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Abstract

The Chinese economy experienced both a historical double-digit inflation in the mid-90s and unprecedented deflation in the late 1990s and early 2000s. The People's Bank of China, which is the Central Bank of China, has been trying to adopt an active monetary policy to reduce inflation and contain deflation. However, there remains an open issue whether its policy is effective. We formally investigate the effectiveness monetary variables in the two regimes of inflation and deflation, respectively, via the vector auto-regressive (VAR) models. One of the biggest challenges to our research is the frequent structural changes in the Chinese monetary system. This implies that both the lags and the parameters of the VAR model are not constant over time. Therefore we apply the surplus lag rolling estimation to conduct our Granger causality tests from money to price. The main findings of this paper are that the monetary variables have

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become less effective to the price level in the deflation era started from 1998. This conclusion is consistent with the recent development of the neo-Keynesian macroeconomic model which predicts that the monetary expansion is less effective in an environment of deflation. It also provides some empirical evidence to support the Chinese government to adopt alternative policies such as an active fiscal policy for the purpose of demand management in the era of deflation.

Keywords: money, price, Granger causality, China
JEL codes: E52, E31, C32.

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1. Introduction

This paper tests the Granger causality from money (m) to price (p) in China since 1990s. This period is chosen for a number of reasons. The Chinese economy experienced both a historical double-digit inflation in the mid-90s and unprecedented deflation in the late 1990s and early 2000s (cf. Fig 1). The People's Bank of China, which was given the status of the Central Bank of China in 1983, has been trying to adopt an active monetary policy to reduce inflation and contain deflation. However, there remains an open issue whether its policy is effective (Sun and Ma, 2003; Sun and Ma, 2005).

[Fig 1 to be inserted here]

In this paper, we formally investigate the effectiveness monetary variables in the two regimes of inflation and deflation, respectively. We apply the Granger causality test based on vector auto-regressive (VAR) models to achieve this objective. If the Granger causality is found from money to price, then we conclude that monetary variable has significant impact on the price level. However, if there is no Granger causality from money to price, then money is ineffective and money supply may not be chosen as a monetary policy instrument for the central bank.

One of the biggest challenges to our research is the frequent structural changes in the Chinese monetary system. This implies that both the lags and the parameters of the VAR model are not constant over time. Therefore we apply a rolling estimation approach on the VAR models to conduct our Granger causality tests from money to price.

The main findings of the paper are that the monetary variables have become impotent to the price level in the deflation era started from 1998. This conclusion is consistent with the recent development of the neo-Keynesian macroeconomic model which predicts that the monetary expansion is less effective in an environment of deflation (e.g., Svensson, 2003).

Since the seminal paper by Lucas (1972) and its further development by Sargent and Wallace (1976), the neoclassical doctrine holds the view that the anticipated monetary changes are impotent. Only the monetary shocks may generate significant impact on the economic variables such as GDP and prices. This view was initially supported with empirical evidence by Barro (1977). However, it was subsequently challenged by neo-Keynesian economists both theoretically and empirically.

For example, Mishkin (1982) was the first to challenge the monetary neutrality hypothesis based on his empirical evidence. Mankiw and Romer (1991) collected some representative theoretical work that provide microeconomic foundations for wage and price rigidity that violate the conditions under which the money neutrality holds. Latest development in this area can be found in, for example, Clarida, Gali and Gertler (2002).

The money neutrality hypothesis is also under much debate in China. The debate is especially important after the witness of the recent Asian financial crisis (Tsang and Ma, 2002) and China's accession to the WTO (Ma, 2001). Li and Ma (1996) and Zhao, Ma, Kueh, Tsang, Yiu, and Liu (2002) showed that the gradual economic reform and price stickiness provide the microfoundation of money non-neutrality in China. Liu (2001) found significant effect of monetary supply over the period of 1987-2000. Tsang and Ma (1997, 2000) found that there was significant monetary impact on the economy of mainland China based on a simulation model. However, Sun (2000) explained theoretically why money supply is decreasingly effective under deflationary period. It is due to the inefficiency of the monetary transmission mechanism in China. This conclusion was supported by empirical evidence by Lu and Shu (2002). Nevertheless, all of the empirical works reviewed above are based on a conventional constant-parameter-constant-structure econometric approach that is subject to model misspecification due to the frequent structural changes in China (Ma, et al, 2002; Ma, et al, 2003). Another drawback of these researches is that they all based on Johansen's (1991) maximum likelihood estimation (MLE) and therefore are subject to the pre-test bias. To overcome both problems of structural changes and pre-test bias, this paper adopts the surplus lag VAR (Lutkepohl and Burda, 1997) rolling estimation method (Swanson, 1998) to examine the effectiveness of the monetary policy in China.

The remainder of the paper is organized as follows. Section 2 discusses in details our procedure to test Granger causality in a system with frequent structural changes. Section 3 implements this procedure to investigate the effectiveness of the monetary variables in China. Finally, Section 4 concludes.

2. Procedure to test Granger causality in a system with frequent structural changes

Granger (1996) pointed out that the structural instability may be the most important problem facing researchers today. This section lays out the econometric testing procedure we adopt carefully in this paper to overcome the problem of structural changes and to minimize the pre-test bias for the Granger causality test. The structure of this section is given as follows.

