	[0.0239]
Constant	0.006	-0.0229*	0.0065	0.0055	0.0092	0
	[0.0080]	[0.0127]	[0.0125]	[0.0114]	[0.0060]	[0.0051]
	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.8268**	0.4918***	0.4938***	-0.2597	0.1663	0.4276***
	[0.3820]	[0.0422]	[0.1908]	[0.3888]	[0.2367]	[0.1174]
L. CPI inflation	0.4339***	0.4409***	0.2038	0.7581***	0.3679	0.3292***
	[0.1624]	[0.0834]	[0.1341]	[0.1832]	[0.2534]	[0.0638]
Output gap	-0.0037	-0.0006	0.0071***	0.0122	0.0295	0.0065***
	[0.0028]	[0.0021]	[0.0027]	[0.0095]	[0.0229]	[0.0018]
Price dummies	0.0639***	0.0703***	0.0763***	0.0831***	0.026	0.0834***
	[0.0239]	[0.0139]	[0.0120]	[0.0244]	[0.0439]	[0.0105]
Constant	-0.0268	-0.0052	0.0085	0.0217	0.0193	0.0025
	[0.0184]	[0.0034]	[0.0058]	[0.0179]	[0.0232]	[0.0077]

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% level, respectively. Robust standard errors are in brackets.

Table 8 Recursive estimates of the models, 1978-2003

		Anhui	Beijing	Fujian	Gansu	Guangdong
F. CPI inflation		0.4454***	0.268	0.5461***	0.5574***	0.4234***
		[0.0538]	[0.1655]	[0.0699]	[0.1350]	[0.0758]
L. CPI inflation		0.4631***	0.4804***	0.3309***	0.3699***	0.2592***
		[0.1020]	[0.1500]	[0.0742]	[0.0675]	[0.0935]
Output gap		0.0005	0.0047	0.0103*	0.0004	0.0165***
		[0.0012]	[0.0044]	[0.0054]	[0.0021]	[0.0046]
Price dummies		0.0674***	0.0716***	0.0668**	0.0679***	0.1026***
		[0.0151]	[0.0259]	[0.0268]	[0.0108]	[0.0244]
Constant		-0.0036	0.0024	-0.0055	-0.0059	0.0036
		[0.0033]	[0.0083]	[0.0056]	[0.0074]	[0.0075]
	Guangxi	Guizhou	Hainan	Hebei	Heilongjiang	Henan
F. CPI inflation	0.3750***	0.9503***	0.3409***	0.4400***	-0.0081	0.2679
	[0.1171]	[0.3542]	[0.0935]	[0.0618]	[0.2758]	[0.2805]
L. CPI inflation	0.3910***	0.2817**	0.4094***	0.3559***	0.5373***	0.3410*
	[0.0995]	[0.1170]	[0.1161]	[0.0826]	[0.1808]	[0.1784]
Output gap	0.0135**	0.0005	0.0071***	0.0028	-0.0006	0.0193
	[0.0061]	[0.0065]	[0.0024]	[0.0033]	[0.0020]	[0.0208]
Price dummies	0.0883***	0.0597***	0.1171***	0.0808***	0.0748***	0.0547
	[0.0258]	[0.0210]	[0.0233]	[0.0184]	[0.0094]	[0.0398]
Constant	0.003	-0.0197	-0.0008	0.0019	0.0125	0.0151
	[0.0092]	[0.0176]	[0.0073]	[0.0049]	[0.0085]	[0.0185]
	Hubei	Hunan	Inner Mongolia	Jiangsu	Jiangxi	Jilin
F. CPI inflation	0.3685***	0.3574**	0.2653	0.4078***	0.4065***	0.3645***
	[0.0762]	[0.1515]	[0.1912]	[0.0615]	[0.0829]	[0.1346]
L. CPI inflation	0.3539***	0.2491**	0.4138***	0.4448***	0.2698***	0.3538***
	[0.0636]	[0.1006]	[0.1348]	[0.0789]	[0.0966]	[0.0618]
Output gap	0.0009	0.01	0.001	0.0105***	0.0011	0.0083***
	[0.0049]	[0.0077]	[0.0051]	[0.0028]	[0.0034]	[0.0029]
Price dummies	0.0775***	0.1018***	0.0587***	0.0454***	0.0949***	0.0698***
	[0.0144]	[0.0212]	[0.0136]	[0.0132]	[0.0175]	[0.0089]
Constant	0.0039	0.0072	0.0021	0.0033	0.0033	0.0061
	[0.0052]	[0.0131]	[0.0108]	[0.0035]	[0.0077]	[0.0076]
	Liaoning	Ningxia	Qinghai	Shaanxi	Shandong	Shanghai
F. CPI inflation	0.4175***	0.8536***	0.2757	0.3884***	0.3063***	0.5894***
	[0.1058]	[0.2157]	[0.1912]	[0.1169]	[0.0973]	[0.0998]
L. CPI inflation	0.3949***	0.3422***	0.4172***	0.3896***	0.3914***	0.3438***
	[0.0782]	[0.1325]	[0.0721]	[0.0752]	[0.0500]	[0.0658]
Output gap	0.0038	-0.0025	0.0023	0.0059	0.0093***	0.0093
	[0.0032]	[0.0048]	[0.0032]	[0.0063]	[0.0035]	[0.0087]
Price dummies	0.0660***	0.0665***	0.0819***	0.0733***	0.0685***	0.0577**
	[0.0129]	[0.0152]	[0.0089]	[0.0269]	[0.0137]	[0.0245]
Constant	0.0034	-0.0203*	0.0042	0.0055	0.0086	-0.0004
	[0.0074]	[0.0110]	[0.0097]	[0.0099]	[0.0056]	[0.0052]
	Shanxi	Sichuan	Tianjin	Xinjiang	Yunnan	Zhejiang
F. CPI inflation	0.7977**	0.4485***	0.5444***	-0.248	0.162	0.4539***
	[0.3749]	[0.0858]	[0.2054]	[0.3740]	[0.2241]	[0.1172]
L. CPI inflation	0.4265***	0.4697***	0.2161*	0.7545***	0.3384	0.3490***
	[0.1620]	[0.0763]	[0.1268]	[0.1821]	[0.2436]	[0.0578]
Output gap	-0.0036	0.0007	0.0080***	0.0124	0.0282	0.0062***
	[0.0028]	[0.0017]	[0.0027]	[0.0095]	[0.0207]	[0.0018]
Price dummies	0.0645***	0.0721***	0.0741***	0.0835***	0.0286	0.0822***
	[0.0240]	[0.0148]	[0.0121]	[0.0243]	[0.0413]	[0.0103]
Constant	-0.0242	-0.008	0.0048	0.021	0.0216	-0.001
	[0.0175]	[0.0076]	[0.0058]	[0.0166]	[0.0220]	[0.0065]

