# The Influence of Current Account Imbalance on Money and Price Stability in China*

**Yue Ma (馬躍)[a] and Shu-ki Tsang (曾澍基)[b]**

[a] Economics Dept, Lingnan University, Hong Kong
[b] Economics Dept, Baptist University, Hong Kong

18 September 2003

## Abstract

This paper focuses particularly on the impact of external balance on money supply and inflation in China. A four-sector equilibrium model that incorporates Chinese institutional features of the state-owned enterprises is built. Specifically, our model consists of an export sector and non-tradable goods sector, both with state-owned enterprises, a banking sector, and a household sector with those working for the export and non-tradable sectors respectively. We then test our main theoretical findings by a time-varying parameter VAR model with error-correction mechanism. An extended Kalman filter (Kim and Nelson, 1999) was applied to estimate the TV parameters of the model. Our new institutional modelling approach give more insight than the conventional constant-parameter-constant-structure econometric approach (see, for example, Tsang and Ma, 1997) for the policymakers. The main findings of the paper are that the external factors such as trade balance and exchange rate exert significant impact on the money supply and inflation in China, although there is no J-curve effect in China's current account. Whilst the real exchange rates create sizeable effects on both money supply and inflation in the short run, the external balance generates significant influence on those two same variables in the long run. The time-varying parameter (TVP) Vector Autoregressive (VAR) model also reveals that the continuous institutional reform in China played an significant role in determining the money supply and generating inflationary and recent deflationary pressures. This bears important policy implications. Since the short run and long run transmission mechanisms are quite different, the policy makers should understand them well before designing and implementing their economic reform packages. Especially given the fact that the external balance will take a long time to be effective to influence the domestic macroeconomic activities, the policy makers should bear in mind their lagged effects when they conduct the short run economic policies.

JEL codes:
F41 - Open Economy Macroeconomics,
O11 - Macroeconomic Analyses of Economic Development
O53 - Asia

Keywords: money supply, exchange rate, Kalman filter, China.

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* Corresponding author: Dr Yue Ma, Economics Department, Lingnan University, Tuen Mun, Hong Kong. Tel: (852) 2616 7202, fax: (852) 2891 7940, email: yuema@Ln.edu.hk, homepage: www.Ln.edu.hk/econ/staff/yuema. This is a pilot research project under the general theme of 'The Interplay of Internal and External Balances in the Chinese Economic Reform: Institutional Dimension and Long Term Implications for the Economic Stability of Hong Kong'. The authors are grateful for a Competitive Earmarked Research Grant (No. LU3110/03H) from the RGC of Hong Kong SAR Government and a research grant from Lingnan University, Hong Kong. Tang Wing Hin provided helpful research assistance.

## 1. Introduction

Since 1979, China has made substantial progress in its economic reforms, which has two major aspects: (1) the internal restructuring of the economy; and (2) the opening up of the economy to external trade and foreign investments. The results have been on the whole remarkable, particularly in overt comparison with the painful reform process of Russia and most of the East European countries.

It will be of considerable academic interest as well as policy importance to model the Chinese open economy from the perspective of the evolution of institutions. Macroeconometric modelling is now a popular art of studying Chinese economy. However, most of the existing literature is based on well-developed market behavioural theories with little consideration of institutional constraints, and is usually adopting a conventional constant-parameter-constant-structure econometric approach (for the recent examples, see Tsang and Ma, 1997 and Ma, Tsang and Tang, 1998).

This approach has both advantage and limitations. The advantage is that it gives a first approximation of the impact of economic reform on China. However, given the fact that the Chinese reform has generated significant changes in her institutions that is unique in the economic development history, using the traditional approach to model and evaluate its impact on both the internal and external balances of the Chinese economy would be clearly inadequate. Our new institutional modelling approach will give more insight than the conventional constant-parameter-constant-structure econometric approach for the policymakers.

Wang *et al*. (1993), for example, present in details about 20 econometric models of China operated by various government and research institutions, catering for different needs. Unfortunately, though, all these models use the so-called MPS (material production system) of national income accounting in their statistical formulation. As a traditional socialist mode based on orthodox Marxian principles of political economy, it differs significantly from the international convention of SNA (system of national accounting) and understates the output of the economy by neglecting "non-material" and "non-productive" activities.

The paper by Yu (1990) also falls into the same vein, using the MPS framework, and the analysis is overwhelmingly supply-side in nature. However, The LINK model as presented in Wang *et al*. (1993, chapter 4, pp.73-91) developed under the project coordinated by Lawrence Klein is a useful reference. Its specifications of the external sector leave ample room for experimentation and improvement.

Recently, there have been some rigorous macroeconometric modelling work on the Chinese economy (see, for example, Tsang and Ma, 1997). They have built a medium-sized econometric model using an approximated SNA database and with explicit emphasis on the importance of foreign investments. Their Chinese model takes into account the stylised facts of China's amazing progress in opening up to the rest of the world, and her particular links with Hong Kong[1]. As much as statistics can allow, it has gone significantly beyond the theoretical and empirical confines of the Chinese LINK model as reported by Wang *et al*. (1993).

[1] For a detailed econometric analysis of the economic integration of the Chinese economy with Hong Kong and the rest of the world, see Ma, Tsang and Tang (1998) and Tsang and Ma (2002). Whist Ma (2001b) contributes to the recent theoretical development on foreign direct investment (FDI), Tsang and Ma (1997) and Ma, Tsang and Tang (1998) provide the empirical evaluation of the impact of FDI on both economies of mainland China and Hong Kong. Ma and Tsang (2002) studied the relationship between the RMB and the Hong Kong dollar.

Moreover, Tsang and Ma (1997) have adopted more rigorous methods of estimation, including cointegration and error-correction techniques in so far as the theory as well as the data suggest desirable, in contrast to the rather casual OLS formulation used by most of the models presented in the book by Wang *et al* (1993). However, Tsang and Ma's approach is mainly concerned the economic integration between China and Hong Kong and is based on conventional constant-parameter-constant-structure econometric techniques.

Research based on institutional approach has been huge and wide ranged (see, for example, recent and relevant work by Naughton, 1995a,b). Sung (1991), Lardy (1992) and Ash and Kueh (1993) focused on the external effects of the Chinese economy. Lardy (1998) and Kueh, Chai and Fan (1999) concentrated on the internal banking and industrial sectors, respectively. However, most of these relevant literature are of a more descriptive nature. Theoretical work has been rare. For example, Li and Ma (1996) presented a theory of fiscal decentralisation resulted from the earlier stage of economic liberalisation to explain the provincial governments' influence on the local monetary authorities. Their model predicts theoretically that the subsequent financial reform to establish commercial banks will reduce inflation but generate excessive fiscal deficits and will lead to a large build-up in the stock of public debt.

There are also a number of works focused on the study of the money demand in China. For example, a recent paper by Xu (1998) looked at the demand side of the three disaggregate components of M2: currency, personal deposits, and institutional deposits. Ma (2002) focused on the relationship of the banking sector and the emerging hi-tech industry in Guangdon province in China. What seems to be lacking, and this prompts this research, is a coherent institutional macroeconomic framework to model the money supply and inflation in China, which has been increasingly influenced by the external factors.

In this paper, we develop a coherent institutional macroeconomic new framework to model the Chinese open economy and provide institutional policy analysis. We will also test our main theoretical findings by some advanced econometric techniques that are suitable to the topic we are studying.

The economic reform generates significant impact on both the internal and external sectors of the Chinese economy. There are basically three phases of reform in China since 1979. The first phase is for the period from 1979 to 1986. During this period, the responsibility system of the enterprises was introduced and the profit tax system established. This provided initial incentive and market mechanism to the state-owned enterprises (SOEs). The second phase is from 1987 to 1993 when the contract system was introduced widely and autonomous rights of management and production were established by the Enterprise Law.

However, dual price and dual exchange rate systems were still operating during this period. Enterprises still adopted a 'quota retention' system of which their exports were subject to the government' plan. Their imports were subject to the government approval, even though they have sufficient 'retained' foreign currencies to cover their import payments. In the third phase from 1994 to present, numerous reform packages have been introduced.