Firstly, we discuss how to determine the structure of the VAR model we will utilize to investigate the effectiveness of the monetary variables in China. This is achieved by choosing the appropriate lag length of the macroeconomic variables in the model. Secondly, we explain how to present the evidence on the instability of the Chinese monetary system. We apply the recursive Johansen (1991) maximum likelihood estimation (MLE) to the VAR model to investigate its changing statistical properties in terms of nonstationarity of the time series and possible number of cointegration relations. Thirdly, we lay out the testing procedure for Granger causality from money to price by surplus lag estimation developed by Lutkepohl and Burda (1997) to minimize the pre-test bias. Finally, we show how to implement the rolling window estimations on the VAR to compare the effectiveness of monetary variables over the inflation and deflation periods.

Following the recent development of the monetary economics research by Estrella and Mishkin (1997) and B. Friedman and Kuttner (1992), we choose our economic model as trivariate vector autoregressive (VAR) of money (m), price (p), and real GDP (y), all in logarithms. Let $X_t = (m_t, p_t, y_t)$ be the vector of the three variables.

Our sample is monthly data ranging from January 1990 to June 2002, a total of 150 observations. Three definitions of money supply will be utilized: M0, M1 and M2. The price variable is defined as consumer price index with 1990 as the base year. Real GDP is in constant 1990 prices. Since only quarterly real GDP time series is available, we applied the best linear unbiased method developed by Chow and Lin (1971) to interpolate the monthly real GDP series from the monthly real industrial value-added series (IVA), together with the quarterly series of real GDP and real IVA. We utilize seasonally adjusted series of real GDP, money, and price. All variables are expressed in logarithms. The data are collected from various issues of International Financial Statistics published by the International Monetary Fund. The inflation and deflation are defined as the year-to-year change of consumer price index (CPI) to be positive and negative, respectively (cf. Fig 1).

2.1. Choice of lag length in a VAR model

There are some commonly used procedures to choose the lag length of a VAR system in the existing literature. One of them is starting from a maximum lag length and then testing down the significance of the longest lags. This is called 'general-to-specific' approach. Another one is starting from a minimum lag length and then expand the VAR by accepting the significant extra lagged variables added in. This is called 'specific-to-general' approach. However, in our opinion, both approaches of lag selection are not appropriate in testing the Granger causality. This is because both approaches involve in testing the causal variables implicitly that may create a pre-test bias. For example, when we test the significance of the lagged money variable m_t in the price equation to choose the optimal lag for m_t, we are actually testing the causality from m_t to price implicitly. This may create potential pre-test bias. As a result, we adopt alternative lag selection approach which is the Schwarz information criterion (SIC). The SIC is a consistent estimator for the lag length (Lutkepohl, 1993). That is, when the sample size approaches to infinity, the estimated order will converge in probability to the true order of the VAR process.

2.2. The nonstationarity of the time series and possible number of cointegration relations

Given the lag length q for a VAR model of X_t selected by the SIC, we have:

$$X_t = B_0 + \sum_{j=1}^{q} B_j X_{t-j} + U_t \,, \tag{1}$$

we can re-parameterize it as the following:

$$\Delta X_t = A_0 + \sum_{i=1}^{q-1} A_i \Delta X_{t-i} + \Pi X_{t-1} + U_t \tag{2}$$

where $\Delta X_t = X_t - X_{t-1}$, $A_0 = B_0$, $A_i = -\Sigma^{q}_{j=i+1} B_j$ (i=1, 2, ….., q-1), $\Pi = -I + \Sigma^{q}_{j=1} B_j$. Applying the Johansen MLE approach to estimate the r=rank(Π) gives the following two possible alternative outcomes:

(a) Matrix Π has full rank, r=3, i.e. all X_t are stationary, or

(b) Matrix Π does not have full rank, $0 \leq r < 3$, i.e. some of X_t are nonstationary and the number of cointegration vectors is r.

However, there are frequent structural changes in the Chinese monetary system. This implies that the parameters of (A_i, Π) (i=0, 1, 2, ….., q-1) are not constant over time. Therefore we apply the recursive Johansen MLE to the VAR model in (1). That allows us to investigate the possible changes of (A_i, Π) as well as the rank of Π over time. It can be regarded as a stability test for the monetary system in China.

2.3. Test the Granger causality by surplus lag estimation

To avoid the pre-test bias that may arise from the integration and cointegration tests, we apply the surplus lag estimation to test the Granger causality from money to price. Suppose the lag length is chosen as *q* by the SIC. We estimate a VAR with q+1 order and then only apply the Wald test on the coefficients of the variables with lags up to *q* to conduct the Granger causality test (Lutkepohl and Burda, 1997). Assume the (q+1)-order VAR is given as follows:

$$X_t = B_0 + \sum_{j=1}^{q+1} B_j X_{t-j} + U_t \, , \qquad (3)$$

Of which, we are particularly interested in the price equation rewritten as follows:

$$p_t = \beta_0^p + \beta_1^{mp} m_{t-1} + ... + \beta_q^{mp} m_{t-q} + \beta_{q+1}^{mp} m_{t-q-1} + \sum_{j=1}^{q+1} \beta_j^p p_{t-j} + \sum_{j=1}^{q+1} \beta_j^{yp} y_{t-j} + u_t^p$$

Then the hypothesis of Granger non-causality from money to price ($m_t \rightarrow p_t$) is to test only the following *q* parameters to be zero:

$$H_0: \beta_1^{mp} = \beta_2^{mp} = ... = \beta_q^{mp} = 0, \tag{4}$$

Suppose we apply the OLS estimator to (3), then the Wald statistic is:

$$\text{Wald} = \hat{\beta}' V^{-1}(\hat{\beta})\hat{\beta} \sim \chi^2(q)$$

where $\beta = (\beta_1^{mp}, \beta_2^{mp}, ..., \beta_q^{mp})'$, $\hat{\beta}$ is the estimated coefficient vector of β, and $V^{-1}(\hat{\beta})$ is the estimated variance-covariance matrix of $\hat{\beta}$.

