Foreign Exchange Reserves and Inflation: an Empirical Study of Five East Asian Economies

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Abstract- Our study extends the time consistency model developed by Kydland and Prescott (1977) to incorporate exchange rate stability in the policymaker's objectives. Through the operations in the foreign exchange market by central bank, we are then able to analyze the relation between foreign exchange reserves and inflation rate. We argue that when the foreign exchange reserves increases (or the domestic currency depreciates), the inflation rate will be rising while the exchange rate effect is strong. On the other hand, the inflation rate will be reduced when the monetary surprise effect is more powerful and the weight placed on output stability is not large. Our empirical study uses the data for five East Asian economies to make this argument more clear.

Keywords: foreign exchange reserves, inflation, time consistency model

JEL classification: E61; F31

1 Introduction

The literature on institutional arrangements for central banks has been developed over the past several years. The most cited paper in this field is perhaps the Kydland and Prescott (1977) which has been a stepping-stone for the subsequent works. In the Kydland and Prescott's simple model, a policymaker with well-specified objective function depending on inflation and unemployment controls the inflation rate via aggregate demand. The unemployment rate is a decreasing function of surprise inflation. They argue that it is feasible to achieve low inflation rate when the policymaker can make binding rules. The insightful extensions of this issue about time consistency are Barro and Gordon (1983a, 1983b), McCallum (1989), Rogoff (1985), Persson and Tabellini (1993) and Walsh (1995).

There has been some literature to examine the empirical implications predicted by the time consistency models. By far the greatest attention has been focused on the role institutional structures play in affecting both policy and macroeconomic outcomes. Olson (1996) shows that policies and institutions are critical in accounting for cross-country differences in real economic growth. However, Boschen and Weise (2004) find the political variables account for only a small fraction of the variation in inflation dynamics across countries. More literature has intensively investigated the relationship between the political independence of central banks and the resulting inflation rates in different countries. Many researchers have constructed measures of central bank independence. Much of this literature is surveyed by Cukierman (1992) and Eijffinger and de Haan (1996). The general conclusion is that greater independence of central bank is associated with lower average inflation. However, independence is often interpreted in terms of weight placed on inflation objectives. So that greater independence is negatively correlated with average inflation but less activist stabilization policy and, as a result, higher output variance. This proposition has been examined by Alesina and Summers (1993), Eijffinger and Schaling (1993), Cukierman, Kalaitzidakis, Summers and Webb (1993), and Pollard (1993). They find no relationship between central bank independence and real economic volatility. Svensson (1997) interprets independence and conservation to be associated with a lower target for inflation. His conclusion is that greater independence will lower average inflation rate but will not result in an increase in the variability of output. An alternative interpretation is that the inflation bias arises from political pressures. Waller and Walsh (1996) measure independence in terms of the political partisanship in appointment process for the central banker and in the length of the term of the office. They show that greater independence can reduce average inflation as well as output volatility. Posen (1995) argues that the absence of political constituencies opposed to inflation, simply increasing central bank independence, will not lower the inflation.

In the previous literature, it is standard to assume that the central bank's objective function involves employment (or output) and inflation within the context of a closed economy. Our study will extend into an open-economy model and highlight the role of foreign exchange in monetary policy. First, the exchange rate will enter the objective function, as do output and inflation. This modification intends to describe the fact that many small or developing countries, like Argentina or Mexico, have made exchange-rate stability the centerpiece of their inflation stabilization attempts. Today even the European Monetary System (EMS) considers fixed exchange rate as an advantage to force governments to pursue more conservative inflation policies. Giavazzi and Pagano (1988) discuss the example of France and Italy and argue that fixing exchange rate to a hard currency will have the benefit of another country's reputation to fight inflation. Therefore incorporating exchange-rate stability into the objective function is sensible. And the similar setting can be seen in Obstfeld (1996) and Vitale (2003).[1] Furthermore, exchange rate in our

[1]The loss function set by Obstfeld (1996) involves the departure of output from its targeted value, the realized rate of currency depreciation and the exchange-rate realignment costs. Vitale (1996)

model will be related to the foreign exchange intervention of central bank. The discussion about the impact of foreign exchange intervention on exchange rate can be seen in a survey by Neely (2000) and is strengthened by some empirical literature such as Dominguez and Frankel (1993), Fischer and Zurlinden (1999), Payne and Vitale (2001). Because the central bank uses foreign exchange reserves as an instrument to sterilize the exchange rate, we will specify an equation to represent the link between exchange rate and foreign exchange reserves.

