E C O N O M I C S B U L L E T I N

Application of the IS−MP−IA model to the Singapore economy and policy implications

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Abstract

Extending the IS−MP−IA model (Romer, 2000), we find that equilibrium output in Singapore is negatively affected by the expected inflation rate and the world interest rate and positively influenced by real appreciation, stock market performance, and world output. Equilibrium GDP would rise by 0.872% if the real effective exchange rate rises by 1%. The coefficient of real government deficit spending is found to be insignificant, suggesting that pursuing fiscal discipline and budget surpluses in the long run by the Singapore government is appropriate.

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1. Introduction

In many aspects, Singapore's economic performance is better than most of other countries in the region. Although the economy suffered a negative growth rate of 1.90% in 2001 due to the worldwide recession, it bounced back and grew at an annual rate of 2.15% in 2002 and 1.09% in 2003. The central government pursued a conservative fiscal policy as there were no budget deficits since 1988 except for small amounts of deficits in 2001 and 2002 mainly due to the worldwide economic slowdown. The economic recovery led to a budget surplus of 10.422 billion in 2003. The 3-month interbank rate reached 0.74% in 2003 compared with the U.S. federal funds rate of 1.13% and Euro rate of 1.22%. It may suggest that the Monetary Authority of Singapore (MAS) closely followed world interest rates in determining the domestic interest rate policy in order to continue attracting foreign investors and make the cost of borrowing affordable. Its inflation rate has remained relatively low and less than 2.0% since 1995. The inflation rates of -0.40% in 2002 and 0.51% in 2003 suggest that monetary policy in maintaining price stability has been effective. Like most other countries in the region, the Singapore dollar depreciated during the Asian financial crisis from 1.40 in 1996 to 1.68 in 1997 and has been relatively stable since then. Stock market performance followed international movements, reaching a high of 114.64 (1995 = 100) in 2000 and declining to 83.66 or 27.02% in 2003. The decrease in stock values is expected to affect household consumption spending and business investments (Mishkin, 1995; Kuttner and Mosser, 2002). One area of potential concern is its relatively high domestic debt/GDP ratio of 106.41% in 2003 compared with a recent low of 69.97% in 1994. The debt service could affect other government services negatively.

Several recent studies examined Singapore's short-run output fluctuations and/or demand and supply shocks (Bhattacharya, 1997; Alba and Papell, 1998; Meng, 1999), monetary or fiscal policy (Alba and Papell, 1998; ; Nadal-De Simone, 2000;Yip, 2003), the exchange rate (Chinn, 2000; Chou and Chao, 2001; Toh and To, 2001; Wilson and Tat, 2001; Wu, 2001; Fujii, 2002; Yip, 2003), the stock market (Wongbangpo and Sharma, 2002; Wu, 2001, Feng, 2002), and the world interest rate (Borensztein, Zettelmeyer, and Philippon, 2001). This paper attempts to apply the IS-MP-IA model (Romer, 2000) to examine the relationships between real output in Singapore and several major macroeconomic variables and has several different features. First, to the author's knowledge, few of the previous studies employed the IS-MP-IA model in specifying the relationships among the variables. Second, the IS-MP-IA model (Romer, 2000) is extended to include stock market performance, the real exchange rate, and world output. In response to better stock market performance, consumption and investment expenditures are expected to increase due to the wealth effect, Tobin 's q theory, and the balance-sheet channel (Mishkin, 1995; Kuttner and Mosser, 2002). Third, the monetary policy function is extended to include the exchange rate and the world interest rate. It would be reasonable to postulate that a small open economy would use monetary policy to maintain currency stability and follow the world trend so that the level of domestic interest rates would be comparable to the world level.

2. Theoretical Model

Suppose that the consumption function is determined by disposable income, the real interest rate and financial stock values, that investment spending is a function of the real interest rate and

stock values, that net exports are a function of the real effective exchange rate and world output, and that the monetary policy function is influenced by the inflation gap, the output gap, the exchange rate gap, and the world interest rate. Extending the IS-MP-IA model (Romer, 2000), we can write the IS, MP (monetary policy), and IA (inflation adjustment) functions as

$$Y = C(Y - T, R, S) + I(R, S) + G + NX[e(P^* / P), WY] \tag{1}$$

$$R = R(\pi - \pi^*, Y - Y^*, e - e^*, R^W) \tag{2}$$

$$\pi = \pi^e + \theta(Y - Y^*) + \lambda e \tag{3}$$

where

Y	= real GDP for Singapore,
C	= the consumption function,
T	= government tax revenues,
R	= the real interest rate,
S	= share stock index,
I	= the investment function,
G	= government spending,
NX	= net exports,
e	= the nominal effective exchange rate (an increase is an appreciation),
P*	= the price level in Singapore,
P	= the price level in selected countries,
WY	= world output,
π	= the inflation rate,
π^*	= the target inflation rate,
Y*	= potential output,
e*	= the target exchange rate,
R^W	= the world interest rate, and
π^e	= the expected inflation rate.