If the Wald test accepted the H_0, then the conclusion is that m_t does not Granger cause p_t. That is, money is neutral. However, if H_0 is rejected, then we conclude that m_t Granger causes p_t, i.e., money has significant impact on the price level.

2.4. Fixed window rolling regression

To accommodate the frequent structural breaks in the Chinese monetary system, we apply the fixed window rolling regression to the level VAR model defined in (3). Rolling regression means we run a series of regressions with fixed sample size in each regression, i.e. fixed window size. Here we use only 5-year monthly observations to run a regression each time, i.e. each window size is fixed to 60 observations. The choice of 60 observations in each window has taken account of the two conflicting demands: 1) the degree of freedom of estimation demands for a larger sample size to estimate the parameters accurately, whilst 2) the potential structural change of the model requires a smaller sample size to reduce the risk of containing a structural break within the sample period. We follow the recommendation by Zapata and Rambaldi (1997) that a minimum of 50 observations are necessary to balance the conflict of the two demands.

The details of the window definitions are given as follows. The 1st regression window uses the observations from Jan. 1990 to Dec. 1994 (the window size is 60). Then we roll the regression window forward by simultaneously adding one new observation of Jan. 1995 and dropping one last observation of Jan. 1990 from the 1st window. Hence the new window's size remains being fixed at 60 observations. Repeat this until we reach the 91st regression window for the period of July 1997 to June 2002.

The lag length is chosen by the SIC in each regression. This indicates that the number of lags of the VAR model is also allowed to be time-varying to fully capture the structural changes due to the major monetary reforms in China.

3. Estimation results

We have three VAR systems corresponding to M0, M1 and M2 respectively. Each VAR has three variables: Lp, Ly, and Lmj (j=0,1,2), which represent log of price, real GDP and Mj, respectively, as discussed in Section 2.

3.1. Empirical evidence on the instability of the Chinese monetary system

Fig 2 presents the time-varying lag lengths of the three VAR models of (Lmj, Lp, Ly) (j=0,1,2) under the rolling regressions discussed in Section 2.4. These lags are estimated by the 91 windows illustrated in Section 2.4. The vertical axis of Fig 2 shows the lag length estimated in a corresponding window given by the date on the horizontal axis. The horizontal axis defines the 5-year windows of fixed size that finishes at the date given at the horizontal axis, and starts 5 years earlier[1]. For example, in Fig 2a, the first date of December 1994 with an estimated lag three indicates that the optimal lag length of the VAR model (Lm0, Lp, Ly) in the first window is lag three according to the SIC. It also tells us that this window starts from January 1990 and finishes in December 1994, given the fact that the window size is fixed to 5 years. Similarly, the date of June 2002 corresponds to the last window, i.e., the 91st window. This window starts from July 1997 and finishes at June 2002. The optimal lag for the VAR model (Lm0, Lp, Ly) is one in this window.

[Fig 2 to be inserted here]

The lag lengths are chosen to minimize the SIC in each window. Fig 2 shows that frequent structural changes occurred during the period of December 1994 to December 1998 in all three VAR models. However, all estimated lag lengths eventually stabilized at lag one since January 1999.

Fig 3 displays the p-values of the augmented Dicky-Fuller (ADF) and Phillips-Perron (PP) unit root tests for the five time series of Lmj (j=0,1,2), Lp and Ly. The tests are based on the fixed window rolling regressions again. The null hypothesis of both ADF and PP tests is that a time series is nonstationary. A straight solid line of 5% significance level is drawn in each of the figures. If a p-value of the test statistic is below the 5% significance line, it indicates that the time series is stationary in the corresponding estimation window. However, if a p-value is above the 5% line, then it implies that the time series is nonstationary for that corresponding period.

[Fig 3 to be inserted here]

It is shown from Fig 3 that all five time series exhibited structural breaks. Nonstationarity could be found in the early estimation periods whilst stationarity could be accepted in the later estimation windows. Furthermore, the ADF and PP tests also generate conflicting results regarding the stationarity of some of the time series from time to time. For example, in the figure for the log of price (Lp), the ADF test indicated that Lp became stationary in the later estimation periods, whilst the PP test indicated that Lp remained nonstationary throughout all the regression windows. This creates uncertainty on the statistical inference for the subsequent Granger causality tests that may generate pre-test bias for the final conclusion about the effectiveness of the monetary variables.

Fig 4 shows that the number of cointegration vectors, i.e., the number of long-run relationships, among the three VAR models for (Lmj, Lp, Ly) (j=0,1,2), respectively. It is estimated by the Johansen maximum likelihood estimation (MLE) (Johansen, 1991) by the rolling windows again. All three VAR models have experienced frequent long-run structural breaks. These breaks are indicated by the changes of the number of cointegration vectors (r) in different estimation windows, ranging from no cointegration (r=0), to one (r=1) or two (r=2) cointegration vectors. These structural breaks may also generate pre-test bias for the subsequent Granger causality, as explained in Section 2.2.