This paper will focus on the reform episode since 1994, i.e. the latest phase of reform. Around 1994, the reform of SOEs had been reached to a stage at which the SOEs had more freedom in the market and less control from the government. They began to pay tax instead of remitting profits to the government. The official exchange rate of Renminbi was devalued to the market levels. The enterprises had to settle their earned foreign exchanges with the state banks instead of retaining part of them. This provided a strong incentive for enterprises to earn foreign exchanges as they could convert them into Renminbi (RMB) at the market rate instead of the official rate.

However, this foreign currency settlement system increased a significant amount of government's foreign reserves when the Chinese trade surplus surges in 1994 due to the managed floating exchange rate policy adopted by the government (Tsang, 1994). As the money multiplier in China is quite high, the surge in foreign reserves, which is also part of the monetary base, generated a jump in inflation. Although the People's Bank of China conducted some sterilisation policies, the evidence was that their sterilisation was incomplete. As a result, inflation was out of control. The subsequent contractionary policies had successfully brought down the inflation, but they had probably overdone (Zhao, Ma, Kueh, Tsang, Yiu, and Liu, 2002).

Against the background of continued streamlining of SOEs and laying off their workers, they generated an uncertainty to the consumption. As the market discipline bit deeper into SOEs, the phenomenon of credit crunch appeared first time in the history of Chinese reform. Just adding salt to the wound, the Asian financial crisis depressed the demand for the Chinese goods[2]. Committed to a non-devaluation policy, the Chinese economy entered an unprecedented deflation era.

Clearly, it is necessary to have a new general framework to look at both the internal and external balance to understand the institutional changes in the Chinese economy. On the internal balance side, the SOEs have more autonomous rights of management and production than before and therefore are subject to more shocks from market fluctuations and business cycles. This makes the government more difficult to maintain the budget balance and to fine-tune the macroeconomy. On the external balance side, the convertibility of RMB on current account transactions was achieved in December 1996. This implies that firms of both public and private sectors can trade RMB to finance their foreign trade and services more easily than before. This makes the current account balance more difficult to maintain as it is subject to the fluctuations in domestic and foreign demands[3]. Existing literature focusing on either internal sector (see for example, Sung, 1991; Lardy, 1992; and Ash and Kueh, 1993), or external sector (e.g., Lardy, 1998 and Kueh, Chai and Fan, 1999) has limitations. This paper intends to bridge those two strands of literature and model rigorously the institutional transition process in China. It also intends to test our theoretical findings by some advanced econometric techniques such as time-varying parameter modelling (see, for example, Kim and Nelson, 1999) that are especially suitable to the topic we are studying.

## 2. A Chinese Open Economy Model

Specifically, a four-sector equilibrium model that incorporates Chinese institutional features of the state-owned enterprises will be built. The model consists of an export sector and non-tradable goods sector, both with state-owned enterprises, a banking sector, and a household sector for those working for the export and non-tradable sectors respectively. We assume there is always abundant labour in the Chinese state-owned enterprises (SOEs), so labour input in the production is exogenous. Due to space constraint, the private sector is not considered here but is left for the future research.

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[2] For research on speculative attacks on Asian currencies such as Hong Kong, see Ma, Meredith and Yiu (2002) and Tsang and Ma (2002).

[3] For a review of the recent literature on the relationship between exchange rates and the economic fundamentals, see Ma and Kanas (2000). Liu, Zhao, Ma, Yiu, Kueh, and Tsang (2002) examined the issue of achieving full convertibility for the Chinese currency Renminbi. Ma, Kueh and Ng (2002) analysed the sources of macroeconomic instability in Hong Kong under the fixed exchange rate regime.

### 2.1. The State-Owned Export Sector

The state-owned export sector produces only export goods (X), using both capital ($K_X$) and imported goods ($I_X$):

$$X = A_X(e_x).Q_X(K_X, I_X) = a_x.e_x^{\eta x}.\ K_X^{\alpha x}.I_X^{\beta x}$$

where $e_x$ is the effort of the workers in the SOE of the export sector including the effort put onto improving quality and increasing varieties of products. $A_X(.)=a_x.e_x^{\eta x}$ is the productivity of the firm.

We assume that SOE tries to maximise the after-tax income with minimum effort (Pan and Luo, 1993, McMillan, *et al*, 1989):

$$\pi_X = (1-\tau_x).s.p_x^*.X - r.K_X - s.p_I^*.I_X - e_x^{\theta x}/(\theta_X.\delta_X)$$

where $\tau_x$ is tax rate for the export sector, s is exchange rate, $p_x^*$ is the price of export goods in terms of foreign currency, r is interest rate, $p_I^*$ is the price of imported goods in terms of foreign currency, the term $e_x^{\theta x}/(\theta_X.\delta_X)$ is the disutility of efforts, with parameters of $\theta_X>1$ and $\delta_X>0$.

The Langranian of the problem is:

$$\Im_x=(1-\tau_x).s.p_x^*.a_x.e_x^{\eta x}.\ K_X^{\alpha x}.I_X^{\beta x} - r.K_X - s.p_I^*.I_X - e_x^{\theta x}/(\theta_X.\delta_X)$$

FOCs:

$$\partial\Im_x/\partial e_x = \eta_x.(1-\tau_x).s.p_x^*.a_x.e_x^{\eta x-1}.\ K_X^{\alpha x}.I_X^{\beta x} - e_x^{\theta x-1}/\delta_X = 0$$

Hence

$$e_x = [\delta_X.\eta_x.(1-\tau_x).s.p_x^*.X]^{1/\theta x} = [\delta_X.\eta_x.(1-\tau_x).s.p_x^*.a_x.Q_X]^{1/\theta x}$$

or,

$$e_x = [\delta_X.\eta_x.(1-\tau_x).s.p_x^*.a_x.K_X^{\alpha x}.I_X^{\beta x}]^{1/(\theta x-\eta x)}$$

$$\partial\Im_x/\partial K_X = \alpha_x.(1-\tau_x).s.p_x^*.a_x.e_x^{\eta x}.K_X^{\alpha x-1}.I_X^{\beta x} - r = 0$$

Hence

$$r.K_X = \alpha_x.(1-\tau_x).\ s.p_x^*.X$$

$$\partial\Im_x/\partial I_X = \beta_x.(1-\tau_x).s.p_x^*.a_x.e_x^{\eta x}.\ K_X^{\alpha x}.I_X^{\beta x-1} - s.p_I^* = 0$$

We have

$$s.p_I^*.I_X = \beta_x.(1-\tau_x).\ s.p_x^*.X$$

As a result, the after-tax labour income of the export sector ($w^X.L^X$) is given by:

$$w^X.L^X = (1-\tau_x).\ s.p_x^*.X - r.K_X - s.p_I^*.I_X = (1-\alpha_x-\beta_x).(1-\tau_x).\ s.p_x^*.X$$

### 2.2. The State-Owned Non-Tradable Goods Sector

The state-owned non-tradable goods sector produces only non-tradable goods ($Q_N$) using both capital ($K_N$) and the imported goods ($I_N$):

$$Q_N = A_N(e_n).Q(K_N, I_N) = a_n.e_n^{\eta n}.\ K_N^{\alpha n}.I_N^{\beta n}$$

where $e_n$ is the effort of the workers in the SOE of the non-tradable sector. $A_N(.)=a_n.e_n^{\eta n}$ is the productivity of the firm.

Similar to the SOE in the export sector, we assume that SOE in the non-tradable sector also tries to maximise the after-tax income with minimum effort:

$$\pi_N = (1-\tau_n).p_n.Q_N - r.K_N - s.p_I^*.I_N - e_n^{\theta n}/(\theta_N.\delta_N)$$

where $\tau_n$ is tax rate, r is interest rate, s is RMB exchange rate, $p_n$ is the price of non-tradable goods, $p_I^*$ is the price of imported goods in terms of foreign currency, the term $e_n^{\theta n}/(\theta_N.\delta_N)$ is disutility of efforts, with parameters of $\theta_N$ and $\delta_N$.