Suppose that a higher real interest rate would reduce household consumption spending, that currency appreciation hurts next exports, that more world output would help net exports, and that the Monetary Authority of Singapore would react positively to a higher inflation rate, more output and the world interest rate and negatively to exchange rate appreciation. Assume that (1), (2) and (3) have continuous partial derivatives. Let

$$\begin{aligned} &C_Y > 0, C_R < 0, C_S > 0, I_R < 0, I_S > 0, NX_e < 0, NX_{WY} > 0, \\ &R_\pi > 0, R_Y > 0, R_e < 0, R^{R^W} > 0, \pi_Y > 0, \pi_e < 0. \end{aligned} \tag{4}$$

The endogenous-variable Jacobian is given by

$$|J| = (1 - C_Y) - \theta R_\pi (C_R + I_R) - R_Y (C_R + I_R) > 0. \tag{5}$$

Applying the implicit-function theorem and solving for three unknowns Y, R, and π, equilibrium output $\bar{Y}$ is given by

$$\bar{Y} = \bar{Y}[\pi^e, G, T, e(P^*/P), S, R^W, WY; \theta, \lambda, \pi^*, Y^*, e^*] \tag{6}$$

Applying comparative static-analysis, the impact of a change in the nominal effective exchange rate on equilibrium output is given by

$$\begin{aligned} \frac{\partial \bar{Y}}{\partial(e)} &= \frac{NX_e(P^*/P) + \lambda R_\pi (C_R + I_R) + R_e (C_R + I_R)}{|J|} \\ &> 0 \; if \; |NX_e(P^*/P)| < |\lambda R_\pi (C_R + I_R) + R_e (C_R + I_R)| \\ &< 0 \; if \; |NX_e(P^*/P)| > |\lambda R_\pi (C_R + I_R) + R_e (C_R + I_R)| \end{aligned} \tag{7}$$

Hence, the appreciation of the Singapore dollar would raise (reduce) output if the positive impact of increased consumption and investment spending caused by a decreased interest rate is greater (less) than the negative effect of decreased net exports. Bahmani-Oskooee and Miteza (2003) reviewed many previous articles and indicated that the influence of currency devaluation on output is unclear, depending upon the specification of a model, the country under study, the time period, the methodology employed in empirical work, and other factors. The impact of a change in stock prices or the world interest rate on equilibrium output is given by (8) and (9), respectively

$$\frac{\partial \bar{Y}}{\partial(S)} = \frac{(C_S + I_S)}{|J|} > 0 \tag{8}$$

$$\frac{\partial \bar{Y}}{\partial(R^W)} = \frac{R_{R^W}(C_R + I_R)}{|J|} < 0 \tag{9}$$

An increase in the stock price is expected to raise equilibrium output because household consumption and business investment expenditures would increase due to the wealth effect, Tobin's q theory, and the balance-sheet channel (Mishkin, 1995; Kuttner and Mosser, 2002). When the world interest rate rises, the central bank is likely to respond in a similar manner in order to follow the trend.

To avoid a high degree of multicollinearity, government deficit spending defined as D = G – T is used in empirical work. The sign of budget deficits may be positive since it would shift aggregate demand upward, uncertain or temporary (Ramsey and Shapiro, 1998; Blanchard and Perotti, 1999; Taylor, 2000; Burnside, Eichenbaum and Fisher, 2000), or neutral in the long run due to the Ricardian-equivalence hypothesis (Barro, 1989).

3. Empirical Results

The sample ranges from 1986.Q2 to 2003.Q2. Real GDP is an index number with 1995 as the base year. Numerical values for real GDP at the 1995 price are not used because the series began in 2000.Q4. The expected inflation rate π^e is the weighted average inflation rate of past four quarters (Davidson and MacKinnon, 1985). Real government deficit is expressed in billions. The real effective exchange rate ε is equal to weighted foreign currencies per Singapore dollar adjusted for relative prices. Hence, an increase in ε is a real appreciation, and vice versa. The world interest rate is represented by the U.S. federal funds rate due to its significant impacts worldwide. World industrial output for industrialized countries is chosen to represent world output. Variables are measured in the logarithmic scale except for the expected inflation rate and real deficit spending due to negative values.

Unit roots are tested first. Based on the ADF test, π^e is stationary in levels at the 5% level, Y, D, ε, S, R^W and WY have unit roots in levels at the 5% level, and all the variables are stationary in first difference at the 1% level. Applying the Johansen test, the value of the trace statistic is 267.11 compared with the critical value of 133.57 at the 1% level. Thus, the null hypothesis of a zero cointegrating relationship can be rejected. Hence, these variables have a long-term stable relationship.

To examine the short-run dynamics, the error-correction model (ECM) with a lag length of 3 is estimated and presented in Table 1. The results show that the coefficient for the error-correction term is significant at the 5% level. The estimated regression and related statistics are presented in Table 2. All the coefficients in the regression are significant at the 1% level except for that of real government deficit spending, which is insignificant at the 10% level. Equilibrium output is negatively influenced by the expected inflation rate and the U.S. federal funds rate and positively affected by real exchange rate appreciation, stock prices, and world output. Equilibrium output in logarithm would decline by 0.040 if the expected inflation rate rises by one percentage point. If the real effective exchange rate rises by 1%, real GDP would increase by 0.872%. An increase in world output by 1% is expected to raise Singapore output by 2.0%.

