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Response of Domestic Price Changes to Exchange Rate Movements in Singapore

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Abstract: Based on a simultaneous-equation model, this paper shows that if the Singapore dollar depreciates 1% versus the U.S. dollar, the consumer price in Singapore would decrease by 0.1274%. In addition, decrease in government borrowing as a percent of GDP, more money supply, a higher U.S. price level, a higher crude oil price, and a higher expected price level would raise Singapore's consumer price level. Therefore, exchange rate pass-through is not confirmed for Singapore.

Keywords: Exchange Rate Pass-Through, Exchange Rates, Consumer Prices, Money Supply, Crude Oil Prices

JEL Classification: F31, F41

1. Introduction

Although the Singapore dollar has been relatively stable and more valuable than many other currencies, scholars and authorities may be concerned about the potential impact of currency depreciation on domestic prices due to increased import costs. Figure 1 shows that the exchange rate between the Singapore dollar and the U.S. dollar (SGD/USD). The Singapore dollar appreciated versus the U.S. dollar from 1.8125 in 1990 to 1.4100 in 1996 and depreciated to 1.7906 in 2002 after the Asian financial crisis. The Singapore dollar continued to show a trend of appreciation afterwards but depreciated slightly after 2014 in order to stimulate its export activities due to a weak global economy.Figure 2 presents the scatter diagram between the consumer price index (CPI) and the exchange rate between the Singapore dollar and the U.S. dollar. With a few exceptions, there seemed to be a negative relationship during the sample period. As the Singapore dollar depreciated, consumer prices declined. In other words, exchange rate pass-through (ERPT) to higher consumer prices is not confirmed.

There have been several recent studies of ERPT focusing on Singapore or other selected Asian countries. The degree of ERPT may vary across countries and over time (Barhoumi, 2006; Ha, Stocker and Yilmazkuday,

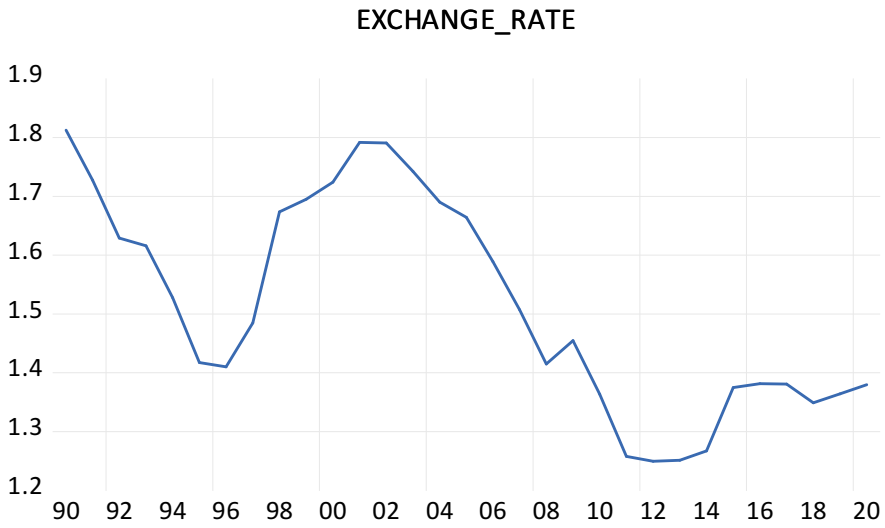

Figure 1: The Exchange Rate between the Singapore Dollar and the U.S. Dollar during 1990-2020

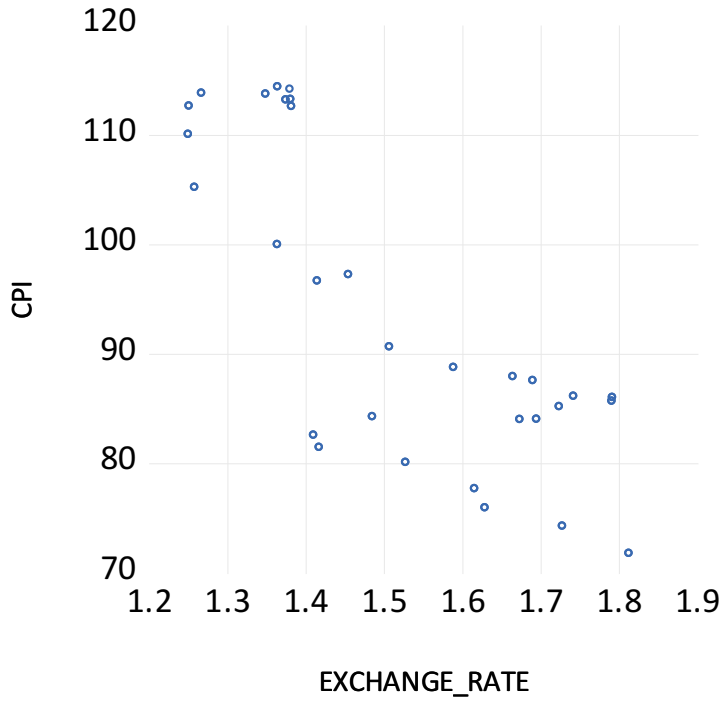

Figure 2: The Scatter Diagram between the CPI and the Exchange Rate during 1990-2020