The Lagrangian of the problem is:

$$\Im_n=(1-\tau_N).p_n.a_n.e_n^{\eta n}.\ K_N^{\alpha n}.I_N^{\beta n} - r.K_N - s.p_I^*.I_N - e_n^{\theta n}/(\theta_N.\delta_N)$$

FOCs:

$$\partial\Im_n/\partial e_n = \eta_n.(1-\tau_n).p_n.a_n.e_n^{\eta n-1}.K_N^{\alpha n}.I_N^{\beta n} - e_n^{\theta n-1}/\delta_N = 0$$

Hence

$$e_n = [\delta_N.\eta_n.(1-\tau_n).p_n.a_n.K_N^{\alpha n}.I_N^{\beta n}]^{1/(\theta n-\eta n)} = [\delta_N.\eta_n.(1-\tau_n).p_n.a_n.Q]^{1/(\theta n-\eta n)}$$

$$\partial\Im_n/\partial K_N = \alpha_n.(1-\tau_n).p_n.a_n.e_n^{\eta n}.K_N^{\alpha n-1}.I_N^{\beta n} - r = 0$$

We have

$$r.K_N = \alpha_n.(1-\tau_n).p_n.Q_N$$

$$\partial\Im_n/\partial I_N = \beta_n.(1-\tau_n).p_n.a_n.e_n^{\eta n}.K_N^{\alpha n}.I_N^{\beta n-1} - s.p_I^* = 0$$

Hence

$$s.p_I^*.I_N = \beta_n.(1-\tau_n).p_n.Q_N$$

As a result, the after-tax labour income of the non-tradable sector ($w^N.L^N$) is given by:

$$w^N.L^N = (1-\tau_n).p_n.Q_N - r.K_N - s.p_I^*.I_N = (1-\alpha_n-\beta_n).(1-\tau_n).p_n.Q_N$$

### 2.3. The Household Sector

The household in the model maximises the following utility function with monetary service:

$$U^h = U(C_N^h, C_I^h, M^h/P) = \theta.[(C_N^h)^{\alpha}.(C_I^h)^{1-\alpha}]^{\beta}.(M^h/P)^{1-\beta}$$

subject to the budget constraint:

$$w^h.L^h - r.M^h/P = p_n.C_N^h + s.p_I^*.C_I^h + M^h/P$$

where superscript h=X,N is for households working for the export and non-tradable sectors respectively. $C_N$ and $C_I$ are consumption of the non-tradable and imported goods respectively. $P=\mu_n.p_n+\mu_I.p_I$ is the aggregate price level with $\mu_n+\mu_I=1$. $M^h/P$ are the real money balance held by the households from which they derive the utility. The cost of holding money is $r.M^h/P$. $w^h.L^h$ is the labour income of the household.

The Lagrangian of the problem is:

$$\Im = \theta.[(C_N^h)^{\alpha}.(C_I^h)^{1-\alpha}]^{\beta}.(M^h/P)^{1-\beta} - \lambda.(w^h.L^h - r.M^h/P - p_n.C_N^h - s.p_I^*.C_I^h - M^h/P)$$

FOCs are:

$$\partial\Im/\partial C_N^h = \alpha.\beta.(C_N^h)^{-1}.\theta.[(C_N^h)^{\alpha}.(C_I^h)^{1-\alpha}]^{\beta}.(M^h/P)^{1-\beta} - \lambda.p_n = 0$$

We have:

$$\alpha.\beta.U^h/C_N^h - \lambda.p_n = 0$$

$$\partial\Im/\partial C_I^h = (1-\alpha).\beta.(C_I^h)^{-1}.\theta.[(C_N^h)^{\alpha}.(C_I^h)^{1-\alpha}]^{\beta}.(M^h/P)^{1-\beta} - \lambda.s.p_I^* = 0$$

Hence

$$(1-\alpha).\beta.U^h/C_I^h - \lambda.s.p_I^* = 0$$

$$\partial\Im/\partial(M^h/P) = (1-\beta).(M^h/P)^{-1}.\theta.[(C_N^h)^{\alpha}.(C_I^h)^{1-\alpha}]^{\beta}.(M^h/P)^{1-\beta} - \lambda.(1+r) = 0$$

That is

$$(1-\beta).U^h/(M^h/P) - \lambda.(1+r) = 0$$

As a result, the demand for non-tradable, imported goods and real money balance are:

$$C_N^h = \alpha.\beta.w^h.L^h/p_n$$

$$C_I^h = (1-\alpha).\beta.w^h.L^h/(s.p_I^*)$$

$$M^h/P = (1-\beta).w^h.L^h/(1+r)$$

### 2.4. The Banking Sector

For the banking sector , a simplified balance sheet of the central bank is given by:

| **Assets** | **Liabilities** |
|---|---|
| Discount loans (L)<br>Government securities (B)<br>Foreign reserves ($R_f$) | Currency in circulation (Cu)<br>Bank reserves ($R_b$) |

The monetary base is:

$$H = Cu + R_b = L + B + R_f$$

Assume the money multiplier is $\phi$, we have the aggregate money supply:

$$M^s = \phi.H = \phi.(L+B+R_f)$$

We assume that the central bank tries to maintain a stable exchange rate of RMB, s. As a result, its foreign reserves ($R_f$) will rise or fall if there is a current account surplus or deficit.

$$R_f = R_f(-1) + CA + K_{inflow}$$

where $R_f(-1)$ is the foreign reserves in the last period, $K_{inflow}$ the net foreign capital inflow, and the current account CA is defined as:

$$CA = s.\, p_x^*.X - s.p_I^*.(I_N + I_X + C_I^X + C_I^N)$$

As a result, the aggregate money supply becomes:

$$M^s = \phi.(L+B+R_f)$$
$$= \phi.[L+B+R_f(-1) + K_{inflow} + s.\, p_x^*.X - s.p_I^*.(I_N + I_X + C_I^X + C_I^N)\ ]$$

### 2.5. Market Equilibrium Conditions

The export market equilibrium is determined by equalising the supply and demand of tradable goods:

$$X = \underline{X}(s, A_X(e_x))$$

where $\underline{X}(s, A_X(e_x))$ is the export demand of the international market. We assume that the Marshall-Learner condition holds, $\partial\underline{X}/\partial s > 0$, i.e. a devaluation will increase the exports, and that $\partial\underline{X}/\partial A_X > 0$, i.e. the export demands will rise if there is an improving quality and increasing varieties of its products. Therefore, we have

$$\partial\underline{X}/\partial e_x = (\partial\underline{X}/\partial A_X).(\partial A_X/\partial e_x) > 0.$$
$$\partial\underline{X}/\partial a_x = (\partial\underline{X}/\partial A_X).[(\partial A_X/\partial a_x) + (\partial A_X/\partial e_x).(\partial e_x/\partial a_x)] > 0.$$

The non-tradable goods market equilibrium is determined by equalising the supply and demand of non-tradable goods:

$$Q_N = C_N^X + C_N^N = (\alpha.\beta/p_n).(w^X.L^X + w^N.L^N)$$
$$= (\alpha.\beta/p_n).[(1-\alpha_x-\beta_x).(1-\tau_x).s.p_x^*.X + (1-\alpha_n-\beta_n).(1-\tau_n).p_n.Q_N]$$

Hence

$$Q_N^e = [\alpha.\beta.(1-\alpha_x-\beta_x).s.(p_x^*/p_n).(1-\tau_x).\underline{X}(s, A_X(e_x))]/[1-\alpha.\beta.(1-\alpha_n-\beta_n).(1-\tau_n)]$$

Money market equilibrium is determined by equating real money supply of the banking sector to real money demand of the household sector:

$$M^s/P = M^d/P$$

Hence

$$M^s/P = M^X/P + M^N/P = (1-\beta).(w^X.L^X + w^N.L^N)/(1+r) = p_n.Q_N^e.(1-\beta)/[\alpha.\beta.(1+r)]$$

and

$$\phi.[L+B+R_f(-1) + CA + K_{inflow}]/P$$
$$= [(1-\beta).(1-\alpha_x-\beta_x).s.p_x^*.(1-\tau_x).\underline{X}(s, A_X(e_x))]/\{[1-\alpha.\beta.(1-\alpha_n-\beta_n).(1-\tau_n)].(1+r)\}$$

### 2.6. Empirically Testable Hypotheses

#### 2.6.1. Effect of Devaluation

Holding aggregate price level constant, we have the effect of devaluation on the real money supply:

$$\partial(M^s/P)/\partial s = \phi.(\partial CA/\partial s)/P > 0$$

due to the Marshall-Learner condition.