To summarize, our study extends the time consistency model to incorporate exchange rate stability in the policymaker's objectives. Through the operations in the foreign exchange market by central bank, we are then able to analyze the relation between foreign exchange reserves and inflation rate. The main conclusion of our model is that when the foreign exchange reserves increases (or the domestic currency depreciates), the inflation rate will be rising while the exchange rate effect is strong. On the other hand, the inflation rate will be reduced when the monetary surprise effect is more powerful and the weight placed on output stability is not large. Our empirical study uses the data for five East Asian economies to make this argument more clear. We conclude that the monetary surprise effect is strong in Japan. And the exchange rate effect may be powerful in Korea and Taiwan. These two effects are approximately equal in Hong Kong and Singapore.

The rest of the article is as follows. In the next section, we set the theoretical model. The third section describes the empirical framework and the result of our study. The last section summarizes our main conclusions.

2 The Model

The specification of the economy follows the analysis of Barro and Gordon (1983a, 1983b). Aggregate output is given by a Lucas-type aggregate supply function with the consideration of the effect of net exports. We suppose the form is

$$\triangle y_t = \alpha(\pi_t - \pi_t^e) + \beta(\triangle S_t + \pi_t^f - \pi_t) + \varepsilon_t, \qquad \alpha > 0,\ \beta \gtrless 0 \tag{1}$$

where $\triangle y_t$ is the growth rate of aggregate output, π_t is inflation rate, π_t^e is expected inflation rate, π_t^f is inflation rate of foreign country, $\triangle S_t$ is the change rate of ex-

specifies the objectives as a function of the quadratic departures of employment and exchange rate from their optimal values respectively.

change rate,[2] and ε_t is the shock to aggregate output. The individual have rational expectations and set π_t^e prior to the realization of the output shock.

In equation (1), three factors contribute to the growth of output: monetary surprise effect, exchange rate effect and the disturbance. The first term, we called monetary surprise effect, is standard and it depicts the aggregate output is a function of inflation surprise. This is motivated from the presence of one-period nominal wage contracts set at the beginning of each period based on the individual's expected inflation rate. If the actual inflation rate exceeds the expected inflation rate, realized real wage will be less than the level expected and the employment (output) will be rising. If the actual inflation rate is less than the expected inflation rate, real wage will be higher than expected wage and the employment (output) will be reduced.

The second term, we called exchange rate effect, describes the impact of exchange rate on labor market and output. Several empirical studies have found statistically significant effects of exchange rate for employment.[3] Burgess and Knetter (1996) link real exchange rate and domestic output through the effect exchange rate has on relative costs of production. In theory, an appreciation of exchange rate will result in lower prices of foreign goods. It will reduce demand for domestic goods and in turn lead to lower domestic output and lower employment as well. The extent of response of output and employment to an exchange rate change will be huge when the market is competitive. On the other hand, Campa and Goldberg (1999) use longer time series data for U.S. industries and find insignificant effect of exchange rate for employment. Goldbery and Tracy (1999) then suggest a dynamic model for labor market to interpret this empirical result. For an industry which is export-oriented, an appreciation of exchange rate will directly reduce the competitiveness of its products and lead to the decline in labor demand. Some adverse consequence of appreciation is arising through spillovers across local industries via expected alternative wages. And this force will expand the labor supply. Therefore the effect of an appreciation has on employment is indeterminable. As shown by these theories and empirical results, the sign of β in equation (1) is ambiguous.

Suppose the central bank tends to influence the exchange rate by exchange market operations. Since the data on central bank intervention is not available in all

[2] The exchange rate is defined as the domestic currency price of a unit of the foreign currency.

[3] See Branson and Love (1988), Revenga (1992), Borjas and Ramey (1995), Burgess and Knetter (1996) and Gourinchas (1999).

countries, we then use the change in foreign exchange reserves as a measure of the size of intervention.[4] The intervention strategy is described by the following equation:

$$\triangle S_t = k \cdot \triangle FR_t, \qquad k > 0, \tag{2}$$

where $\triangle FR_t$ is the change rate of foreign exchange reserves. The central bank should purchase foreign currency in the foreign exchange market, thus increase foreign exchange reserves, to let foreign currency appreciate (domestic currency depreciate); that is $k > 0$. This expression of foreign exchange intervention strategy has been adopted by Wonnacott (1965) and Kohli (2003).