[Fig 4 to be inserted here]

To conclude, all of the findings from Fig 2, 3, and 4 show that the Chinese monetary system has experienced significant structural breaks and uncertain statistical properties over the period of January 1990 to June 2002. As a result, this paper adopts a different estimation strategy to bypass the potential pre-test bias and uncertainty in statistical inference from unit root tests and Johansen MLE. We utilize the surplus lag estimation approach developed by Lutkepohl and Burda (1997) recursively, as explained in Section 2.3 and 2.4, to examine the effectiveness of the monetary variables in China.

3.2. Empirical results of effectiveness of monetary variables

Fig 5 presents the p-values of the Granger causality tests from Lmj to Lp (j=0,1,2) based on rolling window regressions defined in Section 2.4. The test is conducted by the surplus lag estimation approach developed by Lutkepohl and Burda (1997). A straight line of 5% significance level is also drawn in these figures. If a p-value of the test statistic is below the 5% significance line, it indicates that there is evidence of Granger causality from money to price in the corresponding estimation window. However, if a p-value is above the 5% line, then it implies that there is no evidence of Granger causality from money to price in that window, which means money is ineffective for that corresponding period.

[Fig 5 to be inserted here]

Fig 5a displays the p-values of the Granger causality tests from Lm0 to Lp. It shows that Lm0 has been significantly Granger causing Lp for the entire inflation period until January 1998. However, it started to Granger cause Lp insignificantly since Feb. 1998. Since the deflation era started from February 1998 (see Fig 1), this indicates that the M0 became impotent during the deflation period in China.

Fig 5b exhibits that Lm1 does not Granger cause Lp until February 1997. Since then, it starts to Granger cause Lp significantly in most of the regressions. This indicates that the monetary variable is effective in these estimation periods. However, we found that the effectiveness of M1 has been declining. This conclusion is supported by regressing the log of coefficients of lagged Lm1, β_{1t}^{mp} [cf. eq. (4)], on a constant and a linear time trend. This regression result is given as follows:

$$\mathrm{Ln}(\beta_{1t}^{mp}) = -1.56 - 0.0072*(\text{time trend}) + u_{1t},$$
$$(18.97) \quad (6.26)$$

Estimation period: January 1999 to June 2002, Adjust. $R^2 = 0.48$, $\sigma_{u1} = 0.09$, where t-values are given in the parentheses[2].

This shows that the effectiveness of M1 measured by the coefficient of β_{1t}^{mp} is declining at the speed of 0.72% each month.

Fig 5c reveals that Lm2 does not Granger cause Lp for most of regression windows until March 1998. Since then, Lm2 Granger causes Lp up to December 2000. After that, there is no Granger causality again from Lm2 to Lp. We also found that the effectiveness of M2 has been decreasing. This evidence is discovered by regressing the log of coefficients of lagged Lm2, β_{2t}^{mp} [cf. eq. (4)], on a constant and a linear time trend. This regression result is given as follows:

$$\mathrm{Ln}(\beta_{2t}^{mp}) = 2.24 - 0.050*(\text{time trend}) + u_{2t},$$
$$(10.25) \quad (16.29)$$

Estimation period: January 1999 to June 2002, Adjust. $R^2 = 0.87$, $\sigma_{u2} = 0.24$, where t-values are given in the parentheses[3].

This regression implies that the effect of M2 measured by the coefficient of β_{2t}^{mp} is falling at the speed of 5% per month. Since the deflation in China began from February 1998 (see Fig 1), the results of M1 and M2 both indicate that the money is getting weaker and weaker impact on the price level in the deflation period.

The policy implication of our findings is that alternative policy such as the fiscal policy may be more useful in the deflation period due to the declining effectiveness of the monetary variables. This is consistent with the recent practice of the Chinese government emphasizing on an active fiscal policy to maintain the economy on a high growth track.

4. Conclusion

This paper formally investigates the effectiveness monetary variables in the two regimes of inflation and deflation, respectively. We applied the Granger causality test on the vector auto-regressive (VAR) models to achieve this objective. One of the biggest challenges in our research is frequent structural changes in the Chinese monetary system. This implies that both the lags and the parameters of the VAR model are not constant over time. Therefore we apply the surplus lag estimation recursively to conduct our Granger causality tests from money to price. The main findings of the paper are that money has become less effective to the price level in the deflation era started from 1998.[4] This conclusion is consistent with the recent development of the neo-Keynesian macroeconomic model which predicts that the monetary expansion is less effective in an environment of deflation. The policy implication is that money supply should not be considered as an effective monetary policy instrument to stabilize price level during the deflation periods in China. It provides some empirical evidence to support the Chinese government to adopt an alternative policy such as an active fiscal policy in the era of deflation.

Notes

1. Similar interpretation applies to the horizontal axis in all of the subsequent figures.
2. We chose the starting date of estimation as Jan. 1999 because the orders of all three VAR models (Lmj, Lp, Ly) (j=0,1,2) have been stabilized to one lag. This simplifies the measure of M1 to only the coefficient on the lag one of Lm1, i.e., β_{1t}^{mp} [cf. eq.(4)].
3. See note 2.
4. For the reverse Granger causality from inflation to money supply, see Sun and Ma (2004).

References

Barro, Robert J (1977) Unanticipated Money Growth and Unemployment in the United States, American Economic Review, 67(2), 101-115.

Chow, G C, and A L Lin (1971) Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series, Review of Economics and Statistics, 53(4), 372-376.

Clarida, R, Gali, J, and Gertler, M (2002) A simple framework for international monetary policy analysis, Journal of Monetary Economics, 49, 879-904.

Estrella, A and F S Mishkin (1997) Is There a Role for Monetary Aggregates in the Conduct of Monetary Policy?, Journal of Monetary Economics, 40(2), 279-304.

