"Regional inflation and monetary policy in China"

| | |
|---|---|
| **AUTHORS** | Jun Nagayasu |
| | |
| | |
| | |
| | |

NUMBER OF REFERENCES

0

NUMBER OF FIGURES

0

NUMBER OF TABLES

0

Jun Nagayasu (Japan)

# Regional inflation and monetary policy in China

## Abstract

This paper empirically examines developments in price and inflation in China. Unlike most previous studies, their determinants were investigated in the panel data context, and the author's findings are as follows. First, using the panel cointegration method, the study confirms a long-run relationship between price, money and output. Secondly, the author provides evidence that inflation can be explained by economic fundamentals such as money, credits, productivity, and exchange rate growth. While an increased concern about regional discrepancies in recent years, this relationship is more sensitive to the sample period than to the region type. Notably money does not seem to be closely associated with inflation over recent years.

**Keywords:** China, inflation, panel data, panel cointegration.
**JEL Classification:** E310, E500, R110.

## Introduction

Over recent years, China has experienced high economic growth with moderate inflation by international standards. Its annual GDP growth rate has often exceeded 10 percent, and the inflation rate has generally been lower than its GDP growth. The low inflation relative to GDP is consistent with China's macroeconomic policy since the five-year economic plan often makes reference to this as one of its economic targets. Furthermore, the moderate inflation rate was argued as resulting from several factors including a strong supply side owing to the cheap labor force and periodic weak demand for consumer goods[1].

However, in the last couple of years, the sustainability of this economic growth has been brought into question since cheap labor is no longer available, and there is considerable upward pressure on wages and inflation. More recently, considerable construction for the 2008 Beijing Olympics as well as soaring commodity (e.g., wheat and oil) prices worldwide have become additional factors contributing to the increased inflationary pressure. While the adverse effects of the sub-prime loan crisis became apparent worldwide in the second half of 2008 and subdued inflationary pressure, inflation began to increase again in China in 2009 along with the world economic recovery and an expansion in domestic credits supported by strong property lending and lower interest rates.

Inflation increases in China have major policy implications for both domestic and international economies. Amongst other possibilities, high inflation may have a deleterious effect on future Chinese economic growth, resulting in higher wages, more expensive exports, and fewer foreign reserves. Moreover, due to the high volume of exported goods, more expensive exports from China might increase inflation overseas also. Thus, it has become a pressing research topic in many countries.

Among many others, pertinent previous studies include Huang (1994), Girardin (1996), Chen (1997), Hasan (1999), Gerlach and Peng (2006), Funke (2006), and Burdekin and Siklos (2006). Using country-level data, Huang (1994) and Chen (1997) confirmed a long-run relationship in the standard money demand function; Hasan (1999) reports a close relationship between price and money supply, and between inflation and monetary growth, and Zhang (2009) recently reviews the close relationship between excess liquidity and inflation in China. In contrast, Girardin (1996) raises evidence against cointegration in the money (currency) demand function. Looking more at the micro level, Pettis (2008) and Porter (2010) suggest that inflation has been driven largely by non-food sectors for the sample period of 1996-2010.

So far, we have reviewed relevant literature based on national-level (aggregate) data, but there are some studies using regional data as well. Mehrotra et al. (2007) is one of a few examples of analyzing regional inflation in China, but focuses on inflationary developments and does not analyze transmission channels of monetary policy or price levels, i.e. the long-run implication of price movements[2].

[1] Yusuf (1994) summarizes Chinese economic developments and policy from 1973 to 1993.

[2] In addition, Guillaumont Jeanneney and Hu (2002) examine Chinese relative prices (i.e. the ratio of the price in one province to another, $P_{it} / P_{ij}$, where $P$ is price and province $i \neq j$). Our study is different from theirs since it focuses on regional inflation ($P_{it} / P_{ij-1}$).

Finally, adjusting our focus to a more global context, evidence is reported of how cheap Chinese exports (i.e. low inflation) helped to achieve lower inflation in many importing countries from 1994 to 2003 (Koyuncu and Yilmaz, 2006) but of their limited effect on Japan and the US (Feyzioglu and Willard, 2008). In addition, Porter (2010) finds evidence that increases in food prices in mainland China influence those in non-mainland China.

Against this background, this paper empirically investigates the dynamics of Chinese price and inflation using regional data. Due to data availability, we focus mainly on the credits and exchange rate channels of the transmission mechanism of monetary policy[1]. Use of regional data sets this study apart from previous studies based on country-level data, and is motivated by the fact that inflation rates, or more generally economic developments, are not uniform across the regions in China[2]. Furthermore, a panel data analysis allows us to check the sensitivity of our results obtained from full sample observations to the sample period and regional groups, which was impossible in time series analysis due to the limited time span available for study and thus was not addressed in previous studies. Finally, while previous panel data studies focused exclusively on inflationary developments, this paper explores the long-run implications of prices as well. In the presence of a long-run relationship (i.e. cointegration) in the price equation, incorporating information of the transition to a steady-state will enrich the analysis.

In order to achieve this, this paper comprises three Sections. Section 1 summarizes the history of recent monetary policy in China. This helps us choose pertinent explanatory variables and interpret the empirical results. Section 2 discusses the economic factors chosen here to explain the inflationary episodes, and presents the empirical results. This Section also investigates the long-run price behavior using the advanced panel cointegration test (e.g., Westerlund, 2007). The last Section concludes the paper. Among many other results, we provide evidence of inflation being explained by economic fundamentals such as money, credits, productivity, and exchange rate growth. However, we show that their relationship with inflation appears to be sensitive to the sample period. Indeed, while policymakers' increasing concerns about regional disparities (Nagayasu and Liu, 2008), this relationship is more sensitive to the time period than region type.

## 1. A brief history of Chinese monetary policy[3]

The People's Bank of China (PBC), the central bank, was established in December 1948 after the consolidation of the Huabei, Beihani and Xibei Farmer Banks. But it was only in September 1983 that the PBC was invested with central bank functions. At present, monetary policy is conducted under the Law of the People's Bank of China, which became effective in 1995 and stipulates that "[t]he objective of monetary policy is to maintain the stability of the value of the currency and thereby promote economic growth" (http://pbc.gov.cn/english/-huobizhengce/objective.asp). Thus, the PBC has a mandate to stabilize prices today[4].