The objective function of the central bank is based upon the assumption that the policymaker dislikes inflation, instability of output growth, and the volatility of exchange rate. Then the loss function is given in the following quadratic form:

$$L(\pi_t, \triangle y_t, \triangle S_t) = \frac{1}{2}\pi_t^2 + \frac{\gamma_1}{2}(\triangle y_t - \triangle \bar{y})^2 + \frac{\gamma_2}{2}\triangle S_t^2 \qquad \gamma_1 > 0,\ \gamma_2 > 0, \tag{3}$$

where $\triangle \bar{y}$ is the targeted growth rate of output. The parameter γ_1 and γ_2 measure, respectively, the importance of stability on output growth and exchange rate relative to inflation. The loss function implies that the central bank intends to fix the exchange rate and the targeted rate of inflation is equal to 0.[5] Substituting equation (1) and equation (2) into equation (3), the policymaker's optimization problem is to choose the inflation rate that minimizes the loss function. By the first order condition, we obtain:[6]

$$\pi_t = \frac{\gamma_1(\alpha - \beta)[\alpha \pi_t^e + \triangle \bar{y} - \beta(k\triangle FR_t + \pi_t^f) - \varepsilon_t]}{1 + \gamma_1(\alpha - \beta)^2} \tag{4}$$

Because the expectations are rational, the equilibrium inflation expectation π_t^e on date $t-1$ satisfies

$$\pi_t^e = E_{t-1}\pi_t = \frac{\gamma_1(\alpha - \beta)[\triangle \bar{y} - \beta(k\triangle FR_t + \pi_t^f)]}{1 - \beta\gamma_1(\alpha - \beta)} \tag{5}$$

[4] According to the empirical study of Kohli (2003) about India, he indicates that the foreign exchange reserves is a reasonable proxy for intervention because of the strong correlation (0.83) between purchases and sales of foreign currency by the Reserve Bank of India and change in foreign exchange reserves for the period 1993-1999.

[5] The targeted value could be set at another value which is inconsequential for the results of our analysis.

[6] The second-order condition $1 + \gamma_1(\alpha - \beta)^2$ is larger than 0 which satisfies the minimization.

where we assume that $E_{t-1}\varepsilon_t = 0$. Finally, substituting equation (5) into equation (4) yields

$$\pi_t = \frac{\gamma_1(\alpha-\beta)[\triangle\bar{y} - \beta(k\triangle FR_t + \pi_t^f)]}{1-\beta\gamma_1(\alpha-\beta)} - \gamma_1(\alpha-\beta)\frac{\varepsilon_t}{1+\gamma_1(\alpha-\beta)^2} \tag{6}$$

To analyze the relation between foreign exchange reserves and inflation rate, differentiation of equation (6) shows that

$$\frac{\partial\pi_t}{\partial\triangle FR_t} = -\frac{(\alpha-\beta)\beta\gamma_1 k}{1-\beta\gamma_1(\alpha-\beta)} \tag{7}$$

The sign of the differentiation represented in equation (7) is indeterminable because the sign of $\alpha - \beta$ is ambiguous. We still try to interpret it by simple economic intuition. Though the volatility of exchange rate erodes the social welfare, the depreciation of domestic currency has positive effect on output. Therefore, the central bank has the intention to reduce inflation rate or output volatility to lower the loss on the objectives while the domestic currency depreciates by increasing the foreign exchange reserves.

Now we analyze the role of inflation in output growth. From equation (1), the inflation enhances the output by monetary surprise effect and inhibits the output by exchange rate effect. Concretely, a 1% increase in inflation rate results in a $\alpha\%$ rise (monetary surprise effect) and a $\beta\%$ reduction (exchange rate effect) of output growth. Thus, when $\alpha = \beta$, the exchange rate effect equals the monetary surprise effect; that is inflation will not alter the output growth. When $\alpha < \beta$, the exchange rate effect is stronger than the monetary surprise effect; that is inflation will reduce the output growth. Conversely, when $\alpha > \beta$, the monetary surprise effect is stronger than the exchange rate effect; that is inflation will stimulate the output growth.