Friedman, B and K N Kuttner (1992) Money, Income, Prices, and Interest Rates, American Economic Review, 82(3), 472-92.

Granger (1996) Can We Improve the Perceived Quality of Economic Forecasts?, Journal of Applied Econometrics, 11(5), 455-73.

Johansen, Soren (1991) Estimation and Hypothesis-Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, Econometrica, 59(6), 1551-1580.

Liu, B (2001) Identification of monetary shock and empirical research, Journal of Financial Research, 253, 1-9 (in Chinese).

Lu, J and S Yuan (2002) Money neutrality in China, Economic Research Journal, No.3, pp.15-22 (in Chinese).

Lucas, Robert E, Jr (1972) Expectations and the Neutrality of Money, Journal of Economic Theory, 4(2), 103-124.

Lutkepohl, H (1993) Introduction to multiple time series analysis, Berlin: Springer-Verlag.

Lutkepohl, H, and M M Burda (1997) Modified Wald test under nonregular conditions, Journal of Econometrics, 78(2), 315-332.

Li, X and Y Ma (1996) Financial Reform and Regional Competition for Investment in China: A Game Theoretic Approach, Economics of Planning, 29, 117-130.

Ma, Y (2001) China's accession to the WTO: a financial economic analysis of an irreversible decision, Economic Research Journal, pp.9-16, No. 12, Beijing (in Chinese).

Ma, Y, Y Y Kueh, and S K Tsang (2002) The Impact of External Balance on Money Supply and Inflation in China, paper presented at the Second Biennial Conference of the Hong Kong Economic Association, Hong Kong Baptist University , 16-17 December 2002.

Ma, Y, S K Lee and H L Chan (2003) Estimating firm behavior under rationing: A panel data study of the Chinese manufacturing industry, Journal of Chinese Economic and Business Studies, 1, 221-244.

Mankiw, N G and D Romer (1991, ed) New Keynesian economics, Cambridge, Mass.: MIT Press.

Mishkin, Frederic S (1982) Does Anticipated Aggregate Demand Policy Matter?, American Economic Review, 1982, 72(4), 788-802.

Sargent, Thomas J and Neil Wallace (1975) 'Rational' Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule, Journal of Political Economy, 83(2), 241-254.

Sun, H (2000) The instrument of the monetary policy should be directed to the interest rate from the money supply, Economic Science, No.1, 13-19 (Peking University Press, in Chinese).

Sun, H and Y Ma (2003) Monetary Policy and Stock Market in China, Economic Research Journal, pp.44-53, No. 7, Beijing (in Chinese).

Sun, H and Yue Ma (2004) Money and Price Relationship in China, Journal of Chinese Economics and Business Studies, 2(3), 225 -247.

Sun, H and Y Ma (2005) Policy strategies to deal with revaluation pressures on the renminbi, China Economic Review, 16(2), 103 -117.

Svensson, L E O (2003) Escaping from a Liquidity Trap and Deflation: The Foolproof Way and Others, Princeton University, mimeo.

Swanson, N R (1998) Money and Output Viewed through a Rolling Window, Journal of Monetary Economics, 41, 455-73.

Tsang, S K, and Y Ma (1997) Simulating the Impact of Foreign Capital in an Open-Economy Macroeconometric Model of China, Economic Modelling, 14(3), 435-478.

Tsang, S K, and Y Ma (2000) The Integration of China and Hong Kong into the World Economy: a Prototype Global Econometric Model, Business Research Centre Discussion Paper No. CP 200007, Hong Kong Baptist University.

Tsang, S K, and Y Ma (2002) Currency substitution and speculative attacks on a currency board system, Journal of International Money and Finance, 21(1), 53-78.

Zapata, H O, and A N Rambaldi (1997) Monte Carlo Evidence on Cointegration and Causation, Oxford Bulletin of Economics and Statistics, 59(2), 285-98.

Zhao, Z, Y Ma, Y Y Kueh, S K Tsang, M S Yiu, and S Liu (2002) Banking Deregulation and Macroeconomic Impact in China: A Theoretical Analysis and Implications of WTO Accession to the Mainland and Hong Kong, Economic Research Journal, No.6, pp.15-22 (in Chinese).

Fig 1. Annual Inflation Rate (%)