Prior to the establishment of this Law, the monetary policy of the PBC had dual objectives. First, the PBC allocated financial resources at the micro level in an effort to stimulate economic growth based on the economic development plans, and secondly, it attempted to stabilize prices. While these objectives are not mutually exclusive, the PBC in practice seemed to be biased toward conducting monetary policy to promote economic growth and development (Montes-Negret, 1995; Xie, 2001).

Furthermore, while money (*M1* and *M2*) has remained as an intermediate target of monetary policy, the PBC's instruments have also changed over time partly due to developments in the financial institutions and markets in China. The PBC frequently employed a credit policy for commercial banks, which had socio-economic implications and resulted in a tendency to lend to the large state-owned enterprises that account for a large number of employees. Under this policy, money in the market was expected to be controlled directly by influencing the lending operations of commercial banks.

Apparently, this credit policy was effective in terms of controlling inflation. The hike in inflation in the early 1990s was argued as resulting from the boom in the construction industry, high investment in the car industry, and the liberalization of lending policies to state owned enterprises (SOE)[5]. High inflation was curbed by the PBC ordering commercial banks to freeze lending.

From 1998, the PBC started using a more market-oriented approach under the initiative of Zhu Rongji because of the increasing problems arising in

---

[1] As will be explained in Section 1, interest rate movements were restricted until very recently.

[2] Xu (2002) shows that region-specific factors account for one third of the variation in Chinese output growth. Sakamoto and Islam (2008) show that some provinces are catching up with the higher income group during the reform period (1978-2003) but an overall provincial convergence is open to question.

[3] In this Section we focus mainly on economic development in China from 1991 to 2005 which is the sample period of our investigation.

[4] With respect to its independence, which is often discussed as negatively associated with inflation (Alesina and Summers, 1993), the PBC is not independent in the sense that it remains institutionally part of the State Council (government).

[5] The framework for interest rate liberalization was initially laid out in November 1993 (Laurens and Marino, 2007).

China's transitional economy, e.g., price distortion and conflicting policy objectives. In this approach, the PBC's instruments include the reserve requirement ratio, central bank base interest rate, rediscounting, central bank lending and open market operations. Furthermore, PBC bills were introduced in September 2002. Similarly, the discount rate (floating rate central bank discount lending) was initiated in 2004, and the reserve requirement was more intensively used. In addition, in 2005, the reverse bond based repo was introduced to cope with foreign exchange inflows resulting from the trade surplus. However, despite such recent developments, Green (2005) discusses that this market-oriented approach has only had limited effectiveness in stimulating the economy due to the slow progress in financial market reform in China[1]. As a result, credit policy remains an important instrument for the PBC even today.

Monetary policy is also closely related to the exchange rate regime since exchange rate devaluation (depreciation) tends to increase domestic prices (e.g., Zhang 2009)[2]. As it is shown in Figure 1 (see Appendix), before 1994, the Renminbi (RMB) was determined by a basket of internationally traded currencies and exhibited substantial movement against the US dollar[3]. But the RMB has become very stable against the US dollar since 1994 due to its exchange rate being, in practice, more or less fixed against the US dollar as a part of the exchange rate policy. Notably its revaluation (July 21, 2005) from RMB8.28/US\$ to RMB8.11/US\$ has generally been welcomed as a part of China's efforts to reduce its trade surplus although the flexibility of the RMB is still very limited[4]. There was a sign of increased flexibility in the RMB, it returned however to a managed floating regime from June 2010 in response to increased uncertainty in the world economy.

In order to maintain the nominal value of the currency and avoid high inflation, the Chinese authorities carried out foreign exchange interventions, and attempted to sterilize their effects through open mar-

ket operations (i.e. sales to the public of government bonds)[5]. However, this policy was not sufficient to sterilize them; aggregate money has increased, and in practice the RMB has been undervalued, leading to a large Chinese current account surplus, in particular against the US (e.g., Corden 2007)[6].

## 2. Empirical analysis

**2.1. Data description.** Our data set covers the period of 1991-2005 (annual data) and 27 regions: Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujina, Jiangxi, Shangdong, Henan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. The sample period and regions are determined solely by data availability at the time of conducting this research. Table 1 (see Appendix) classifies the regions into high- and low-growth groups in terms of real GDP growth. In order to carry out empirical research later, a similar number of provinces are allocated to each of these two groups.

Furthermore, based on previous studies and data availability, we consider the following variables for our analysis. The reasons for choosing them and their expected relationship with inflation are summarized briefly below. Note that since this paper is applied research in nature, our explanation is limited to a minimum[7].

*2.1.1. Price and inflation.* Due to the lack of a consumer price index (CPI), our regional inflation is based on retail price index (RPI) data obtained from the World Bank Database. The similarity between average CPI and RPI is shown in Figure 2 (see Appendix). Log inflation is calculated using the RPI.

*2.1.2. Money (M1 & M2).* Narrow money (*M1*) by definition is a part of broad money (*M2*) which here is the total of narrow money and quasi money. Classical economic theory (e.g., the quantity theory) argues that there is a positive correlation between money and prices, indicating that a decrease in money should bring about price reduction (i.e. less inflation). The data are obtained from the IMF's International Financial Statistics (IFS).

---

[1] See Feyzioglu, Porter and Takats (2009) about interest rate liberalization in China.

[2] The Chinese currency, the Renminbi, was first issued in 1949. But it was only during the late 1980s and early 1990s, that it became convertible for current account transactions.

[3] In conventional economic theory, monetary authorities lose one policy instrument for economic stabilization under the fixed rate regime. In the past, some high inflation countries pegged their exchange rate against countries with low inflation in order to reduce their domestic inflation rate by importing the credibility of the partner's central bank. However, this argument may not be valid in China which is a huge country in terms of geographical area, population, and economy although per capita income may be very low.

[4] For example, RMB/US\$ is allowed to move within ± 0.3 percent around the central parity published by the PBC. Since 2005, the RMB has begun to rise but is again more or less fixed against the US dollar since July 2008.