Whilst the impact of depreciation on the real money demand is given by:

$$\partial(M^d/P)/\partial s = (M^d/P)/\underline{X}.[(\partial \underline{X}/\partial s) + (\partial \underline{X}/\partial e_x).(\partial e_x/\partial s)] > 0$$

due to the incentive mechanism from the institutional reform.

Hence, the effect of devaluation on the aggregate price level, P, depends upon the relative increase of real money supply and demand. If demand increases faster than the supply, the price will rise, i.e. inflationary effect. Otherwise, there will be deflationary effect. To conclude, we can decompose the total effect of devaluation on the aggregate price level:

$$\partial P/\partial s = (\partial M^s/\partial s)/(M^d/P) - P.[(\partial M^d/P)/\partial s]/(M^d/P)$$

into two components. The first one is the supply factor:

$$(\partial M^s/\partial s)/(M^d/P) > 0$$

which gives inflationary pressure. The second one is the demand factor:

$$- P.[(\partial M^d/P)/\partial s]/(M^d/P) < 0$$

which produces deflationary effect. The demand and supply effects offset each other and make the net effect on inflation ambiguous.

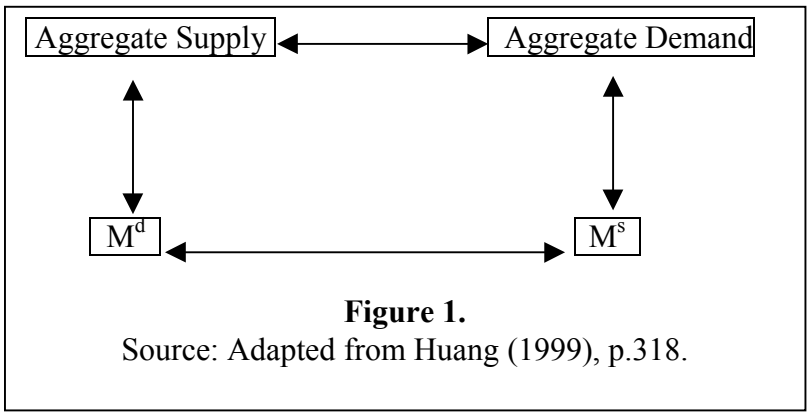


**Figure 1.**
Source: Adapted from Huang (1999), p.318.

### 2.6.2. Effect of Institutional Reform

We have assumed that:

$$\partial \underline{X}/\partial a_x = (\partial \underline{X}/\partial A_X).[(\partial A_X/\partial a_x) + (\partial A_X/\partial e_x).(\partial e_x/\partial a_x)] > 0.$$

Now we look at the effect of an increase $a_x$ resulted from institutional reform.
The impact on the real money demand is given by:

$$\partial(M^d/P)/\partial a_x = (M^d/P)/\underline{X}.(\partial \underline{X}/\partial a_x) > 0$$

However, holding aggregate price level constant, the effect on the real money supply

$$\partial(M^s/P)/\partial a_x = \phi.(\partial CA/\partial a_x)/P$$

is ambiguous. This is because an increase in the incentive due to the institutional reform raises both exports and imports.

As a result, the effect on the aggregate price level, P, remains ambiguous:

$$\partial P/\partial a_x = (\partial M^s/\partial a_x)/(M^d/P) - P.[(\partial M^d/P)/\partial a_x]/(M^d/P)$$

If $a_x$ increase would reduce money supply due to current account deficit, it would generate a deflationary effect, *ceteris paribus*. However, if the institutional reform creates a huge current account surplus, is would be very likely to produce an inflationary effect.

From the equilibrium solution of the model, we can derive three empirically testable hypotheses:
(1) Is there a J-curve effect for China's current account?

(2) What were the effects of the devaluation of RMB in 1994 on money supply and inflation in China?
(3) To what extent can the money growth and inflation be attributed to the institutional reform in China?

## 3. A Time-Varying Parameter Model of the Chinese Open Economy

In this section, we apply a time-varying parameter (TVP) model to estimate the impact of the external balance on money supply and inflation in China. The theoretical model built in the previous section has investigated transmission mechanisms in detail. These channels of transmission can be estimated by the well-established vector autoregressive (VAR) model (see, for example, Bernanke and Blinder 1992, Blanchard and Quah 1989 and 1993, Bernanke and Mihov 1998, Sims and Zha 1999, Clarida, Gali and Gertler 1999, Heckman 2000, Stock and Watson 2001).

However, most of the literature that utilized the VAR analysis are based on the assumption of fixed parameter. Given the fact that the Chinese economic reform is progressive that involves structural changes continuously, the VAR model with fixed-parameter clearly is inadequate to serve for our purpose. Therefore, we utilized a time-varying parameter (TVP) VAR model in this paper for our empirical analysis. This approach has been utilized by Song, *et al* (1996) to study a single equation model of the consumption behavior in China. Rockinger and Urga (2000) also applied a single equation with time-varying parameters to test the efficiency of the Czech and Polish stock markets. Our TVPVAR approach extends their single-equation method to the multi-equation context.

### 3.1. A time-varying parameter (TVP) VAR model

To focus on the relationship among external balance, money supply, and inflation, we select three representative indicator variables plus an exogenous variable to form our VAR model. The three indicator variables are: trade balance (TB), log of real $M_1$ ($\log RM_1$), and log of consumer price index (logP). The exogenous variable is log of effective nominal exchange rate (logEXR). As most of the macroeconomic time series are nonstationary, it is necessary to parameterize our TVPVAR model into the first-difference form with an error-correction term. It can be conveniently written in the state-space format as follows:

$$\Delta X_t = \sum_{i=1}^{q} A_{i,t} [\Delta X_{t-i}', \Delta \log EXR_{t-i}]' - \alpha_t A_{0,t} [X_{t-p}', \log EXR_{t-p}]' + \varepsilon_t \qquad (1)$$

$$\alpha_t = \alpha_{t-1} + \nu_t \qquad (2)$$

$$A_{i,t} = A_{i,t-1} + \eta_t \qquad (i=0,1,2,\ldots,q) \qquad (3)$$

where $\Delta X_t = X_t - X_{t-1}$,

$X_t = (TB, \log RM_1, \log P)'_t$

$\varepsilon_t = (\varepsilon_t^{TB}, \varepsilon_t^{RM1}, \varepsilon_t^{P})'$, $\varepsilon_t \sim N(0, \sigma_\varepsilon^2 I_3)$, …

$\nu_t = (\nu_t^{TB}, \nu_t^{RM1}, \nu_t^{P})'$, $\nu_t \sim N(0, \sigma_\nu^2 I_3)$, …

$\eta_t = (\eta_t^{TB}, \eta_t^{RM1}, \eta_t^{P})'$, $\eta_t \sim N(0, \sigma_\eta^2 I_3)$, …

The parameter matrices $A_{i,t}$ ($i \neq 0$) give the *short-run effects* of the explanatory variables on the dependent variable.

If some of the variables in $X_t$ and $\log EXR_t$ are cointegrated, then the adjustment parameter vector of the error-correction term $\alpha_t \neq 0$. In this case, the parameter matrix $A_{0,t}$ (in which the diagonal elements are normalized to unity) is the cointegation matrix which provides the *long-run effects* of the explanatory variables on the dependent variable. It is expected that $\alpha_t < 0$, since

the error-correction mechanism makes sure that the system will stay at the long-run relationship given by the matrix $A_{0,t}$. If none of the variables in $X_t$ cointegrates, then $\alpha_t = 0$ and we are left with a standard VAR in the first-difference of $X_t$ (Johansen, 1991).

A random walk specification is chosen for the time-varying parameters. This implies that the shocks to the random parameters $A_{i,t}$ have permanent effect. Since we interpret the changes in the parameters as the structural changes, the random walk parameter assumption is a good approximation to the structural changes.

A Kalman filter developed by Kalman (1960) and recently extended by Kim and Nelson (1999) can be applied to estimate the TV parameters $A_{i,t}$.