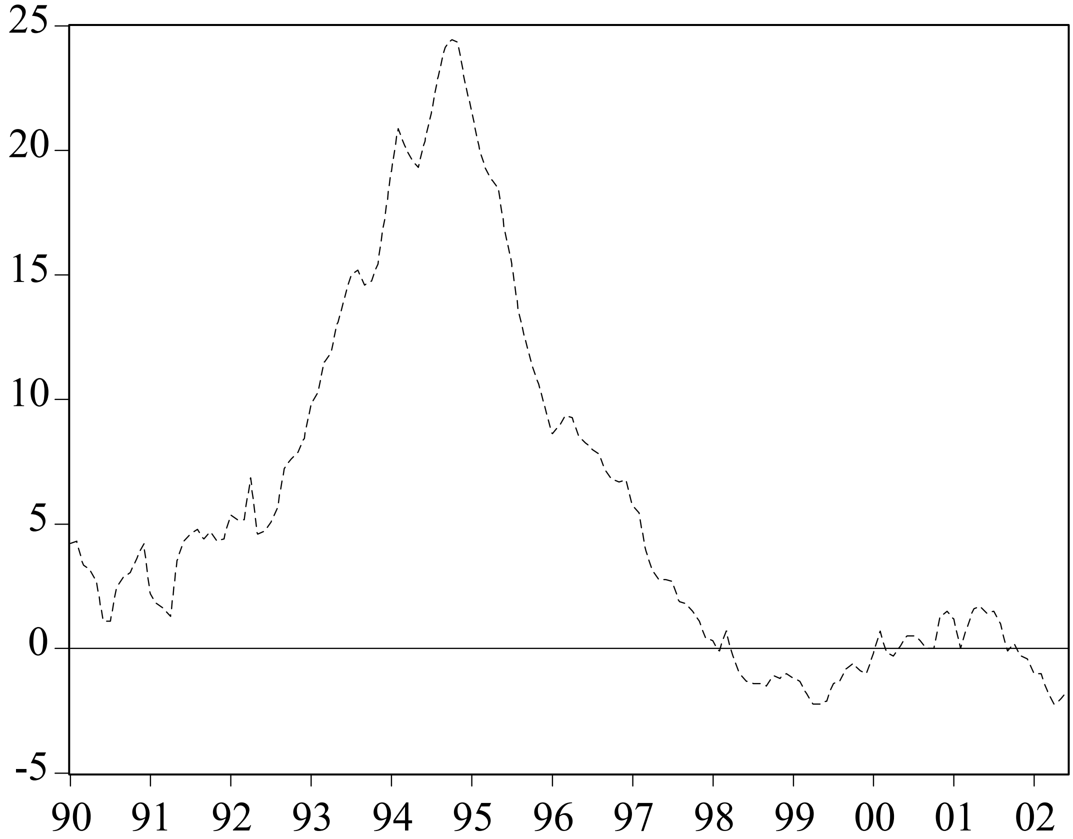


Fig 2a. Lags of VAR: (Lm0, Lp, Ly)

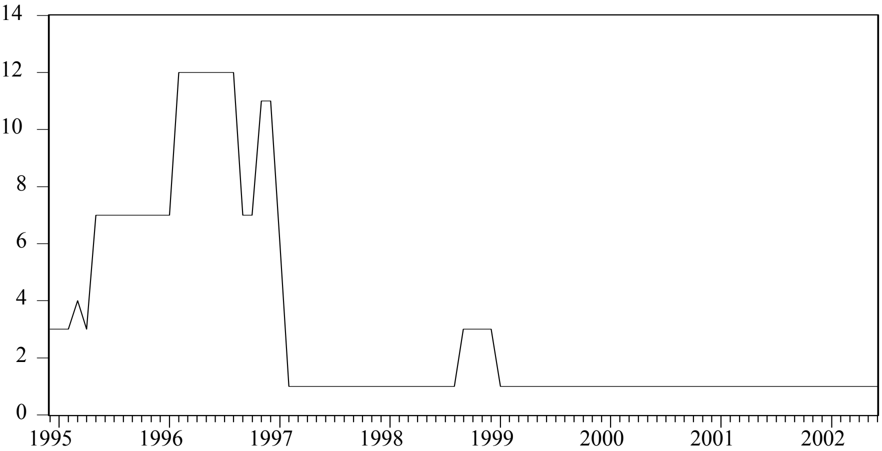


Fig 2b. Lags of VAR (Lm1, Lp, Ly)

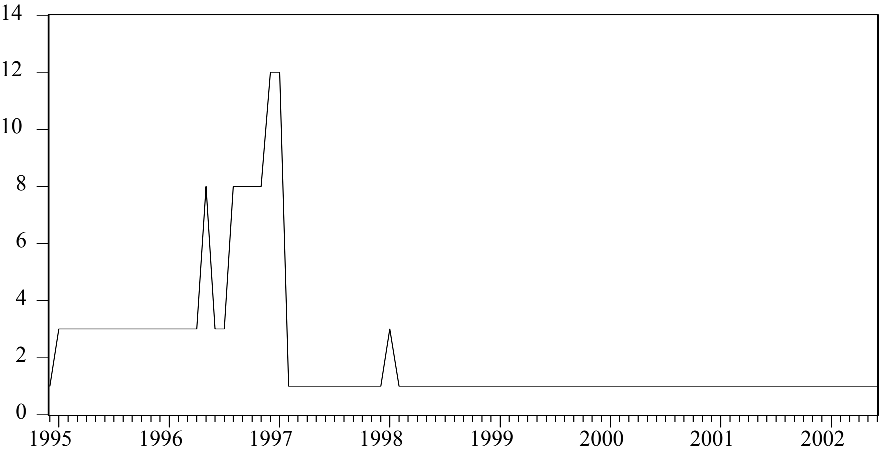


Fig 2c. Lags of VAR: (Lm2, Lp, Ly)