[5] Green (2005) estimates that the authorities sterilized about 47 percent of capital inflows in 2004.

[6] Since the gradual transition from a command- to market-oriented economy was pronounced in 1989 when Jiang Zemin (1989-2002) became the General Secretary of the Community Party, the introduction of the market oriented approach has been included as a key agenda item in the comprehensive 5 year economic plans. This policy continues under the Hu Jintao administration (since 2002).

[7] One could also consider using other scale variables such as the output gap, and expected and lagged inflation in order to evaluate inflation in a Keynesian-type model. But given our short historical data and data availability, they are not used in this study.

*2.1.3. Credits.* As reviewed in the previous Section, the Chinese monetary authorities attempted to influence market liquidity by means of administrative controls. A decline in credits indicates reduced lending to economic organizations and thus this credit policy should help curb inflation. These data are also from the IFS[1].

*2.1.4. Productivity.* Generally, it is believed that there is a negative relationship between inflation and productivity since improved productivity may bring about less expensive goods and lower inflation (e.g., De Gregorio, 1992; Christopoulos and Tsionas, 2005). In this study, productivity is measured by real GDP per employee and is calculated for each region. The provincial GDP data are obtained from the World Bank Database, and employment figures from the National Bureau of Statistics of China and the Chinese Statistical Yearbook[2].

*2.1.5. Population growth.* The relationship between inflation and population growth may not be clear at least from theoretical point of view. Population growth often results in higher demand for products. If the supply side remains unchanged, we would expect higher inflation. Thus, a positive relationship would be expected between population growth and prices (inflation). In contrast, when the supply-side effect of population growth is stronger, this variable may be negatively correlated with inflation. Population data between 1995 and 2005 are obtained from the National Bureau of Statistics of China, and those prior to 1995 are from the Chinese Population Yearbook[3].

*2.1.6. Exchange rates.* This is considered here as one determinant of Chinese inflation although the bilateral exchange rate vis-á-vis the US dollar is more or less fixed after 1994 (Figure 1). Consideration of this variable is due to the visible exchange rate fluctuations prior to 1994. Here the exchange rate is the RMB against the US dollar and is obtained from the IFS. One may argue for using the effective exchange rate, but the bilateral rate is employed here since these two types of rates are highly

correlated with one other (e.g., the correlation coefficient equals 0.9). Furthermore, recently the bilateral rate has more policy implications due to the rise in Chinese trade surpluses against the US.

In short, unlike previous studies, we use both region- and country-level data when analyzing developments in regional inflation. General inflationary trends common to regions would be expected to be described by country-level data, and region-specific movements by regional data[4]. Furthermore, these data are examined using the instrumental variable estimation method in order to take account of the possible endogeneity problem in Section 2.4. Instrumental variables will be listed in the relevant Tables (see Appendix) and are obtained from the IMF's World Economic Outlook database.

**2.2. Preliminary analysis.** The inflation (price) equations are estimated using the abovementioned determinants and several statistical methods, and the results are summarized in Tables 2 to 5 (see Appendix). One general conclusion is that inflation can be explained by economic fundamentals such as money, credits, productivity, and exchange rate growth.

We start the preliminary analysis by estimating the following equation:

$$\Delta P_{it} = \beta_0 + \beta_1 \Delta Money_t + \beta_2 \Delta Credits_t + \\ + \beta_3 \Delta Prod_{it} + \beta_4 \Delta Pop_{it} + \beta_5 \Delta RMB_t + u_{it}. \quad (1)$$

In the above equation, $Money_t$ refers to either broad money or narrow money. Credits and the exchange rate are denoted as $Credits_t$ and $RMB_t$, respectively. Productivity and population growth are shown as $\Delta Prod_{it}$ and $\Delta Pop_{it}$. The residual is indicated as $u_{it}$. All data are in log form, and $\Delta$ is the difference operator. Subscript $i$ ($i = 1, \ldots, 27$) represents region and $t$ ($t = 1991, \ldots, 2005$) is time, and the $\beta$s are parameters to be estimated. Consideration of both money and credits in the monetary transmission process is pointed out for example by Brunner and Heltzer (1988) and Bernanke and Gertler (1995). Previous research (see Introduction) often showed that these variables are nonstationary, and therefore a differenced equation should be more appropriate.

Table 2 shows the empirical results from the standard panel data estimation methods (i.e. the fixed and random effects models). The results from the different methods nevertheless share many similari-

---

[1] Empirical results which will be shown later are based on an inflation equation comprising both money and credits. The general results remain unchanged even though money and credits enter separately in the equation. Furthermore, while there exist credit data at the provincial level, they seem to be limited only from 1992 to 1998 (see Guillaumont Jeanneney and Hua, 2002). Due to the available sample size, we opted not to use the regional level data.

[2] Using the data of nine Asian countries, Mahadevan and Asafu-Adjaye (2006) analyzed the relationship between inflation and productivity growth and reported evidence of no unique causal relationship for most (eight out of nine) countries.

[3] While population growth is not necessarily equivalent to labor growth, in China there is a tendency of migration from poorer western areas to the richer coastal areas in order to seek employment or a better working environment. Fan (2002) confirms that there is a significant demographic difference between the eastern and western regions, which partly reflects this migration.

[4] Here, data availability determines the role of explaining general or specific inflation movements. The inclusion of the time dummy does not alter our general conclusion.

ties. Consistent with economic theory, money and credits are positively and significantly related with inflation. Given the fact that *M1* and *M2* have been used as intermediate targets of monetary policy and credits as instruments, this raises evidence that the Chinese monetary authorities have indeed been influencing inflation. Furthermore, this Table shows clear evidence of productivity being negatively associated with inflation; improved productivity helped suppress inflation movements. In addition, the exchange rate is found to be positively and significantly correlated with Chinese inflation, indicating that RMB appreciation tends to lead to lower inflation. This finding seems to be in conformity with previous studies (e.g., Liu and Tsang, 2008; Zhang, 2009)[1] and the PBC's concern that inflation may be triggered by an increase in RMB. Finally, while their parameter signs are consistent with our expectations, population growth is statistically insignificant.