### 3.2. Estimation results

We utilize monthly data ranging from January 1990 to June 2000 to estimate our time-varying parameter VAR model. The data source of money supply of $M_1$ comes from The Peoples's Bank of China Quarterly Statistical Bulletin. Trade balance and consumer price index (CPI) both are from the IMF's International Financial Statistics (IFS). The effective exchange rate index is constructed as trade-weighted RMB spot rates of China's major trading partners at the end of the month, which include US, Germany, Japan, Hong Kong, Taiwan, and South Korea. All the spot rates come from the CEIC, except RMB/USD which comes from the IFS of the IMF.

Augmented Dickey-Fuller (ADF) tests were first performed to investigate the stationarity of these 4 time series of logTB, log$RM_1$, logP and logEXR. The results indicated that all the time series are integrated of order one, I(1) (see Table 1a).

A Kalman filter is applied to estimate the TV parameters $A_{i,t}$ of the VAR model (1) and (2). Following the 'simplicity postulate' of Zellner (1988), we select the order of the VAR and the lag of the error-correction term both to be 1, i.e. q=p=1 in equations (1). ADF tests are applied again to test the stationarity of the residuals and the error-correction terms of each equation. Table 1b indicates that all the residuals and the error-correction terms are stationary. It implies that the 4 time series of logTB, log$RM_1$, logP and logEXR are indeed cointegrated and there exists a long-run relationship among them.

Table 2 presents the estimated adjustment parameters $\alpha_t$ of equation (1). It shows that the adjustment parameters in all of the three equations are negative and are significant at the 5% level. This implies that the Chinese system has the error-correction mechanism to restore the long-run equilibrim, although that long-run relationship and the adjustment speed are both time-varying due to the continuous economic reform implemented by the Chinese government.

The estimated time-varying parameters of each equation of the VAR model are reported in Table 3 with p-values in parentheses. Due to space constraint, we only report selectively the estimation results in March, June, September and December of each year. Initial values of the parameters are estimated by some of the observations at the beginning of the sample.

Table 3a shows the impact of the real money supply, price level, and effective exchange rate on the trade balance. It is quite noticeable that all parameters have been changing continuously, although their signs remain consistent for most of the time. This indicates the importance of the structural changes in our analysis. The short-run impact of money supply on the trade balance is negative but insignificant at the 5% level. However, its impact becomes positive since December 1999. In the long run, most of its negative impacts have remained insignificant until September 1999. Its negative long-term impacts become significant at the 5% level after September 1999.

This was expected because an increase in real money supply would increase the demand for both domestically and foreign produced goods. That would reduce the trade surplus of China.

Whilst the impact of effective exchange rate exhibits the *nominal* effect on the trade balance, the joint impact of effective exchange rate *and* price level indicate the *real* exchange rate effect. Table 3a shows that the nominal exchange rate has no significant impact on the trade balance in both the short run and the long run. However, the price level has significant negative impact on the trade balance in the short run. This implies that there is no J-curve effect in China. This empirical evidence is consistent with the findings by Cerra and Dayal-Gulati (1999).

Table 3b presents the time-varying parameter estimates for the real $M_1$ equation. Both nominal and real effective exchange rates have significant negative impact on the money supply in the short run. It implies that either a nominal or real appreciation of RMB would reduce real money supply. This is consistent with the transmission channel of our theoretical model in the previous section. An appreciation of RMB would reduce trade surplus, which, in turn, would reduce foreign reserves. As a consequence, the money supply would fall.

The trade balance does not show any significant impact on the money supply in the short run. However, it exerts significant *positive* impact on money supply in the long run during the periods of June 1993 to March 1994, and June 2000. Again, this can be explained by the foreign reserves transmission channel. An increase of trade surplus would increase the foreign reserves, which in turn would raise the money supply eventually.

In addition, the trade balance exhibits some significant *negative* impacts on the real money supply in the long run during the period of December 1994 to June 1995, and September 1996 to June 1999. The latter period was the deflation era in China whilst the trade balance was in surplus. The negative impact can be expounded via the demand transmission channel of our previous theoretical model. An increase of trade surplus indicates a weakening of domestic demand, which in turn would reduce both demand and supply of money.

Finally, Table 3c shows the Kalman filter estimation of the price equation. It indicates that all three explanatory variables are only significant in the long run. An increase in money supply would increase the long run price level significantly at the 5% level. An appreciation of RMB would reduce the long run price level during the period of post exchange rate reform, i.e. March 1993 to June 2000.

An increase of the trade surplus would *increase* the long run price level during the periods of September 1994 to December 1995, June 1996 to December 1996, and March 1993 to June 2000. The transmission channel of foreign reserves may shed some light on this effect. An increase of trade surplus would increase the foreign reserves, which in turn would increase the money supply. As a result, the price level would increase in the long run.

However, Table 3c also indicates that the trade surplus produced some significant *negative* impacts on the price level during the periods of March 1992 to June 1994, March 1996 alone, and March to December 1997. This may be elucidated by the demand transmission channel from our theoretical model. If an increase of trade surplus indicates a fall of domestic demand, then the price level also would fall in the long run.

## 4. Conclusion

In this paper, we first develop a coherent institutional macroeconomic new framework to model the state-owned enterprises. We focus particularly on the impact of external balance on money supply and inflation in China. A four-sector equilibrium model that incorporates Chinese

institutional features of the state-owned enterprises is built. Specifically, our model consists of an export sector and non-tradable goods sector, both with state-owned enterprises, a banking sector, and a household sector with those working for the export and non-tradable sectors respectively. Due to space constraint, the private sector is not considered but is left for the future research.

We then test our main theoretical findings by a time-varying parameter VAR model with error-correction mechanism. An extended Kalman filter (Kim and Nelson, 1999) was applied to estimate the TV parameters of the model. Our new institutional modelling approach give more insight than the conventional constant-parameter-constant-structure econometric approach (see, for example, Tsang and Ma, 1997) for the policymakers.

The main findings of the paper are that the external factors such as trade balance and exchange rate exert significant impact on the money supply and inflation in China, although there is no J-curve effect in China's current account. Whilst the real exchange rates create sizeable effects on both money supply and inflation in the short run, the external balance generates significant influence on those two same variables in the long run. The time-varying parameter (TVP) Vector Autoregressive (VAR) model also reveals that the continuous institutional reform in China played an significant role in determining the money supply and generating inflationary and recent deflationary pressures.

This bears important policy implications. Since the short run and long run transmission mechanisms of the extyernal factors are quite different, the policy makers should understand them well before designing and implementing their economic reform packages. Especially given the fact that the external balance will take a long time to be effective to influence the domestic macroeconomic activities, the policy makers should bear in mind their lagged effects when they conduct the short run economic policies.

**Table 1a. Augmented Dicky-Fuller unit root tests of time series**

| Variable name | $H_0$: I(1) level | $H_0$: I(2) 1st difference | Conclusion |
|---|---|---|---|
| TB (trade balance) | -2.55435 | -4.44311** | I(1) |
| LogRM1 (real money supply M1) | -1.48111 | -3.82184** | I(1) |
| LogP (price level) | -1.32276 | -4.46727** | I(1) |
| LogEXR (effective exchange rate) | -1.73730 | -4.92930** | I(1) |

NB: 1) ** denotes rejection of the null hypothesis at the 5% significance level. 2) The definition of the variables are given in eq. (1) in the main text.

**Table 1b. Augmented Dicky-Fuller unit root tests of residuals and error-correction term**

| | $H_0$: I(1) level | Conclusion |
|---|---|---|
| Residuals ($\varepsilon_t$) of: | | |
| Trade balance ($\Delta$TB) equation | -4.02476** | I(0) |
| Real money supply M1 ($\Delta$LogRM1) equation | -4.85243** | I(0) |
| Price ($\Delta$LogP) equation | -4.63468** | I(0) |
| Error-correction term, $A_{0,t}\,[X_{t-p}', \log EXR_{t-p}]'$, in: | | |
| Trade balance ($\Delta$TB) equation | -7.25982** | I(0) |
| Real money supply M1 ($\Delta$LogRM1) equation | -4.86562** | I(0) |
| Price ($\Delta$LogP) equation | -6.70700** | I(0) |

NB: 1) ** denotes rejection of the null hypothesis at the 5% significance level. 2) The definition of the variables are given in eq. (1) in the main text.