2019). ERPT may be affected by inflation targeting or non-inflation targeting, exchange rate regimes, degree of central bank independence (Ha, Stocker and Yilmazkuday, 2019; Pham, Nguyen, Nasir and Huynh, 2020;Anh, Quan, Phuc, Chi, and Duc, 2021), and other factors such as oil shocks (Pham, Nguyen, Nasir and Huynh, 2020; Anh, Quan, Phuc, Chi, and Duc, 2021). ERPT is generally higher in emerging economies than in developed economies (Ca'Zorzi, Hahn and Sánchez; 2007). ERPT may be affected by a threshold of inflation volatility and exhibit asymmetric impacts (Soon, Baharumshah and Wohar, 2018;Pham, Nguyen, Nasir and Huynh, 2020). ERPT to the CPI is generally less than ERPT to the PPI or import prices (Mihaljek and Klau, 2008; Sek and Kapsalyamova, 2008). ERPT to consumer prices may have negative values (Ghosh and Rajan, 2006; Sek and Kapsalyamova, 2008; Anh, Quan, Phuc, Chi and Duc; 2021).

This paper examines exchange rate pass-through to consumer prices in Singapore. This paper has several different aspects. A major contribution of this paper is to present a theoretical model suggesting that currency depreciation could lead to a lower domestic price level. An extended IS-LM-AS model is applied in the formulation of the theoretical model. Besides the exchange rate, several other relevant variables are incorporated in the model. External shocks including crude oil prices are considered as a higher crude oil price is expected to shift aggregate supply to the left.

2. The Model

It is postulated that aggregate spendingis a function of real income, government taxes, government spending, the real interest rate and the real exchange rate, that real money demand is determined by the nominal interest rate, real income and the nominal exchange rate, and that the price level is affected by the expected price level, the output gap, the nominal exchange rate, and the energy cost. We can express the extended IS-LM-AS model (Romer, 2006) as:

$$Y = F[Y, T, G, R - \pi^e, E(P^*/P)] \quad (1)$$

$$M/P = H(R, Y, E) \quad (2)$$

$$P = S(P^e, Y - Y^*, E, C) \quad (3)$$

Where

Y = real GDP in Singapore,

T = government taxes,

G = government spending,

R = the nominal interest rate,

π^e = the expected inflation rate,

E = the nominal exchange rate measured as units of the Singaporedollar per U.S. dollar,

P^* = the price level in the U.S.,

P = the price level in Singapore,

M = the money supply,

P^e = the expected price level in Singapore,

Y^* = potential real GDP, and

C = the energy cost.

Suppose that Y^* does not change in the short term. Solving for the three endogenous variables, we obtain $\bar{P}$ as:

$$\bar{P} = \bar{P}(E, M, G-T, C, P^*, P^e) \tag{4}$$

The partial derivative of the equilibrium P with respect to the nominal exchange rate can be expressed as:

$$\partial \bar{P}/\partial E = [-H_R S_E(1-F_Y) - F_E H_R S_Y - F_R H_Y S_E + F_R H_E S_Y]/|J| > 0 \text{ if } H_E < 0 \\ < \text{or} > 0 \text{ if } H_E > 0 \tag{5}$$

where $|J|$ is the Jacobian matrix and has a positive sign.The sign in equation (5) is unclear as the sign of the first three terms is positive whereas the sign of the last term depends on the sign of H_E. The exchange rate may affect real money demand through the substitutioneffect and the wealtheffect. If $H_E < 0$ or if the substitution effect dominates the wealth effect, the sign in equation (5) would be positive. If $H_E > 0$ or if the wealth effect dominates the substitution effect, the sign in equation (5) would be unclear.