We implement the Hausman test in order to investigate which analytical model is statistically more appropriate. Although empirical results are very similar regardless of estimation method, the test result suggests that the random effects model is more suited for describing inflation movements in China.

**2.3. Long-run analysis.** While our research focus was on inflation in the previous subsection, existing studies often identified the presence of a long-run relationship between price and economic fundamentals using the money demand function and country-level data (see Introduction). In the presence of cointegration in our data, the inflation model such as equation (1) is misspecified since we could incorporate the disequilibrium condition in the money market measured by the so-called error correction mechanism (ECM). One distinguishing feature of our study is that the ECM is estimated in the panel data context[2].

Our long-run analysis is based on the following general equation:

$$P_{it} = \beta Money_t + \theta Y_{it} + e_{it}, \qquad (2)$$

where $Money_t$ is either broad or narrow money. The constant is dropped for simplicity in equation (2) but is included in the estimation. The $Y_{it}$ represents real output deflated by regional RPI ($P_{it}$). The

residual $e_{it}$ is equivalent to the ECM and is defined as $P_{it} - \hat{P}_{it}$, where $\hat{P}_{it}$ is an estimate of $P_{it}$. All variables are in log form. Thus, equation (2) is analogous to the quantity theory of money.

This price equation estimated by the OLS is reported in Table 3 (see Appendix). It shows that $Money_t$ is positively correlated with prices while $Y_{it}$ is negatively correlated. These parameter signs are in line with standard economic theory, and we can observe that money is much more influential over prices given the relative insensitivity of $Y_{it}$ to prices.

We have also checked the presence of a long-run relationship in equation (2) using panel cointegration tests (Kao, 1999; Pedroni, 1999; Westerlund, 2007). Cointegration tests allow short-term deviation from the steady-state and thus are viewed as well-suited for long-run analysis. The presence of cointegration in equation (2) suggests a common trend and a long-run linear relationship between price, money, and output. Classical studies (Kao, 1999; Pedroni 1999) proposed a two-step residual-based cointegration method. The first step is to estimate equation (2) to obtain $e_{it}$ while the second step involves analysis of this residual using for example equation (3):

$$e_{it} = \rho e_{it-1} + \theta \Delta e_{it-1} + u_{it}, \qquad (3)$$

where $\Delta e_{it-1}$ is introduced to control for autocorrelation but equation (3) can be of higher order like the Augmented Dickey Fuller (ADF) test. The null hypothesis of no cointegration can be tested by examining $\rho = 1$, and a rejection of this hypothesis indicates the presence of cointegration[3].

Furthermore, recently Westerlund (2007) proposes two types of tests, of which we use one, what he calls "the panel statistic"[4]. This test is especially suitable for our research since it exploits the cross-sectional information of the panel, and $p$-values to analyze the null are based on the bootstrap method in order to circumvent the cross-sectional dependence problem which likely exists in our data. In short, this test is based on the following specification:

$$\Delta p_{it} = \theta_i d + \alpha_i \left( p_{it-1} - \beta_i' x_{it-1} \right) +$$
$$+ \sum_{j=1}^{q_i} \alpha_{ij} \Delta p_{it-j} + \sum_{j=0}^{q_i} \gamma_{ij} \Delta x_{it-j} + \vartheta_{it}, \qquad (4)$$

---

[1] Liu and Tsang (2008) discuss that RMB appreciation is one way to suppress inflationary pressure in China arising from an increase in global commodity prices.

[2] Interest rates are not included here since, as discussed previously, they have been highly regulated and have not yet performed adequately as an instrument of monetary policy. Furthermore, the Westerlund (2007) method does not allow us to include another variable due to our short sample period.

[3] The null hypothesis becomes $\rho = \rho_i$ in the Pedroni test.

[4] Only the panel statistic is used here because the other test does not utilize the cross sectional information of the data and its alternative hypothesis is different from the panel statistic and becomes $\alpha_i < 0$.

where $x$ is the explanatory variables of the price, and $\vartheta$ is the residual. The maximum lag length of one is used for $q_i$. The presence of the error correction term (or cointegration) can be tested by the null hypothesis of $\alpha_i = 0$ for all $i$ against the alternative of $\alpha_i = \alpha < 0$. A rejection of the null hypothesis provides evidence of cointegration for the panel as a whole.

The results from these panel tests are also reported in Table 3, and suggest cointegration between price, money and output. This finding is consistent with previous studies using country-level price data (e.g., Huang, 1994; Chen, 1997)[1]. Furthermore, this result is of particular interest since price stabilization was not the sole objective of the monetary authorities in years past and about 24 percent of prices are said to be regulated through price controls (Laurens and Maino, 2007).

**2.4. Further analysis.** Using the ECM ($p_{it-1} - \beta_i' x_{it-1}$) obtained in the previous Section, we will extend equation (1) and estimate the inflation specification using the instrumental variables (IV) since our reduced form equation may suffer from endogeneity bias. For example, this bias may arise in the inflation-productivity relationship. Higher inflation may increase the tax burden on the private sector in the non-neutral tax structure (Jarrett and Selody, 1982), and reduces the optimal contract and planning period which results in a rise in contracting costs (Hayes and Abernathy, 1980). In both cases, firms will confront additional costs which hinder productivity growth.

Thus, we consider now the following extended inflation equation:

$$\Delta p_{it} = \beta_0 + \beta_1 \Delta Money_t + \beta_2 \Delta Credits_t + \\ + \beta_3 \Delta Prod_{it} + \beta_4 \Delta RMB_t + \beta_5 ECM_{it-1} + u_{it}. \quad (5)$$

The first difference of $Y_{it}$ is indirectly included in this equation as productivity growth. Equation (5) is estimated using the 2SLS random effects IV regression method[2]. Population growth is dropped from the specification since this variable is found to be statistically insignificant in the preliminary analysis[3].

Table 4 (see Appendix) summarizes the results from the estimation of equation (5) for the full and post-1994 sample periods. This Table also lists instrumental variables used in this analysis. For the full sample analysis, the results from the 2SLS random effects IV method are generally consistent with those reported in Table 2. Money, credits and RMB are significantly and positively related with inflation. Improved productivity seems to have relaxed the inflationary pressure. Finally, the ECM enters the inflation equation negatively and significantly, confirming the presence of cointegration between price, money and output.