**Table 2. Estimated adjustment parameters of the error-correction terms in the three equations**

| Date | Trade balance (△TB) equation | Real money supply (△LogRM1) equation | Price (△logP) equation |
|---|---|---|---|
| 1992.03 | -2.14 (0.11) | -0.008 (0.15) | -0.67 (0.00) |
| 1992.06 | -1.83 (0.21) | -0.010 (0.03) | -0.67 (0.00) |
| 1992.09 | -1.85 (0.21) | -0.014 (0.02) | -0.67 (0.00) |
| 1992.12 | -2.14 (0.06) | -0.018 (0.00) | -0.66 (0.00) |
| 1993.03 | -1.60 (0.20) | -0.017 (0.00) | -0.64 (0.00) |
| 1993.06 | -1.65 (0.18) | -0.028 (0.00) | -0.64 (0.00) |
| 1993.09 | -1.37 (0.26) | -0.033 (0.00) | -0.64 (0.00) |
| 1993.12 | -1.76 (0.22) | -0.039 (0.00) | -0.61 (0.00) |
| 1994.03 | -2.71 (0.01) | -0.036 (0.00) | -0.57 (0.00) |
| 1994.06 | -2.97 (0.01) | -0.042 (0.00) | -0.56 (0.00) |
| 1994.09 | -2.74 (0.02) | -0.049 (0.00) | -0.55 (0.00) |
| 1994.12 | -2.55 (0.03) | -0.055 (0.00) | -0.54 (0.00) |
| 1995.03 | -2.07 (0.03) | -0.056 (0.00) | -0.55 (0.00) |
| 1995.06 | -2.22 (0.06) | -0.062 (0.00) | -0.54 (0.00) |
| 1995.09 | -1.89 (0.08) | -0.066 (0.00) | -0.54 (0.00) |
| 1995.12 | -2.05 (0.10) | -0.069 (0.00) | -0.54 (0.00) |
| 1996.03 | -2.46 (0.06) | -0.071 (0.00) | -0.53 (0.00) |
| 1996.06 | -2.54 (0.07) | -0.074 (0.00) | -0.53 (0.00) |
| 1996.09 | -1.84 (0.15) | -0.074 (0.00) | -0.53 (0.00) |
| 1996.12 | -1.96 (0.11) | -0.076 (0.00) | -0.53 (0.00) |
| 1997.03 | -1.28 (0.22) | -0.069 (0.00) | -0.53 (0.00) |
| 1997.06 | -1.46 (0.18) | -0.068 (0.00) | -0.53 (0.00) |
| 1997.09 | -1.52 (0.19) | -0.071 (0.00) | -0.53 (0.00) |
| 1997.12 | -1.51 (0.21) | -0.068 (0.00) | -0.53 (0.00) |
| 1998.03 | -1.84 (0.08) | -0.075 (0.00) | -0.53 (0.00) |
| 1998.06 | -2.26 (0.06) | -0.073 (0.00) | -0.53 (0.00) |
| 1998.09 | -2.53 (0.05) | -0.071 (0.00) | -0.53 (0.00) |
| 1998.12 | -2.41 (0.08) | -0.073 (0.00) | -0.53 (0.00) |
| 1999.03 | -2.51 (0.06) | -0.074 (0.00) | -0.53 (0.00) |
| 1999.06 | -2.95 (0.02) | -0.071 (0.00) | -0.53 (0.00) |
| 1999.09 | -3.08 (0.00) | -0.071 (0.00) | -0.53 (0.00) |
| 1999.12 | -3.24 (0.01) | -0.070 (0.00) | -0.53 (0.00) |
| 2000.03 | -3.20 (0.01) | -0.072 (0.00) | -0.53 (0.00) |
| 2000.06 | -3.46 (0.01) | -0.070 (0.00) | -0.54 (0.00) |

Note: (1) p-values are in parentheses. (2) Adjustment parameters are the elements in the vector $\alpha_t$ of equation (1) in the main text.

**Table 3a. Estimated time-varying parameters of trade balance (ΔTB) equation**

| | Real money supply | | Price level | | Effective exchange rate | |
|---|---|---|---|---|---|---|
| | △log(RM1) | log(RM1) | △log(P) | log(P) | △log(EXR) | log(EXR) |
| Date | short run | long run | short run | long run | short run | long run |
| 1992.03 | -33.20 (0.48) | 0.35 (0.03) | -485 (0.00) | 37.0 (0.96) | 3.24 (0.89) | 8.98 (0.97) |
| 1992.06 | -22.40 (0.62) | 0.24 (0.17) | -460 (0.00) | 44.8 (0.98) | 3.56 (0.87) | 10.50 (0.97) |
| 1992.09 | -22.30 (0.60) | 0.20 (0.29) | -460 (0.00) | 44.4 (0.97) | 3.60 (0.87) | 10.50 (0.97) |
| 1992.12 | -21.80 (0.60) | 0.01 (0.93) | -459 (0.00) | 37.7 (0.95) | 3.12 (0.88) | 9.93 (0.95) |
| 1993.03 | -32.10 (0.40) | -0.30 (0.52) | -480 (0.00) | 48.0 (0.98) | 0.10 (1.00) | 14.80 (0.97) |
| 1993.06 | -23.60 (0.50) | -0.42 (0.34) | -463 (0.00) | 46.8 (0.98) | 1.17 (0.95) | 14.40 (0.96) |
| 1993.09 | -17.40 (0.61) | -1.09 (0.27) | -450 (0.00) | 56.0 (0.99) | 0.75 (0.97) | 18.60 (0.97) |
| 1993.12 | -10.40 (0.75) | -1.34 (0.30) | -438 (0.00) | 42.9 (0.98) | 1.85 (0.92) | 15.20 (0.96) |
| 1994.03 | -11.10 (0.72) | -1.07 (0.00) | -434 (0.00) | 33.4 (0.87) | 10.00 (0.44) | 0.87 (0.97) |
| 1994.06 | -6.18 (0.83) | -1.01 (0.01) | -424 (0.00) | 30.8 (0.86) | 11.70 (0.34) | 0.71 (0.97) |
| 1994.09 | -6.42 (0.83) | -1.06 (0.03) | -423 (0.00) | 33.4 (0.89) | 10.30 (0.39) | 0.89 (0.97) |
| 1994.12 | -7.05 (0.81) | -1.26 (0.13) | -424 (0.00) | 35.3 (0.91) | 8.87 (0.45) | 1.05 (0.97) |
| 1995.03 | -9.63 (0.73) | -1.48 (0.32) | -428 (0.00) | 43.2 (0.92) | 7.85 (0.50) | 1.51 (0.97) |
| 1995.06 | -7.99 (0.77) | -1.67 (0.31) | -424 (0.00) | 40.2 (0.93) | 7.35 (0.52) | 1.84 (0.96) |
| 1995.09 | -8.69 (0.75) | -2.59 (0.39) | -425 (0.00) | 46.6 (0.95) | 7.07 (0.53) | 1.87 (0.97) |
| 1995.12 | -9.20 (0.74) | -2.56 (0.40) | -425 (0.00) | 42.8 (0.95) | 7.11 (0.52) | 1.68 (0.97) |
| 1996.03 | -5.70 (0.83) | -2.25 (0.18) | -418 (0.00) | 35.9 (0.93) | 7.29 (0.51) | 1.36 (0.96) |
| 1996.06 | -5.71 (0.83) | -2.23 (0.26) | -418 (0.00) | 34.8 (0.93) | 7.29 (0.50) | 1.29 (0.96) |
| 1996.09 | -5.80 (0.82) | -2.90 (0.61) | -417 (0.00) | 48.2 (0.97) | 7.24 (0.50) | 1.89 (0.97) |
| 1996.12 | -6.34 (0.80) | -2.82 (0.55) | -418 (0.00) | 45.2 (0.96) | 7.30 (0.49) | 1.70 (0.97) |
| 1997.03 | -15.50 (0.47) | -4.17 (0.79) | -435 (0.00) | 68.1 (0.98) | 6.17 (0.55) | 2.64 (0.98) |
| 1997.06 | -16.70 (0.43) | -3.70 (0.75) | -435 (0.00) | 60.6 (0.98) | 6.04 (0.56) | 2.36 (0.97) |
| 1997.09 | -14.70 (0.47) | -3.59 (0.75) | -430 (0.00) | 58.2 (0.98) | 6.33 (0.53) | 2.13 (0.97) |
| 1997.12 | -14.40 (0.47) | -3.82 (0.78) | -429 (0.00) | 58.8 (0.98) | 6.14 (0.54) | 1.77 (0.98) |
| 1998.03 | -12.20 (0.52) | -2.83 (0.55) | -425 (0.00) | 48.2 (0.95) | 5.72 (0.56) | 2.32 (0.95) |
| 1998.06 | -7.74 (0.68) | -2.34 (0.43) | -412 (0.00) | 40.1 (0.94) | 4.90 (0.62) | 1.90 (0.94) |
| 1998.09 | -8.40 (0.65) | -1.95 (0.34) | -412 (0.00) | 35.8 (0.93) | 4.32 (0.66) | 1.78 (0.93) |
| 1998.12 | -7.97 (0.66) | -2.19 (0.38) | -411 (0.00) | 37.7 (0.94) | 4.53 (0.64) | 1.97 (0.93) |
| 1999.03 | -7.62 (0.67) | -2.21 (0.33) | -410 (0.00) | 36.2 (0.93) | 4.43 (0.64) | 1.88 (0.92) |
| 1999.06 | -6.46 (0.72) | -2.06 (0.10) | -407 (0.00) | 31.3 (0.89) | 4.56 (0.63) | 1.53 (0.91) |
| 1999.09 | -2.71 (0.88) | -1.65 (0.02) | -393 (0.00) | 30.7 (0.81) | 4.46 (0.65) | 1.37 (0.92) |
| 1999.12 | 1.02 (0.95) | -1.62 (0.03) | -383 (0.00) | 29.6 (0.84) | 4.86 (0.62) | 1.27 (0.92) |
| 2000.03 | 1.48 (0.93) | -1.69 (0.03) | -382 (0.00) | 29.9 (0.86) | 4.89 (0.61) | 1.28 (0.92) |
| 2000.06 | 2.40 (0.89) | -1.58 (0.02) | -380 (0.00) | 27.9 (0.82) | 5.21 (0.58) | 1.15 (0.91) |