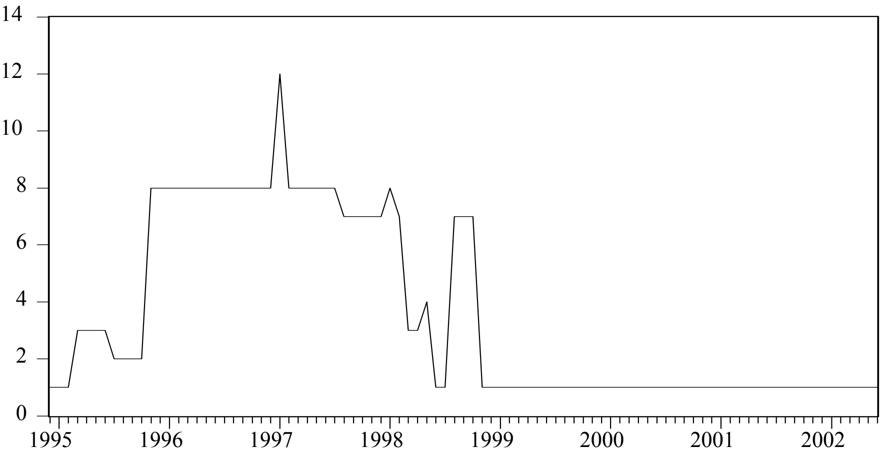


Fig 3. P-values of ADF and Phillips-Perron (PP) tests

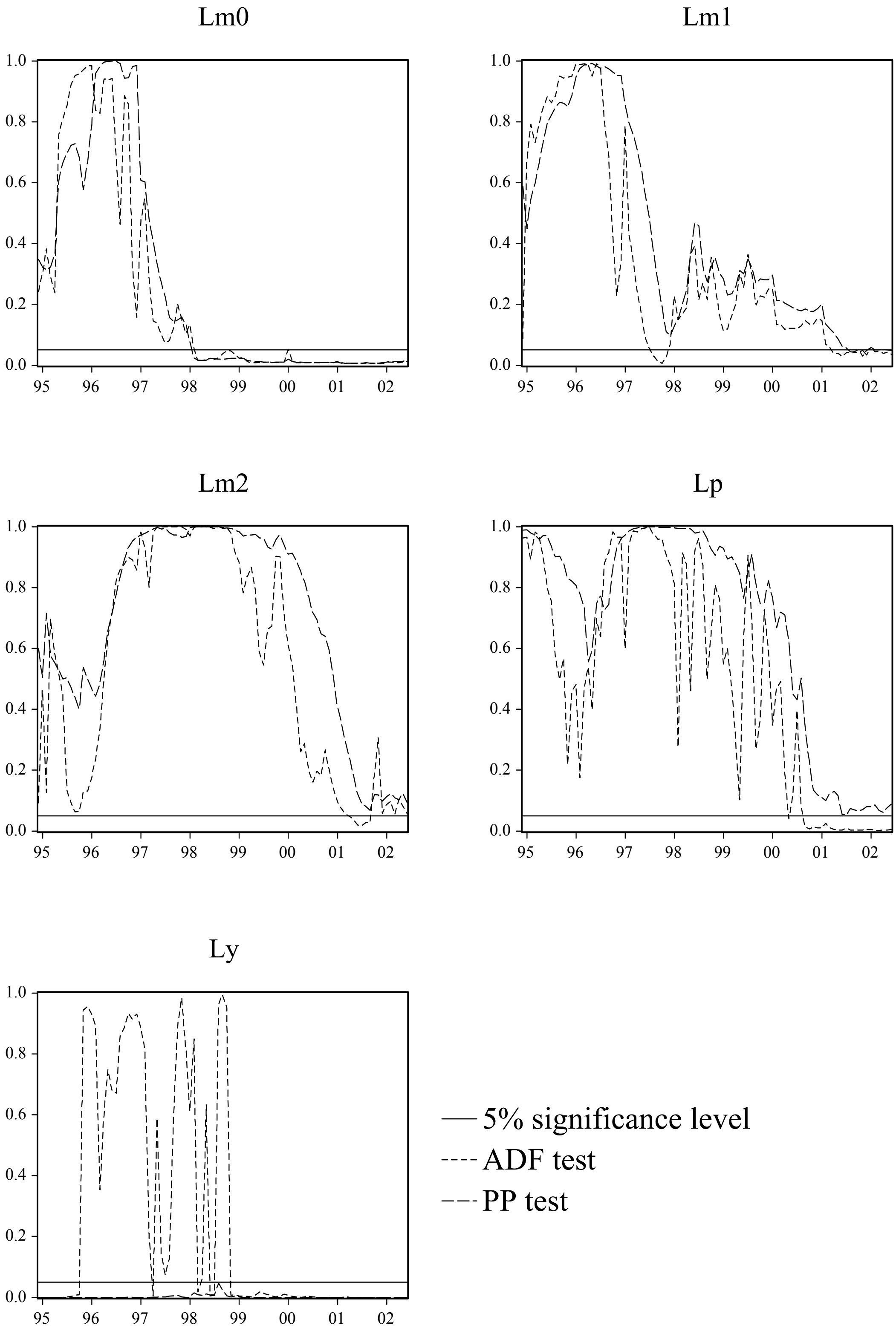
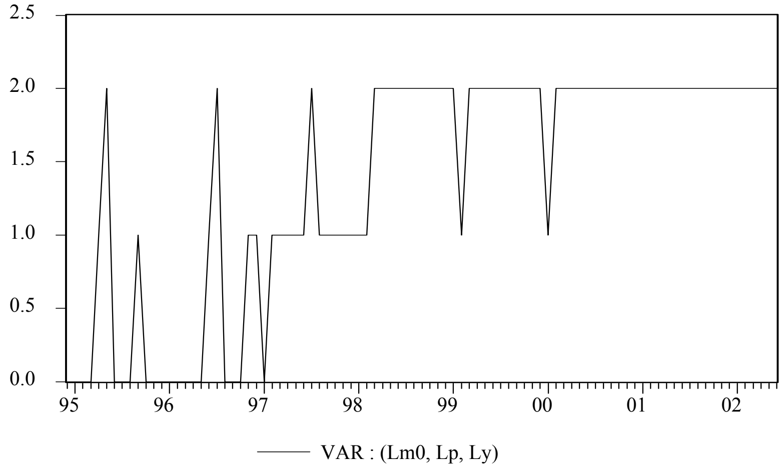
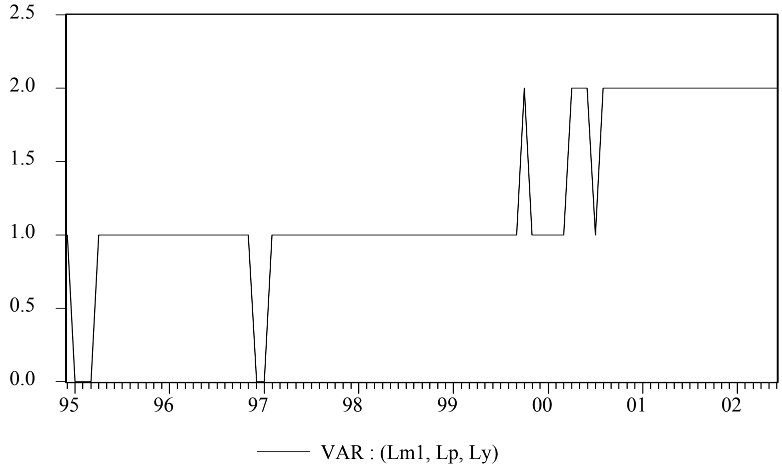