We then combine these two effects on output: the direct effect of the depreciation in exchange rate and the indirect effect of the inflation. When the depreciation of domestic currency directly increases output growth, the output volatility could be offset by the inflation effect indirectly. When $\alpha = \beta$, equation (7) is zero. It means that the exchange rate effect is equivalent to the monetary surprise effect. And it is ineffective for the central bank to lower the output growth by altering the inflation rate. When $\alpha < \beta$, the sign of equation (7) is positive. It implies that the exchange rate effect dominates the monetary surprise effect and the central bank will increase the inflation rate to lower the output growth indirectly. When $\alpha > \beta$, the sign of equation (7) will depend on the degree of γ_1. Equation (7) will be negative when $\gamma_1 < \frac{1}{\beta(\alpha-\beta)}$ and will be positive when $\gamma_1 > \frac{1}{\beta(\alpha-\beta)}$. We argue that when the weight placed on output stability objectives (γ_1) is not large, the central bank should lower the inflation rate to reduce the output growth. Namely, the central bank would rather substitute the monetary surprise effect for the exchange rate effect. However, if the weight placed on output stability objectives is large enough, the inflation rate should be rising to lower the output growth as the case of $\alpha < \beta$.

The summary of our conclusion is shown in Table 1.

Table 1 Summary of the theoretic conclusion

B.Indirect effect	A.Direct effect
B1.$\alpha = \beta : \pi \uparrow \Rightarrow \triangle y_t \rightarrow$	A+B1: The increase in foreign exchange reserves will not alter the inflation rate: $\frac{\partial \pi_t}{\partial \triangle FR_t} = 0$.
B2.$\alpha < \beta : \pi \uparrow \Rightarrow \triangle y_t \downarrow$	A+B2: The increase in foreign exchange reserves will rise the inflation rate; that is $\frac{\partial \pi_t}{\partial \triangle FR_t} > 0$.
B3.$\alpha > \beta : \pi \uparrow \Rightarrow \triangle y_t \uparrow$	A+B3 with $\gamma_1 < \frac{1}{\beta(\alpha-\beta)}$ The increase in foreign exchange reserves will reduce the inflation rate; that is $\frac{\partial \pi_t}{\partial \triangle FR_t} < 0$. A+B3 with $\gamma_1 > \frac{1}{\beta(\alpha-\beta)}$ The increase in foreign exchange reserves will rise the inflation rate; that is $\frac{\partial \pi_t}{\partial \triangle FR_t} > 0$.

3 Empirical Framework

To show how the intervention of the central bank influences the domestic economy, a simple regression model is set for the empirical study. We then describe the data and the econometric methodology utilized in our analysis.

3.1 The data

Our empirical study consists of five East Asian economies: Japan(JPN) and four “Tigers” (Hong Kong(HK), Korea(KOR), Singapore(SNG) and Taiwan(TWN)). The inflation rate is measured as the annual change in Consumer Price Index(CPI). The exchange rate is defined as the domestic currency price of a unit of the U.S. dollar. So the inflation rate of foreign country is the CPI inflation rate of U.S.. All the data are quarterly and span from 1981Q1 to 2003Q4, except from 1994Q1 to 2003Q4 for Hong Kong. The data for U.S., Japan, Hong Kong, Korea, Singapore are from *International Financial Statistics*, IMF. For Taiwan, the data are from *Financial Statistics Monthly Taiwan District,* the central Bank of China.

The descriptive statistics on inflation rate (π) and foreign exchange reserves (FR) are seen in Table 2. We also plot the scatter diagram with the change rate of foreign exchange reserves on the horizontal axis and the inflation rate on the vertical axis for each economy in Figure 1. The correlation coefficient between these two variables is -0.4323 for Japan, 0.2216 for Hong Kong, -0.0500 for Korea, 0.1525 for Singapore, and 0.3352 for Taiwan.