Next, given the dynamic nature of the Chinese economy, we check the sensitivity of our results to the sample period. There are a number of factors which could possibly bring about structural shifts in the Chinese economy since the Chinese government has implemented a number of economic policies. Such an example is shown in Figure 1 where the RMB has become very stable against the US dollar since 1994 due to the Chinese exchange rate policy. In this connection, we ask whether the exchange rate regime may have influenced our results.

The result from the 2SLS random effects IV regression method is summarized in Table 4 (post-1994) which again lists instrumental variables used in this analysis. This Table shows outcomes which are different between sample periods. First, while money was a significant indicator in the full-sample analysis, it no longer becomes statistically significant in the post-1994 period. This result can be expected from developments and changes in the financial markets[4], and implies that the Chinese economy is relying more heavily on non-cash transactions. This also serves as a warning to the PBC in its heavy reliance on money as an intermediate target when conducting monetary policy. Similarly, it should be noted that the significance level of credits has dropped in this period from the one to five percent level. Our result seems to be consistent with Zhang (2010) who reports, using a stochastic model, that improved monetary policy since 1997 accounts for only a fraction of the reduction in inflation uncertainty.

Secondly, more consistent evidence for productivity is reported in the post-1994 period. It is now significantly negative in the inflation equation with narrow money as well, which was insignificant in the full sample analysis. This result may have been brought about by the adoption of a more market-

---

[1] One needs to be careful about interpreting our results since the sample period is limited. However, given that there is a bias in favor of no cointegration when the sample period is short (Gutierrez, 2003), our result of rejecting the null hypothesis at one percent significance in most cases seems to support our conclusion.

[2] See Baltagi (2008) about details of this estimation method.

[3] Equation (5) is not inconsistent with the long-run formation (2) in the sense that the first differences of log price, money and output (income) are included in equation (5) although output is transferred to productivity (GDP divided by labor).

[4] We note that further investigation is needed to reach a firm conclusion that financial innovation (or sophistication) is a cause of breakdown in the inflation-money relationship. Fischer (2007) examines instability of the money demand function in Switzerland and found that financial sophistication is not the cause.

oriented economic policy, e.g., the privatization of state-owned firms, which induces more competition in the market.

Thirdly, the sensitivity of inflation to the RMB has increased during this period. Since the currency exhibited negligible fluctuations compared with the pre-1994 period, our result should be interpreted as signifying that very small changes in the RMB were associated with a moderate rate of inflation. This result may also underline the increased importance of international trade in China and the economy's increased sensitivity to exchange rate changes[1].

In short, we find evidence that economic fundamentals, notably money, are very sensitive to the sample period, and that credits, productivity and exchange rate growth remain significant driving forces of inflation movements in China regardless of the sample period.

We also analyze the sensitivity of our results to the choice of provinces in the presence of the heterogeneous economic development among regions. Generally it is believed that in the past Chinese economic policy was successful in development of the coastal (eastern) provinces, while the middle and western provinces have lagged behind the east and have benefitted less from the recent economic growth in China. Therefore, we divide the sample into fast- and slow-growing provinces in terms of real GDP growth (as it is shown in Table 1).

Due to data availability, our study is limited to a full sample analysis, and the results are reported in Table 5 (see Appendix) where instrumental variables used in this analysis are also shown. Generally, our results are very similar to those from the full-sample analysis reported in Table 4 and thus are robust to the choice of region; Chinese inflation can be explained by economic fundamentals. Credits and exchange rates, the monetary authorities' instruments, are significantly and positively related with inflation. So is money which has been used in the past as an intermediate target. Also we note that, consistent with the long-run analysis, the ECM enters the inflation equation with a negative sign, which again confirms panel cointegration between price, money and output.

## Conclusion

Using advanced econometric methods, this paper has analyzed Chinese inflation using a panel of regional data from 1991 to 2005. Use of regional data is in sharp contrast to previous studies that employed country-level price/inflation data and allows us to conduct sensitivity analysis using the subsamples of our data set. Since excess Chinese inflation has adverse effects on both the domestic and international economies, we believe that it is important to understand the evolution of Chinese inflation.

Based on a reduced form equation, our results show that recent Chinese inflation (price) can be explained by some economic fundamentals although it is still in transition to the market-oriented economy. As in industrial countries, there is evidence of a long-run relationship between price, money, and output and of a significant relationship between inflation and growth in money, credits, productivity, and exchange rates, with the signs of their parameters consistent with economic theory. Since in the past Chinese monetary authorities have closely monitored growth in money as an intermediate target and used credits and the exchange rate as instruments, we conclude that Chinese monetary policy was influential over inflation although it was not its sole objective during our sample period. In addition, it should be noted that none of these results are sensitive to the choice of region; the data from high- and low-growing provinces show very similar results. However, this result should be interpreted with caution since the relationship between money growth and inflation seems to have weakened over recent years.

Finally, this study could be extended in a number of ways. First, one could consider different dates for structural breaks. We determined the date of the structural break based on the exchange rate which exhibited very clear signs of a break. However, since the Chinese economy is in transition to a market-oriented market, it may be more appropriate to allow more possibilities for break dates. Secondly, other scale variables such as output gap, and expected and lagged inflation could be incorporated to further develop this study. We acknowledge that there are severe constraints on data availability as of this writing.

## References

1. Alesina, A. and L. Summers. (1993). Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence, *Journal of Money, Credit and Banking*, 25, 151-62.
2. Aziz, J. and X. Li. (2007). China's Changing Trade Elasticities, IMF Working Paper, WP/07/266.
3. Baltagi, B.H. (2008). Econometric Analysis of Panel Data 4th Edition. Chichester: John Wiley & Sons Ltd.
4. Bernanke, B.S. and M. Gertler (1995). Inside the Black Box: the Credit Channel of Monetary Policy Transmission, *Journal of Economic Perspectives*, 9 (4), 27-48.

---

[1] This is particularly so since 2004. The trade balance-to-GDP ratio soared from around 2 percent in 2003/04 to 5 percent in 2005. Furthermore, demand and price elasticities have risen significantly in recent years (Azia and Li, 2007).