Fig 4. No. of cointegration vectors by
Johansen MLE of VAR (Lmj,Lp,Ly), j=0,1,2





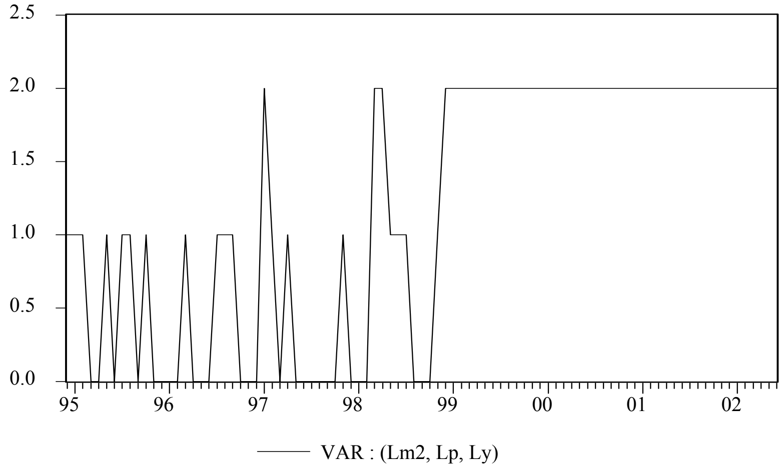


Fig 5. P-values of Granger causality test of Lmj => Lp (j=0,1,2)

Fig 5a. Lm0 => Lp

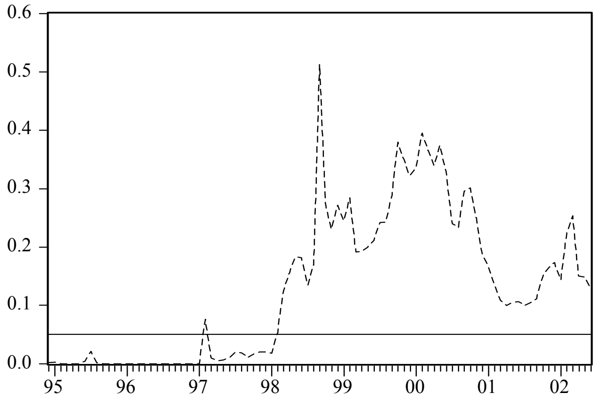


Fig 5b. Lm1 => Lp

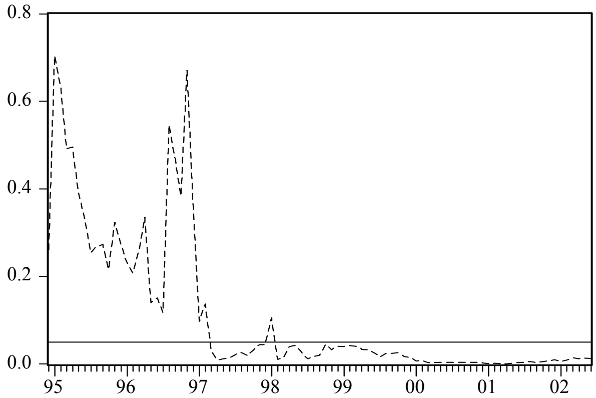
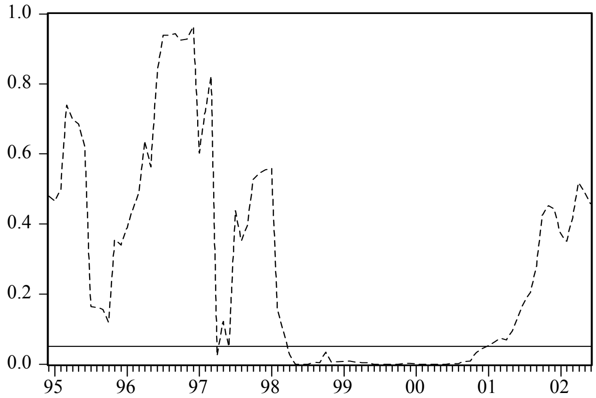


Fig 5c. Lm2 => Lp



— 5% significance level