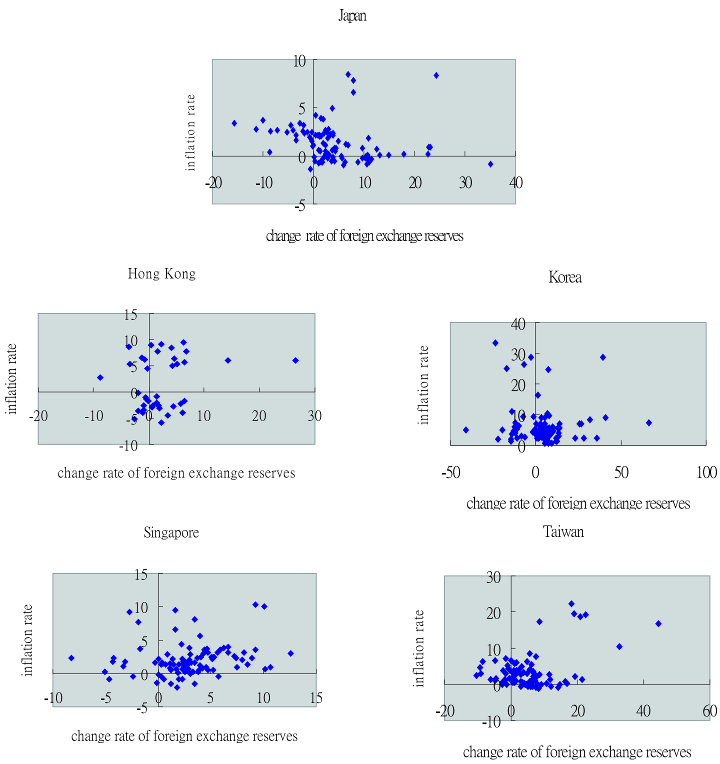

Figure 1: Change rate of foreign exchange reserves (%) and inflation rate(%)

Table 2. Basic statistics

	JPN		HK		KOR	
	π (%)	FR (US Million)	π (%)	FR (US Billion)	π (%)	FR (US Million)
Mean	1.1924	149722.0544	1.0250	90.2328	5.5294	33233.6423
Maximun	6.6000	652790.0000	9.5000	114.5900	28.6000	149540.7000
Minimun	-1.4000	19172.0000	-5.9000	46.3800	0.60000	1927.8000
Standard Deviation	1.5337	146519.5861	4.8190	22.3383	4.6403	39321.8528
Skewness	0.6844	1.3978	0.3660	-0.5903	3.0680	1.4630
Kurtosis	0.4592	1.3957	-1.4699	-1.1251	11.6537	1.0321
	SNG		TWN		US	
	π (%)	FR (US Million)	π (%)	FR (US Billion)	π (%)	
Mean	1.8250	42531.5598	2.7480	74756.8587	3.5370	
Maximun	10.0000	92800.0000	19.5700	206632.0000	11.2000	
Minimun	-2.1000	6622.90000	-1.2000	2665.0000	1.3000	
Standard Deviation	2.1362	29322.4465	3.7833	44494.0853	1.9142	
Skewness	1.6170	0.1458	2.5632	0.3362	2.0753	
Kurtosis	4.4675	-1.6871	8.5226	0.4217	5.2847	

3.2 Econometric Methodology

To study the relationship between inflation rate and the foreign exchange reserves. We could estimate equation (1), (2) and (3) to get those parameters α, β, k, γ_1 and γ_2. However, the estimation for the parameters of objective function γ_1 and γ_2 needs more complicated econometric method. This is an important issue and is beyond the scope of our study. Therefore we decide to estimate equation (6) directly instead of estimating equation (1), (2) and (3) separately.

We suggest a regression model motivated by equation (6) as the following form

$$\pi_t = \beta_0 + \beta_1 \text{Trend}_t + \beta_2 \triangle FR_t + \beta_3 \pi_t^f + e_t, \tag{8}$$

where Trend_t is time trend, e_t is the disturbance term. $\triangle FR_t$ denotes the annual change rate of foreign exchange reserves. The sign of estimated coefficient β_2 can tell us the relation between inflation rate and the foreign exchange reserves. Furthermore, comparing the differences of coefficient estimator β_2 among these five economies, we may have a rough understanding about the structure of each economy.

The regression can be estimated for each economy respectively or as a system of separate equations for the individual economy. We assume the disturbances are independent across equations when the regressions are estimated by the first method. However, the second method known as seeming unrelated regressions (SUR) is allowing the disturbances across equations to be freely correlated.