Note: (1) p-values are in parentheses. (2) Short-run parameters are the elements in the matrix $A_{i,t}$ ($i \neq 0$) of equation (1) in the main text. Long-run parameters are the elements in the matrix $A_{0,t}$ of equation (1).

**Table 3b. Estimated time-varying parameters of real money supply (ΔLogRM1) equation**

| | Trade balance | | Price level | | Effective exchange rate | |
|---|---|---|---|---|---|---|
| | ΔTB | TB | Δlog(P) | log(P) | Δlog(EXR) | log(EXR) |
| Date | short run | long run | short run | long run | short run | long run |
| 1992.03 | -0.0011 (0.87) | 0.311 (0.64) | -0.32 (0.58) | 165.0 (0.99) | 0.005 (0.97) | -1.02 (1.00) |
| 1992.06 | -0.0009 (0.88) | 0.171 (0.78) | -0.34 (0.52) | 134.0 (0.96) | 0.001 (0.99) | -0.26 (1.00) |
| 1992.09 | -0.0000 (0.99) | -0.136 (0.76) | -0.37 (0.48) | 103.0 (0.94) | 0.000 (0.99) | -0.27 (1.00) |
| 1992.12 | -0.0020 (0.73) | -0.088 (0.56) | -0.37 (0.46) | 78.4 (0.81) | -0.007 (0.95) | 0.93 (0.99) |
| 1993.03 | 0.0015 (0.77) | 0.026 (0.88) | -0.31 (0.51) | 80.7 (0.87) | 0.006 (0.95) | 0.18 (1.00) |
| 1993.06 | -0.0043 (0.52) | 0.284 (0.00) | -0.16 (0.73) | 50.1 (0.57) | 0.005 (0.96) | 1.23 (0.97) |
| 1993.09 | -0.0051 (0.44) | 0.323 (0.00) | -0.08 (0.85) | 42.3 (0.46) | 0.004 (0.97) | 1.30 (0.95) |
| 1993.12 | -0.0015 (0.85) | 0.132 (0.03) | -0.30 (0.49) | 34.8 (0.09) | -0.018 (0.88) | 1.53 (0.93) |
| 1994.03 | -0.0011 (0.84) | 0.146 (0.00) | -0.36 (0.38) | 34.8 (0.46) | -0.085 (0.30) | 4.54 (0.70) |
| 1994.06 | -0.0026 (0.67) | 0.052 (0.11) | -0.37 (0.35) | 29.7 (0.18) | -0.080 (0.31) | 3.81 (0.62) |
| 1994.09 | 0.0038 (0.59) | 0.022 (0.34) | -0.40 (0.31) | 25.0 (0.05) | -0.071 (0.36) | 3.50 (0.53) |
| 1994.12 | -0.0000 (0.99) | -0.067 (0.00) | -0.40 (0.31) | 22.2 (0.01) | -0.074 (0.34) | 3.15 (0.46) |
| 1995.03 | 0.0030 (0.52) | -0.068 (0.00) | -0.37 (0.33) | 21.6 (0.03) | -0.071 (0.35) | 3.06 (0.43) |
| 1995.06 | 0.0008 (0.89) | -0.054 (0.00) | -0.37 (0.33) | 19.5 (0.00) | -0.079 (0.28) | 2.89 (0.35) |
| 1995.09 | 0.0008 (0.88) | 0.016 (0.14) | -0.38 (0.30) | 18.1 (0.00) | -0.083 (0.25) | 2.66 (0.28) |
| 1995.12 | 0.0013 (0.84) | 0.022 (0.10) | -0.38 (0.29) | 17.4 (0.00) | -0.083 (0.24) | 2.57 (0.24) |
| 1996.03 | -0.0016 (0.74) | 0.007 (0.57) | -0.38 (0.28) | 16.9 (0.00) | -0.084 (0.23) | 2.50 (0.21) |
| 1996.06 | 0.0008 (0.87) | -0.018 (0.20) | -0.38 (0.28) | 16.2 (0.00) | -0.084 (0.23) | 2.38 (0.17) |
| 1996.09 | 0.0014 (0.84) | -0.030 (0.01) | -0.39 (0.26) | 16.1 (0.00) | -0.084 (0.22) | 2.37 (0.16) |
| 1996.12 | 0.0023 (0.73) | -0.019 (0.07) | -0.39 (0.25) | 15.8 (0.00) | -0.084 (0.21) | 2.33 (0.13) |
| 1997.03 | -0.0046 (0.51) | -0.162 (0.00) | -0.86 (0.01) | 17.0 (0.00) | -0.102 (0.16) | 2.41 (0.26) |
| 1997.06 | -0.0055 (0.50) | -0.142 (0.00) | -0.85 (0.01) | 17.3 (0.00) | -0.102 (0.15) | 2.47 (0.26) |
| 1997.09 | 0.0005 (0.94) | -0.964 (0.00) | -0.87 (0.01) | 16.5 (0.00) | -0.106 (0.13) | 2.37 (0.22) |
| 1997.12 | 0.0020 (0.80) | -0.917 (0.00) | -0.86 (0.01) | 17.1 (0.00) | -0.104 (0.14) | 2.55 (0.22) |
| 1998.03 | -0.0011 (0.81) | -0.103 (0.00) | -0.86 (0.00) | 15.6 (0.00) | -0.092 (0.18) | 2.07 (0.16) |
| 1998.06 | 0.0006 (0.92) | -0.099 (0.00) | -0.81 (0.01) | 16.2 (0.00) | -0.091 (0.18) | 2.08 (0.18) |
| 1998.09 | 0.0002 (0.97) | -0.088 (0.00) | -0.81 (0.00) | 16.7 (0.00) | -0.091 (0.18) | 2.16 (0.18) |
| 1998.12 | 0.0032 (0.69) | -0.064 (0.00) | -0.81 (0.00) | 16.2 (0.00) | -0.081 (0.22) | 2.07 (0.16) |
| 1999.03 | 0.0001 (0.98) | -0.079 (0.00) | -0.81 (0.00) | 16.1 (0.00) | -0.081 (0.22) | 2.04 (0.15) |
| 1999.06 | 0.0023 (0.70) | -0.058 (0.00) | -0.84 (0.00) | 16.7 (0.00) | -0.082 (0.21) | 2.14 (0.16) |
| 1999.09 | 0.0024 (0.64) | 0.005 (0.54) | -0.84 (0.00) | 16.6 (0.00) | -0.081 (0.21) | 2.10 (0.16) |
| 1999.12 | 0.0002 (0.97) | -0.001 (0.93) | -0.87 (0.00) | 16.9 (0.00) | -0.082 (0.20) | 2.14 (0.16) |
| 2000.03 | 0.0053 (0.32) | -0.014 (0.31) | -0.90 (0.00) | 16.4 (0.00) | -0.085 (0.19) | 2.10 (0.15) |
| 2000.06 | 0.0048 (0.45) | 0.026 (0.07) | -0.89 (0.00) | 16.8 (0.00) | -0.085 (0.18) | 2.16 (0.15) |