5. Brunner, K. and A.H. Meltzer (1988). Money and Credit in the Monetary Transmission Process, *American Economic Review*, 78 (2), 446-451.
6. Burdekin, R.C.K. and P.L. Siklos (2006). What Has Driven Chinese Monetary Policy since 1990? Investigating the People's Bank's Policy Rule, *Journal of International Money and Finance*, forthcoming.
7. Chen, B. (1997). Long-run Money Demand and Inflation in China, *Journal of Macroeconomics*, 19 (3), 609-617.
8. Corden, W.M. (2007). Exchange Rate Policies and the Global Imbalances: Thinking about China and the IMF, Paper for James Meade Centenary Conference, Bank of England.
9. Cristopoulos, D.K. and E.G. Tsionas (2005). Productivity Growth and Inflation in Europe: Evidence from Panel Cointegration Tests, *Empirical Economics*, 30, 137-150.
10. De Gregorio, J. (1992). The Effects of Inflation on Economic Growth: Lessons from Latin America, *European Economic Review*, 36, 417-425.
11. Fan, C.C. (2002). Population Changes and Regional Development in China: Insights Based on the 2000 Census, *Eurasian Geography and Economics*, 43(6), 425-442.
12. Feyzioglu, N. and L.B. Willard (2008). Does China have Inflation Effects on the USA and Japan? *China & World Economy*, 16 (1), 1-16.
13. Feyzioglu, T., N. Porter and E. Takats (2009). Interest rate liberalization in China, IMF Working Paper, WP/09/171.
14. Fischer, A.M. (2007). Measuring Income Elasticity for Swiss Money Demand: what do the Cantons Say about Financial Innovation? *European Economic Review*, 51, 1641-1660.
15. Funke, M. (2006). Inflation in China: Modelling a Roller Coaster Ride, *Pacific Economic Reivew*, 11(4), 413-429.
16. Gerlach, S. and W. Peng (2006). Output Gaps and Inflation in Mainland China, BIS Working Papers, No. 194.
17. Girardin, E. (1996). Is There a Long-Run Demand for Currency in China? *Economics of Planning*, 29, 169-184.
18. Green, S. (2005). Making Monetary Policy Work in China: a Report from the Money Market Front Line, Stanford Center for International Development, Working Paper, No. 245, Stanford University.
19. Guillaumont Jeanneney, S. and P. Hua (2002). The Balassa-Samuelson Effect and Inflation in the Chinese Provinces, *China Economic Review*, 13, 134-160.
20. Guitierrez, L. (2003). On the power of panel cointegration tests: a Monte Carlo comparison, *Economics Letters*, 80, 105-111.
21. Hasan, M.S. (1999). Monetary Growth and Inflation in China: a Reexamination, *Journal of Comparative Economics*, 27, 669-685.
22. Hayes, R.H. and W.J. Abernathy (1980). Managing our Way to Economic Decline, *Harvard Business Review*, 58, 67-77.
23. Huang, C. (1994). Money Demand in China in the Reform Period: an Error Correction Model, *Applied Economics*, 26, 713-719.
24. Jarrett, J.P. and J.G. Selody (1982). The Productivity-Inflation Nexus in Canada, 1963-1979, *Review of Economics and Statistics*, 64 (3), 361-368.
25. Kao, C. (1999). Spurious Regression and Residual-based Tests for Cointegration in Panel Data, *Journal of Econometrics*, 90, 1-44.
26. Koyuncu, C. and R. Yilmaz (2006). Can China Help Lower World Inflation? A panel Study, *Emerging Markets Finance and Trade*, 42(2), 93-103.
27. Laurens, B.J. and R. Marino (2007). China: Strengthening Monetary Policy Implementation, IMF Working Paer WP/07/14.
28. Liu, L. and A. Tsang (2008). Pass-through Effects of Global Commodity Prices on China's Inflation: an Empirical Investigation, *China & World Economy*, 16 (6), 22-34.
29. Mahadevan, R. and J. Asafu-Adjaye (2006). Is There a Case for Low Inflation-induced Productivity Growth in Selected Asian Countries? *Contemporary Economic Policy*, 24 (2), 249-261.
30. Mehrotra, A., T. Peltonen, and A. Santos Rivera (2007). Modelling inflation in China – a Regional Perspective, Bank of Finland, Institute for Economics in Transition, Discussion Papers 18.
31. Montes-Negret, F. (1995). China's Credit Plan: an Overview, *Oxford Review of Economic Policy*, 11(4), 25-42.
32. Nagayasu, J. and Y. Liu (2008). Relative Prices and Wages in China: Evidence from a Panel of Provincial Data, *Journal of Economic Integration*, 23 (1), 183-203.
33. Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors, *Oxford Bulletin of Economics and Statistics*, 61, 653-670.
34. Pettis, M. (2008). Chinese Inflation: It's Money, not Pork, *Far Eastern Economic Review*, 42-45.
35. Porter, N. (2010). Price Dynamics in China, IMF Working Paper, WP/10/221.
36. Sakamoto, H. and N. Islam (2008). Convergence across Chinese provinces: an analysis using Markov Transition Matrix, *China Economic Review*, 19, 66-79.
37. Xie, D. (2001). China's Monetary Policy Objectives and the Central Bank's Operations, Inflation Targeting: Theories, Empirical Models and Implementation in Pacific Basin Economies, Proceedings of the 14th Pacific Central Bank Conference. Seoul, Bank of Korea.
38. Xu, X. (2002). Have the Chinese Provinces Become Integrated under Reform? *China Economic Review*, 13, 116-133.
39. Westerlund, J. (2007). Testing for Error Correction in Panel Data, *Oxford Bulletin of Economics and Statistics*, 69 (6) 709-748.

40. Yusuf, S. (1994). China's Macroeconomic Performance and Management during Transition, *Journal of Economic Perspectives*, 8 (2), 71-92.
41. Zhang, C. (2009). Excess liquidity, Inflation and the Yuan Appreciation: what Can China Learn from Recent History, *World Economy*, 998-1018.
42. Zhang, C. (2010). Inflation Uncertainty and Monetary Policy in China, *China & World Economy*, 18 (3), 40-55.