3.3 Results

First, we estimate equation (8) for each economy respectively and this regression is named for Case 1 to differ from the seeming unrelated regressions. The regressions are estimated with a correction for serial correlation by Cochrane-Orcutt method. The empirical results are reported in Table 3. The inflation rate in Japan has significantly negative trend. And the trends in other four economies are not obvious. The inflation rate of U.S. is positively related to the domestic inflation rate in each economy.

The coefficient on $\triangle FR_t$ is different among these five economies. For Japan, on an average a 1% rise in foreign exchange reserves leads to a 0.0034% fall in inflation rate. However, on an average a 1% rise in foreign exchange reserves results in a 0.0043% rise in inflation rate of Korea and a 0.0090% rise in inflation rate of Taiwan. This relation is significant for Japan, Korea and Taiwan. Similarly, on an average a 1% rise in foreign exchange reserves invokes an inflation response of approximately 0.0033% for Hong Kong, -0.0053% for Singapore. In these two economies, nevertheless, this relation is insignificant.

Table 3. Case 1 : Estimated results of equation (8) in each economy respectively
Dependent variable: π_t

Variable	JPN	HK	KOR	SNG	TWN
Constant	1.3934	23.4924	0.8002	-0.4333	0.0257
	(1.9146)**	(1.2478)	(0.3986)	(-0.3464)	(0.0123)
Trend_t	-0.0209	-0.2894	0.0282	-0.0062	0.0111
	(-2.1086)*	(-1.3662)	(0.9947)	(-0.3970)	(0.3729)
$\triangle FR_t$	-0.0034	0.0033	0.0043	-0.0053	0.0090
	(-1.8263)**	(0.5117)	(2.1183)*	(-1.1063)	(1.6656)**
π_t^f	0.2128	0.2368	0.5782	0.7825	0.2658
	(2.2342)*	(0.4855)	(2.3235)*	(4.3788)*	(1.0855)
ρ	0.7842	0.9118	0.7982	0.7819	0.8179
	(13.2675)*	(11.9885)*	(21.6623)*	(10.2634)*	(19.7725)*
$\bar{R}^2$	0.8700	0.9419	0.8498	0.8605	0.8529
observations	91	39	91	91	91

1.The regressions are estimated with a correction for serial correlation by Cochrane-Orcutt method.
2. The t-statistics are given in parentheses.
3. *(**) indicates significant at 5% (10%).

Equation (8) can also be estimated as a system of separate equations for the individual economy. We use generalized least squares (GLS) to estimate this system. The standard errors are computed from heteroscedastic-consistent matrix developed by White (1980). Because the sample period for Hong Kong is not as long as other four economies, we estimate this system by two periods of analysis: Case 2 is from 1981Q1 to 2003Q4 for four economies excluding Hong Kong, and Case 3 is from 1994Q1 to 2003Q4 for all five economies. The results are presented in Table 4 and Table 5 respectively.

To simplify the analysis, we focus on the first point of our argument that is the relation between inflation and foreign exchange reserves. Table 4 shows that the sign of coefficient on $\triangle FR_t$ is negative for Japan and is positive for Korea. Both are significantly different from zero. This result of Case 2 is exactly the same in quality as Case 1. However, the coefficient on $\triangle FR_t$ is not significant in Singapore and Taiwan.

Finding of Table 5 indicates that the sign of coefficient on $\triangle FR_t$ is significantly positive for Korea and Taiwan which is similar to the result in Case 1. For Japan, Hong Kong and Korea, the coefficient is insignificant, nevertheless.

To sum up, the coefficient on $\triangle FR_t$ is significantly positive for Korea in three cases we estimate. And the value of the coefficient reveals that on an average a 1% rise in foreign exchange reserves invokes an inflation response of approximately 0.0043% to 0.0102%. The sign is significantly negative for Japan and the significance is weak in Case 3. For those significant cases, an average a 1% rise in foreign exchange reserves leads to about 0.0034% to 0.0130% fall in inflation rate. For Taiwan, an average a 1% rise in foreign exchange reserves results in about 0.0090% to 0.0163% rise and this positive relation disappears in Case 2. And this relation is not evident in Hong Kong and Singapore.

Though the significance and magnitude of the coefficient on $\triangle FR_t$ are not robust to the sample period or the estimation method we choose, we still have some rough findings from the empirical study in this section. The main conclusion is that the monetary surprise effect is strong in Japan. And the exchange rate effect may be powerful in Korea and Taiwan probably. These two effects are approximately equivalent in Hong Kong and Singapore.