3. Empirical Results

The data were taken from the International Financial Statistics, the St. Louis Federal Reserve Bank,the Reserve Bank of Singapore, and the World Economic Outlook.The CPI in Singapore is used as the dependent variable. The exchange rate is measured as units of the Singapore dollar per U.S. dollar. An increase means depreciation of the Singapore dollar. The money supply is represented by M2 money. Fiscal policy is represented bygovernment borrowingas a percent of GDP. The energy cost is represented by the average crude oil price per barrel. The U.S. price level is represented by the CPI in the U.S. The lagged CPI is used to represent the expected price level. The sample ranges from 1990 to 2020. Annual data for the average crude oil price before 1990 is not available.The ADF tests show

that these variables have unit roots in level, are stationary in difference, and are cointegrated in the long run.

Table 1 presents the estimated regression and related statistics. Except for government borrowing as a percent of GDP due to negative values in some years, other variables are transformed to a log scale in order to reduce the degree of multicollinearity. The GARCH process is employed to correct for potential autoregressive conditional heteroskedasticity. Approximately 99.62% of the change in the consumer price index(CPI) can be explained by the six right-hand side variables. All the right-hand side variables are significant at the 1% level. The CPI is positively associated with M2 money, the U.S. CPI, the crude oil price, and the expected CPI and negatively affected bythe exchange rate and government borrowing as a percent of GDP.

Table 1
Estimated Regression for the Log(CPI) in Singapore

Variable	*Coefficient (Probability)*
Intercept	0.7595
	(0.0000)
Log(SGD/USD exchange rate)	-0.1274
	(0.0000)
Log(M2 money)	0.0043
	(0.0000)
Government borrowing/GDP ratio	-0.0004
	(0.0002)
Log(crude oil price)	0.0080
	(0.0000)
Log(U.S. CPI)	0.0713
	(0.0000)
Log(Expected CPI)	0.7578
	(0.0000)
R-squared	0.9962
Adjusted R-squared	0.9952
Sample period	1990-2020
Number of observations	31
Mean absolute percent error	1.0351%
Root mean squared error	1.1522%

Notes: The SGD/USD exchange rate is measured as units of the Singapore dollar per U.S. dollar. An increase means depreciation of the Singapore dollar.

Specifically, if the SGD/USD exchange rate rises 1% or if the Singapore dollar depreciates 1%, the consumer price would decline by 0.1274%. A 1 percent increase in M2 money would result in a 0.0043% rise in the consumer

price. If government borrowing as a percent of GDP rises by 1 percentage point, the log of the consumer price would decreaseby 0.0004, suggesting that the crowding-out effect may overwhelm fiscal expansion. When the crude oil price rises 1%, the consumer price would increase by 0.0080%. A 1% increase in the U.S. CPI would cause Singapore's CPI to rise by 0.0713%. If the expected CPI rises 1%, the CPI would rise by 0.7578% These results suggest that exchange rate pass-through is not confirmed and that the impact of other relevant variables cannot be overlooked.

The finding that depreciation of the Singapore dollar leads to a lower consumer price in this study is consistent with Ghosh and Rajan (2006),Sek and Kapsalyamova (2008), and Anh, Quan, Phuc, Chi and Duc (2021) but is in contrast to other previous studies.Currency depreciation tends to shift aggregate demand to the right due to expected increase in net exports and aggregate supply to the left due to increased import costs. On the other hand, the J-curve effect may occur and cause the trade balance to deteriorate initially as the value effect is greater than the quantity effect due to long-term contracts and price rigidity. Expected currency depreciation tends to increase international capital outflows and reduce demand for domestic goods and services. Both tend to shift aggregate demand to the left. Another possible reason is that the wealth effect dominates the substitution effect in real money demand, shifting aggregate demand to the left and reducing the price level.Hence, it would be possible that currency depreciation may cause the consumer price to decline.

4. Summary and Conclusions

This paper has examined the impact of exchange rate pass-through on the consumer price in Singapore. Other relevant variables are also considered. An extended IS-LM-AS model is employed to derive a reduced-form equation. The results show that a 1% increase in the SGD/USD exchange rate would lead to a decrease in the consumer price by 0.1274%, suggesting that exchange rate pass-through to consumer prices is not confirmed. Furthermore, less government borrowing as a percent of GDP, more money supply, a higher U.S. consumer price, a higher crude oil price, and a higher expected consumer price would raise the consumer price level in Singapore.

There are several policy implications. Recent trends of depreciation of the Singapore dollarversus the U.S. dollar from 1.2671 in 2014 to 1.3797 in 2020tend to increase global competitiveness, stimulate exports, and reduce consumer prices. The negative coefficient of government borrowing as a percent of GDP may imply that authorities have pursued fiscal prudence in the long run and that moderate increase in government borrowing would not cause too much concern.On the other hand, recent increase in world

crude oil prices tends to cause domestic prices to rise. Authorities may need to contain the expected inflation or price level as its impact on the domestic consumer price is relatively large.

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