## Appendix

Table 1. Economic growth

| High-growth region | Low-growth region |
|---|---|
| Beijing | Liaoning |
| Tianjin | Jilin |
| Hebei | Heilongjiang |
| Shanxi | Jiangxi |
| Inner Mongolia | Guangxi |
| Shanghai | Hainan |
| Jiangsu | Sichuan |
| Zhejiang | Guizhou |
| Anhui | Yunnan |
| Fujian | Shaanxi |
| Shandong | Gansu |
| Henan | Qinghai |
| Guangdong | Ningxia |
|  | Xinjiang |

Note: Based on real GDP growth rates.

Table 2. Fixed and random effects models

|  | FE |  | RE |  | FE |  | RE |  |
|---|---|---|---|---|---|---|---|---|
| $\Delta M2_t$ | 0.187 [0.035] | ** | 0.181 [0.033] | ** | -- |  | -- |  |
| $\Delta M1_t$ | -- |  | -- |  | 0.172 [0.038] | ** | 0.171 [0.036] | ** |
| $\Delta Credits_t$ | 0.074 [0.012] | ** | 0.075 [0.011] | ** | 0.084 [0.012] | ** | 0.084 [0.011] | ** |
| $\Delta Prod_{i,t}$ | -0.167 [0.028] | ** | -0.160 [0.026] | ** | -0.101 [0.022] | ** | -0.098 [0.021] | ** |
| $\Delta Pop_{i,t}$ | 0.057 [0.074] |  | 0.048 [0.067] |  | 0.088 [0.074] |  | 0.074 [0.068] |  |
| $\Delta RMB_t$ | 0.166 [0.019] | ** | 0.167 [0.018] | ** | 0.169 [0.019] | ** | 0.169 [0.018] | ** |
| Const | -0.025 [0.005] | ** | -0.025 [0.005] | ** | -0.030 [0.007] | ** | -0.030 [0.006] | ** |
| $R^2$ | 0.425 |  | 0.425 |  | 0.414 |  | 0.414 |  |
| No. of obs. | 378 |  | 378 |  | 378 |  | 378 |  |
| F-test | 1.000 |  | -- |  | 1.000 |  | -- |  |
| Hausman test | -- |  | 0.974 |  | -- |  | 0.995 |  |

Notes: Regional inflation $\Delta p$ is regressed against broad money (*M2*), narrow money (*M1*), credits, productivity, population, and exchange rate growth. The Const is the constant term. These terms are defined in the main text. The statistics significant at the one, five and ten percent levels are indicated by \*\*, \*, and + respectively. The sample period is from 1991 to 2005. The fixed effects estimates are not shown in this Table. The F-test examines whether individual effects are identical across regions. Rejection of the null hypothesis by the Hausman test raises evidence in favor of the fixed effects model. For these tests, *p*-values are reported in the Table.

Table 3. The long-run relationship

|  | 1 |  | 2 |  |
|---|---|---|---|---|
| $M2_t$ | 0.548 [0.007] | ** | -- |  |
| $M1_t$ | -- |  | 0.610 [0.008] | ** |
| $Y_t$ | -0.153 [0.020] | ** | -0.153 [0.021] | ** |
| Panel ADF cointegration test (Pedroni) | -5.952 | ** | -6.974 | ** |
| Panel cointegration test (Kao) | -10.970 | ** | -11.279 | ** |
| Panel cointegration test (Westerlund) | -10.398 | ** | -8.241 | + |

Notes: These estimates are obtained from the OLS. Price is regressed against money (*M2* or *M1*) and real income (*Y*). The panel cointegration tests are based on Pedroni (1999), Kao (1999) and Westerlund (2007), and examine the null hypothesis of no cointegration. The SIC is used to decide the lag order. The *p*-value for the Westerlund test is obtained by the bootstrap method. The statistics significant at the one, five and ten percent levels are indicated by \*\*, \*, and + respectively. The sample period is from 1991 to 2005.

Table 4. 2SLS random effects IV regression (all provinces)

| | Full sample | | | | Post-1994 | | | |
|---|---|---|---|---|---|---|---|---|
| $\Delta M2_t$ | 0.430 [0.054] | ** | -- | | -0.041 [0.067] | | -- | |
| $\Delta M1_t$ | -- | | 0.555 [0.059] | ** | -- | | 0.078 [0.061] | |
| $\Delta Credits_t$ | 0.083 [0.014] | ** | 0.115 [0.013] | ** | 0.023 [0.011] | * | 0.025 [0.011] | * |
| $\Delta Prod_{i,t}$ | -0.142 [0.028] | ** | -0.005 [0.024] | | -0.117 [0.023] | ** | -0.117 [0.019] | ** |
| $\Delta RMB_t$ | 0.196 [0.018] | ** | 0.172 [0.019] | ** | 0.287 [0.016] | ** | 0.268 [0.016] | ** |
| $ECM_{i,t-1}$ | -0.067 [0.008] | ** | -0.071 [0.008] | ** | -0.052 [0.006] | ** | -0.058 [0.006] | ** |
| Const | -0.073 [0.008] | ** | -0.106 [0.010] | ** | 0.005 [0.010] | | -0.015 [0.011] | |
| $R^2$ | 0.507 | | 0.482 | | 0.664 | | 0.666 | |
| No. of obs. | 351 | | 351 | | 324 | | 324 | |

Notes: Regional inflation $\Delta p$ is regressed against money (*M2* or *M1*), credits, productivity, and exchange rate (RMB) growth as well as the error correction (ECM) and constant terms. The statistics significant at the one, five, and ten percent levels are indicated by **, *, and + respectively. The full sample period is from 1991 to 2005. Instrumental variables are the first difference of bank rates, crude oil prices (worldwide), and commodity food and beverage prices (worldwide) as well as US inflation and population growth.