The results could be interpreted by the structure of each economy. For the period 1986 to 2003, the average trade dependency ratio[7] is 16.51% for Japan, 55.91% for Korea, 81.83% for Taiwan, 286.08% for Singapore, and 231.02% for Hong Kong. We argue that Japan is a large economy and the trade dependence is relatively smaller than other economies. We guess in Japan the impact of international trade on output may not be as strong as that of other factor such as the domestic monetary effect. However, Korea and Taiwan are both small open economies where the international trade will play very important role in economic growth. Thus we suspect that in these two economies the exchange rate effect should dominate the domestic monetary surprise effect. Hong Kong and Singapore are like cities. Though the trade dependency ratios in these economies are large, the domestic monetary effect will influence the whole economy as well. By the empirical result, we conclude these two forces are approximately balanced in Hong Kong and Singapore.

[7]The ratio is measured as the rate of sum of export and import to GDP.

Table 4. Case2: Estimated results of equation (8) by SUR: 1981Q1 to 2003Q4

Dependent variable: π_t

Variable	JPN	KOR	SNG	TWN
Constant	1.2844	-4.6297	-2.2327	-3.8883
	(3.3115)*	(-3.6671)*	(-3.7905)*	(-3.3495)*
Trend_t	-0.0225	0.0382	0.0109	0.0183
	(-5.4952)*	(2.7994)*	(1.7344)*	(1.4426)
$\triangle FR_t$	-0.0130	0.0102	0.0012	-0.0018
	(-5.0739)*	(3.1341)*	(0.1354)	(-0.3213)
π_t^f	0.3499	2.2775	0.9877	1.6257
	(5.9899)*	(11.9357)*	(11.3537)*	(9.2253)*
$\bar{R}^2$	0.7115	0.6484	0.6549	0.5511
observations	92	92	92	92

1. The t-statistics are given in parentheses.

2. *(**) indicates significant at 5% (10%).

Table 5. Case3: Estimated results of equation (8) by SUR: 1994Q1 2003Q4

Dependent variable: π_t

Variable	JPN	HK	KOR	SNG	TWN
Constant	3.9990	33.1612	11.5167	3.1571	10.2683
	(4.2342)*	(9.9101)*	(5.0102)*	(2.7601)*	(9.1923)*
Trend_t	-0.0406	-0.3900	-0.0846	-0.0557	-0.1328
	(-4.1420)*	(-11.1956)*	(-3.5720)*	(-4.6977)*	(-10.7723)*
$\triangle FR_t$	-0.0065	0.0111	0.0091	0.0014	0.0163
	(-1.4264)	(0.8893)	(2.3468)*	(0.0176)	(2.3391)*
π_t^f	-0.2973	-0.6723	-0.4543	0.8911	0.4826
	(-1.7312)**	(-1.1114)	(-1.0908)	(4.3555)*	(2.3433)*
$\bar{R}^2$	0.3545	0.7720	0.2773	0.5768	0.7769
observations	40	40	40	40	40

1. The t-statistics are given in parentheses.

2. *(**) indicates significant at 5% (10%).

4 Conclusions

Our study is an extension of the consistency model developed by Kydland and Prescott (1977). However, we consider the exchange rate stability as the policy-maker's objectives additionally. Through the operations in the foreign exchange market by central bank, we are then able to analyze the relation between foreign exchange reserves and inflation rate. Our main conclusion is that when the foreign exchange reserves increases (or the domestic currency depreciates), the inflation will be rising while the exchange rate effect is stronger than monetary surprise effect. And the inflation rate will be reduced when the monetary surprise effect is powerful if the weight placed on output stability is not large.

We use the data for five East Asian economies to make our argument more clear. The empirical result shows that the relation between the change in foreign exchange reserves and inflation rate is negative for Japan and is positive for Korea and Taiwan. And this relation is insignificant for Hong Kong and Singapore. However, the significance is not robust to the sample period or the estimation method we utilize. The brief conclusion from our empirical study is that the monetary surprise effect is strong in Japan. And the exchange rate effect may be powerful in Korea and Taiwan possibly. These two effects are approximately equivalent in Hong Kong and Singapore.

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