Several comments can be made. The insignificant coefficient for government deficit spending suggests that Singapore's conservative fiscal policy to maintain budget surpluses in the long run is appropriate. The positive coefficient of stock prices indicates that when stock prices increase, households would spend more due to the wealth effect and that firms would investment more due to Tobin's q theory or the Balance-sheet channel. Because real exchange rate appreciation would help raise output, the conventional approach to devalue a currency to stimulate the economy would not apply to Singapore. The Monetary Authority of Singapore would be rational to change the domestic interest rate in response to the world interest rate in order to keep international investments from flowing out of Singapore. The current relatively low interest rate, which was initiated by the Federal Reserve Bank in the U.S., is expected to stimulate consumption and investment spending in Singapore. Lastly, the Singapore economy will be helped by a stronger world economy since its international trade plays a major role in its economic growth.

4. Summary and Conclusions

In this paper, the author has applied IS-MP-IA model (Romer, 2000) to examine the impacts of changes in selected macroeconomic variables on real output for Singapore. Empirical outcomes suggest that the IS-MP-IA model seems to work well. A lower expected inflation rate, a higher real effective exchange rate, a higher stock price, a lower world interest rate, and more world output are expected to increase equilibrium output for Singapore.

There are several policy implications. The Monetary Authority of Singapore plays a significant role in determining the directions and magnitude of output fluctuations when the economy responds to a change in any of the right-hand side variables. The world interest rate and world output are external forces that are beyond Singapore's control. More world output or a lower world interest rate leading to a lower domestic interest rate would help the Singapore economy because they would stimulate household consumption, business investment expenditures, and net exports. The potential impact of real depreciation on an economy is more complicated than some would expect. The positive effect of real appreciation on the Singapore output may be attributable to the benefits of lower import prices, lower domestic inflation, inflows of capital and other factors. Because stock market performance would affect equilibrium output positively, it would be appropriate for the Singapore government to maintain a healthy stock market, reduce irregularities, and encourage international fund managers to invest in Singapore.

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Table 1. Estimated Error-Correction Model: 1987.Q2 – 2003.Q2

$d(\overline{Y}(-1))$	$d(\overline{Y}(-2))$	$d(\overline{Y}(-3))$	$d(\pi^e(-1))$	$d(\pi^e(-2))$	$d(\pi^e(-3))$
-0.689987	-0.490882	-0.186028	-16.30669	3.316279	-12.07723
(-4.14704)	(-2.49817)	(-1.17501)	(-1.73238)	(0.30901)	([-1.33757)
d(D(-1))	*d(D(-2))*	*d(D(-3))*	$d(\varepsilon(-1))$	$d(\varepsilon(-2))$	$d(\varepsilon(-3))$
-0.915905	-0.629861	-0.476803	0.332378	-1.509583	-1.54614
(-2.38015)	(-2.35287)	(-1.47807)	(0.46928)	(-2.15016)	(-2.13213)
d(S(-1))	*d(S(-2))*	*d(S(-3))*	R^W	*WY*	*INT*
-0.125088	-0.090914	-0.000576	-0.039349	0.465783	-42.35623
(-1.17555)	(-0.83853)	(-0.00600)	(-0.08421)	(1.78279)	(-1.65257)
EC					
-0.235506					
(-2.14049)					

R^2	0.562293
Adj. R^2	0.391016
F-statistic	3.282946
Log likelihood	-192.4902
Akaike AIC	6.507391
Schwarz SC	7.142981

EC: the error-correction term.
INT: the constant term.

Table 2. Estimated Regression of Equilibrium GDP for Singapore: 1986.Q2 – 2003.Q2

Dependent Variable: LOG($\overline{Y}$)
Method: Least Squares
Sample(adjusted): 1986:2 2003:2
Included observations: 69 after adjusting endpoints
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.070648	0.371920	-24.38871	0.0000
π^e	-0.039652	0.012338	-3.213690	0.0021
D	0.001132	0.003436	0.329446	0.7429
LOG(ε)	0.871614	0.103694	8.405670	0.0000
LOG(*S*)	0.127557	0.028581	4.463020	0.0000
LOG(R^W)	-0.092466	0.011770	-7.856253	0.0000
LOG(*WY*)	1.999771	0.089124	22.43820	0.0000
R-squared	0.973252	Mean dependent variable		4.472525
Adjusted R-squared	0.970663	S.D. dependent variable		0.357097
S.E. of regression	0.061164	Akaike info criterion		-2.654599
Sum squared residuals	0.231942	Schwarz criterion		-2.427951
Log likelihood	98.58368	F-statistic		375.9832
Durbin-Watson stat	1.706793	Prob (F-statistic)		0.000000

$\overline{Y}$ is equilibrium real GDP.
π^e is the weighted inflation rate of past four quarters.
D is real government deficit spending.
ε is real effective exchange rate. An increase is real appreciation.
S is stock price index.
R^W is the U.S. federal funds rate.
WY is world output.