Table 5. 2SLS random effects IV regression (full sample, separate regions)

| | Fast growing region | | | | Slow growing region | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 1 | | 2 | |
| $\Delta M2_t$ | 0.577 [0.783] | ** | -- | | 0.394 [0.062] | ** | -- | |
| $\Delta M1_t$ | -- | | 0.622 [0.085] | ** | -- | | 0.401 [0.068] | ** |
| $\Delta Credits_t$ | 0.049 [0.019] | ** | 0.096 [0.018] | ** | 0.077 [0.015] | ** | 0.090 [0.015] | ** |
| $\Delta Prod_{i,t}$ | -0.197 [0.037] | ** | 0.002 [0.032] | | -0.126 [0.037] | ** | -0.018 [0.033] | |
| $\Delta RMB_{i,t}$ | 0.190 [0.023] | ** | 0.163 [0.026] | ** | 0.213 [0.026] | ** | 0.205 [0.026] | ** |
| $ECM_{i,t-1}$ | -0.090 [0.013] | ** | -0.085 [0.012] | ** | -0.066 [0.011] | ** | -0.059 [0.010] | ** |
| Const | -0.080 [0.011] | ** | -0.109 [0.015] | ** | -0.075 [0.011] | ** | -0.083 [0.013] | ** |
| $R^2$ | 0.559 | | 0.492 | | 0.516 | | 0.512 | |
| No. of obs | 169 | | 169 | | 182 | | 182 | |

Notes: Regional inflation $\Delta p$ is regressed against lagged inflation, credits, productivity, population growth, and the constant term. These terms are defined in the main text. The statistics significant at the one, five, and ten percent levels are indicated by **, *, and + respectively. The sample period is from 1991 to 2005. Instrumental variables are the first difference of bank rates, crude oil prices (worldwide), and commodity food and beverage prices (worldwide) as well as US inflation and population growth.
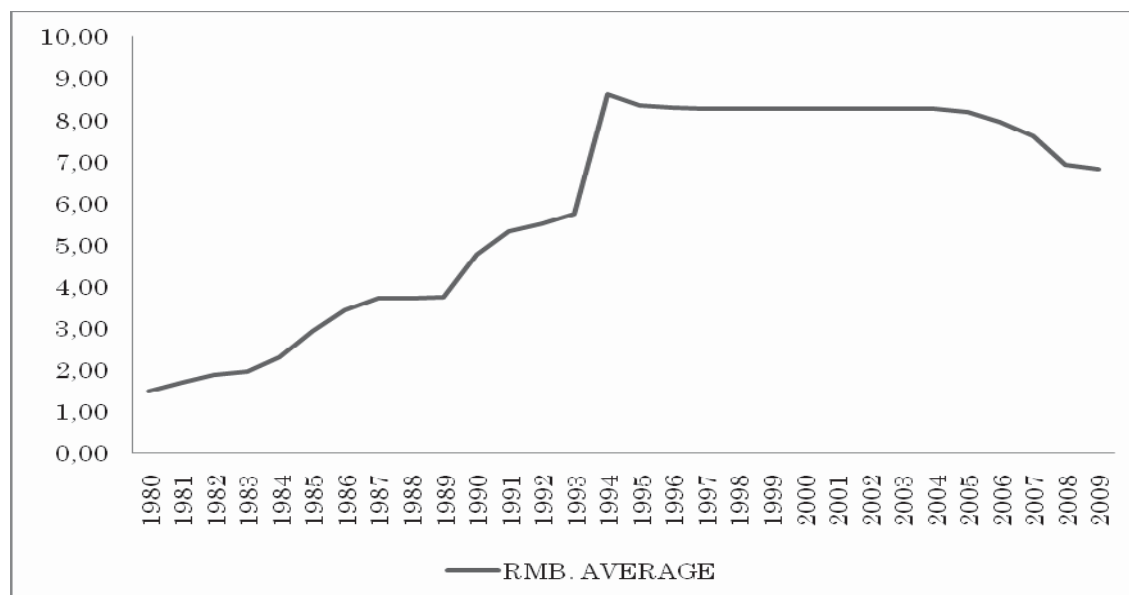


Source: IMF's International Financial Statistics

**Fig. 1. Chinese exchange rate vis-à-vis US dollar (1980-2009)**
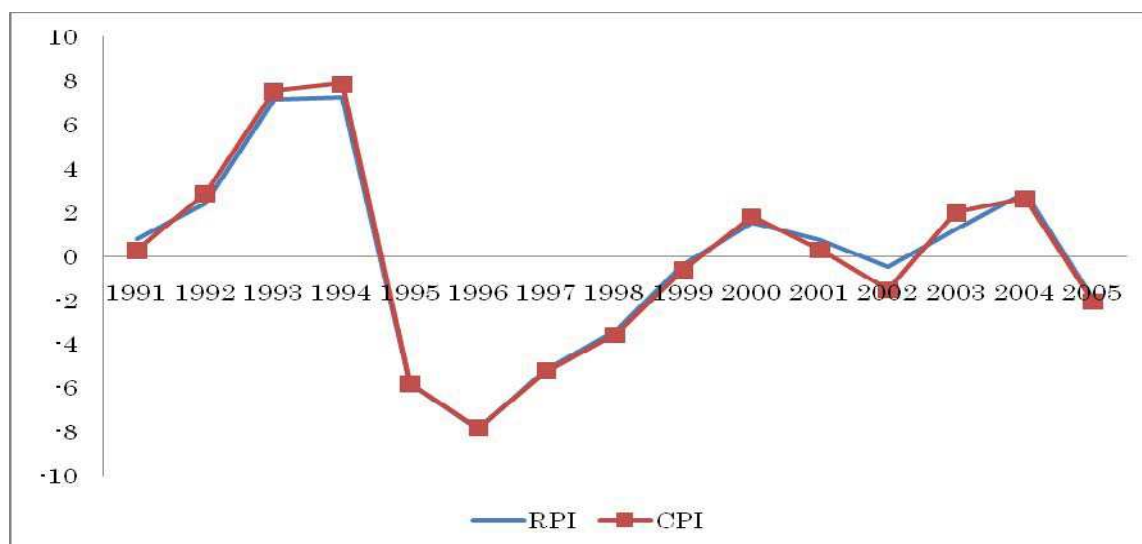
Source: National Bureau of Statistics of China

**Fig. 2. Chinese retail price and consumer price indices (1991-2005)**