Note: see Table 3a.

**Table 3c. Estimated time-varying parameters of price (ΔLogP) equation**

| | Trade balance | | Real money supply | | Effective exchange rate | |
|---|---|---|---|---|---|---|
| | ΔTB | TB | Δlog(RM1) | log(RM1) | Δlog(EXR) | log(EXR) |
| Date | short run | long run | short run | long run | short run | long run |
| 1992.03 | 0.0003 (0.94) | -0.0022 (0.00) | -0.19 (0.26) | 0.010 (0.00) | -0.056 (0.51) | 0.105 (0.00) |
| 1992.06 | 0.0016 (0.70) | -0.0031 (0.00) | -0.18 (0.25) | 0.013 (0.00) | -0.051 (0.53) | 0.098 (0.00) |
| 1992.09 | 0.0012 (0.81) | -0.0000 (0.38) | -0.18 (0.25) | 0.016 (0.00) | -0.051 (0.52) | 0.100 (0.00) |
| 1992.12 | 0.0012 (0.73) | -0.0004 (0.00) | -0.18 (0.22) | 0.018 (0.00) | -0.049 (0.51) | 0.090 (0.00) |
| 1993.03 | -0.0001 (0.97) | -0.0040 (0.00) | -0.14 (0.29) | 0.022 (0.00) | -0.036 (0.61) | 0.076 (0.00) |
| 1993.06 | 0.0012 (0.74) | -0.0052 (0.00) | -0.16 (0.22) | 0.025 (0.00) | -0.036 (0.60) | 0.070 (0.00) |
| 1993.09 | 0.0014 (0.70) | -0.0055 (0.00) | -0.16 (0.18) | 0.026 (0.00) | -0.035 (0.60) | 0.067 (0.00) |
| 1993.12 | 0.0014 (0.75) | -0.0020 (0.00) | -0.11 (0.31) | 0.036 (0.00) | -0.019 (0.78) | 0.047 (0.01) |
| 1994.03 | 0.0009 (0.76) | -0.0034 (0.00) | -0.10 (0.36) | 0.037 (0.00) | 0.017 (0.70) | -0.054 (0.00) |
| 1994.06 | 0.0011 (0.74) | -0.0001 (0.05) | -0.10 (0.32) | 0.044 (0.00) | 0.011 (0.79) | -0.054 (0.00) |
| 1994.09 | -0.0014 (0.72) | 0.0014 (0.00) | -0.10 (0.32) | 0.050 (0.00) | 0.007 (0.86) | -0.062 (0.00) |
| 1994.12 | -0.0005 (0.86) | 0.0034 (0.00) | -0.10 (0.31) | 0.053 (0.00) | 0.008 (0.84) | -0.063 (0.00) |
| 1995.03 | -0.0012 (0.63) | 0.0038 (0.00) | -0.11 (0.27) | 0.054 (0.00) | 0.006 (0.87) | -0.061 (0.00) |
| 1995.06 | -0.0005 (0.87) | 0.0034 (0.00) | -0.11 (0.26) | 0.059 (0.00) | 0.010 (0.79) | -0.068 (0.00) |
| 1995.09 | -0.0007 (0.80) | 0.0001 (0.00) | -0.10 (0.26) | 0.062 (0.00) | 0.011 (0.76) | -0.066 (0.00) |
| 1995.12 | -0.0005 (0.87) | 0.0005 (0.00) | -0.10 (0.25) | 0.063 (0.00) | 0.011 (0.76) | -0.066 (0.00) |
| 1996.03 | 0.0002 (0.91) | -0.0007 (0.00) | -0.10 (0.25) | 0.067 (0.00) | 0.012 (0.75) | -0.067 (0.00) |
| 1996.06 | -0.0006 (0.83) | 0.0005 (0.00) | -0.10 (0.24) | 0.069 (0.00) | 0.012 (0.74) | -0.066 (0.00) |
| 1996.09 | -0.0009 (0.78) | 0.0005 (0.00) | -0.10 (0.24) | 0.070 (0.00) | 0.012 (0.74) | -0.066 (0.00) |
| 1996.12 | -0.0007 (0.84) | 0.0009 (0.00) | -0.10 (0.24) | 0.070 (0.00) | 0.012 (0.74) | -0.066 (0.00) |
| 1997.03 | 0.0012 (0.72) | -0.0023 (0.00) | -0.03 (0.60) | 0.069 (0.00) | 0.018 (0.60) | -0.065 (0.00) |
| 1997.06 | 0.0005 (0.88) | -0.0000 (0.11) | -0.03 (0.65) | 0.071 (0.00) | 0.018 (0.60) | -0.064 (0.00) |
| 1997.09 | 0.0006 (0.85) | -0.0003 (0.00) | -0.03 (0.62) | 0.070 (0.00) | 0.017 (0.61) | -0.064 (0.00) |
| 1997.12 | 0.0006 (0.86) | -0.0006 (0.00) | -0.03 (0.60) | 0.070 (0.00) | 0.017 (0.61) | -0.065 (0.00) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1998.03 | -0.0007 (0.76) | 0.0004 (0.00) | -0.03 (0.55) | 0.070 (0.00) | 0.017 (0.61) | -0.064 (0.00) |
| 1998.06 | -0.0013 (0.67) | 0.0005 (0.00) | -0.04 (0.46) | 0.069 (0.00) | 0.017 (0.61) | -0.061 (0.00) |
| 1998.09 | -0.0012 (0.73) | 0.0007 (0.00) | -0.04 (0.46) | 0.068 (0.00) | 0.017 (0.59) | -0.061 (0.00) |
| 1998.12 | -0.0013 (0.73) | 0.0013 (0.00) | -0.04 (0.48) | 0.068 (0.00) | 0.018 (0.57) | -0.060 (0.00) |
| 1999.03 | 0.0003 (0.92) | 0.0015 (0.00) | -0.04 (0.46) | 0.067 (0.00) | 0.017 (0.57) | -0.058 (0.00) |
| 1999.06 | -0.0014 (0.62) | 0.0061 (0.00) | -0.04 (0.49) | 0.064 (0.00) | 0.019 (0.54) | -0.058 (0.00) |
| 1999.09 | -0.0029 (0.25) | 0.0044 (0.00) | -0.03 (0.54) | 0.066 (0.00) | 0.019 (0.54) | -0.057 (0.00) |
| 1999.12 | -0.0023 (0.38) | 0.0045 (0.00) | -0.03 (0.53) | 0.064 (0.00) | 0.018 (0.54) | -0.056 (0.00) |
| 2000.03 | -0.0019 (0.43) | 0.0058 (0.00) | -0.03 (0.58) | 0.064 (0.00) | 0.019 (0.53) | -0.057 (0.00) |
| 2000.06 | -0.0006 (0.84) | 0.0053 (0.00) | -0.03 (0.49) | 0.062 (0.00) | 0.018 (0.56) | -0.056 (0.00) |

Note: see Table 3a.

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