Notes. Asterisks *, ** and *** indicate significance at 10%, 5%, and 1% level, respectively. Robust standard errors are in brackets.

Earlier BOFIT Discussion Papers

For a complete list of Discussion Papers published by BOFIT, see www.bof.fi/bofit

2007

No 1 Yuqing Xing: Foreign direct investment and China's bilateral intra-industry trade with Japan and the US
No 2 A.A. Peresetsky, A.M. Karminsky and S.V.Golovan: Russian banks´private deposit interest rates and market discipline
No 3 Barry Harrison and Yulia Vymyatnina: Currency substitution in a de-dollarizing economy: The case of Russia
No 4 Jesús Crespo Cuaresma and Tomas Slacik: An “almost -too-late” warning mechanism for currency crises
No 5 Andrei V. Vernikov: Russia's banking sector transition: Where to?
No 6 Alicia García-Herrero and Tuuli Koivu: Can the Chinese trade surplus be reduced through exchange rate policy?
No 7 Nienke Oomes and Katerina Kalcheva: Diagnosing Dutch disease: Does Russia have the symptoms?
No 8 Iikka Korhonen and Tuuli Juurikkala: Equilibrium exchange rates in oil-dependent countries
No 9 Balázs Égert and Carol S. Leonard: Dutch disease scare in Kazakhstan: Is it real?
No 10 Mikael Mattlin: The Chinese government's new approach to ownership and financial control of strategic state-owned enterprises
No 11 Aaron Mehrotra and Jouko Rautava: Do sentiment indicators help to assess and predict actual developments of the Chinese economy?
No 12 Pertti Haaparanta and Tuuli Juurikkala: Bribes and local fiscal autonomy in Russia
No 13 Ian Babetskii and Nauro F.Campos: Does reform work? An econometric examination of the reform-growth puzzle
No 14 Iikka Korhonen and Aaron Mehrotra: Money demand in post-crisis Russia: De-dollarisation and re-monetisation
No 15 Svetlana Ledyaeva: Spatial econometric analysis of determinants and strategies of FDI in Russian regions in pre- and post-1998 financial crisis periods
No 16 David G Mayes and Vesa Korhonen: The CIS – does the regional hegemon facilitate monetary integration?
No 17 Roberta Colavecchio and Michael Funke: Volatility dependence across Asia-pacific on-shore and off-shore U.S. dollar futures markets
No 18 William Pyle: Organized business, political regimes and property rights across the Russian Federation
No 19 Aaron Mehrotra, Tuomas Peltonen and Alvaro Santos Rivera: Modelling inflation in China – a regional perspective

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