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Financial, Exchange Rate, and Wage Policies in Singapore, 1979–86

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SINGAPORE'S recent experience with the conduct of financial and exchange rate policies suggests that the authorities' ability to implement an independent monetary policy has been constrained. Because the economy is small and highly integrated with international markets, movements in the money supply have been influenced significantly by developments in the external sector, and domestic interest rates have been determined largely by foreign rates.[1] At the same time, the authorities' exchange rate policy has been geared toward the often conflicting objectives of mitigating external inflationary pressures and sustaining economic activity by increasing external competitiveness.

The cornerstone of financial policies in Singapore has been budgetary discipline, evidenced by the government's budget surpluses that have been recorded every year since the late 1960s. These surpluses have been substantially augmented by savings generated by the social security scheme (Central Provident Fund) and government-controlled financial institutions (for example, the Post Office Savings Bank), which have been deposited in government accounts with the Monetary Authority of Singapore (MAS). Consequently, government financial operations have drained liquidity from the banking system, creating persistently tight liquidity conditions.

Because the banking sector has easy access to international capital markets, the tight conditions of domestic liquidity have been eased by the inflow of funds from abroad. In the process, the authorities have provided domestic liquidity to the banking system by purchasing foreign exchange from, or arranging swap transactions with, the commercial banks.[2] As a

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[1] Edwards and Khan (1985) found that over 90 percent of movements in domestic interest rates in Singapore were explained by changes in foreign rates.

[2] Under these swap arrangements, the MAS typically purchases foreign exchange from commercial banks at the prevailing spot exchange rate with the provision to unwind the swap on a future date at a rate determined at the time of the arrangement.

result, the short-run increases in the net foreign assets of the MAS have been closely associated with increases in government deposits with the MAS. Reflecting these financial policies, monetary aggregates have exhibited significant short-term fluctuations, but over the longer run the upward trend in foreign assets has sustained the underlying growth of domestic liquidity.

Exchange rate movements have reflected the authorities' reserve management policies. During 1979–84, increases in foreign reserves were rather moderate, and the effective exchange rate of the Singapore dollar appreciated substantially.[3] Since early 1985, however, the level of reserves has risen sharply, and the effective exchange rate depreciated markedly, reversing most of the appreciation that had taken place earlier.

To benefit from the emerging pattern of external demand, the authorities pursed a high wage policy during 1979–85 with a view to inducing a shift in production away from labor-intensive to capital-intensive and "high-tech" activities. During this period labor costs increased at an annual average rate of 15 percent as nominal wages increased rapidly and the employers' (as well as workers') contributions to the Central Provident Fund were raised significantly. This wage policy had important implications for Singapore's external competitiveness and, thus, for economic activity. During the first half of the 1980s, Singapore's external competitiveness, measured in relative unit labor costs adjusted for the exchange rate, deteriorated by more than 60 percent, contributing to the slowdown in economic activity and to the severe, but short-lived, recession in 1985—the first decline in more than two decades. In 1986, concerned with the loss of external competitiveness, the authorities implemented several measures to reduce labor costs, including imposing limits on nominal wage increases and reductions in contributions to the Central Provident Fund. The reduction in unit labor costs, together with the depreciation of the Singapore dollar, helped to regain some of the lost external competitiveness and contributed to economic recovery.

Although the causal links between key macroeconomic variables described above have been well identified, there has been little attempt to formalize such relationships.[4] The present paper is an attempt to fill this gap. The major objectives are to analyze transmission processes and to quantify the importance of alternative policy instruments in influencing key macroeconomic variables, including output, prices, the ex-

[3]This rate is defined as a weighted average of the bilateral exchange rates between the Singapore dollar and the currencies of Singapore's major trading partners and competitors.

[4]Different aspects of financial and exchange rate policies in Singapore have been reviewed by studies contained in Singapore (1981).

change rate, and foreign reserves. For this purpose, a simple short-term model is formulated and estimated, and various policy simulations are conducted.

Section I discusses the underpinnings to the specification of the model, taking into account the unique features of the Singapore economy. Section II presents the estimates of the behavioral equations, and Section III analyzes the simulation results based on alternative policy scenarios. Section IV makes some concluding remarks and draws policy implications for macroeconomic management in Singapore. Data sources and definitions are given in the appendix.

I. Model Specification

In this section a simple macroeconomic model is formulated to describe the movements of foreign reserves, the exchange rate, prices, real output, and government revenue and expenditure.

Foreign Reserves

Because financial operations have consistently resulted in a significant drainage of liquidity, as explained earlier, a familiar feature of financial operations in Singapore has been increases in net foreign assets to eliminate the domestic excess demand for money. To describe this aspect of adjustment, we assume that actual holdings of real money balances (M/P) adjust with a lag to the difference between the desired holdings $(M/P)^d$ in the current period and the actual holdings in the previous period.[5] The rationale behind this equation is that, if the current demand exceeds the actual holdings in the previous period, the public adjusts its holdings by adding to its balances, and vice versa. This partial adjustment mechanism, expressed in terms of natural logarithms, can be described as

$$\Delta \ln (M/P)_t = k\,[\ln (M/P)_t^d - \ln (M/P)_{t-1}], \tag{1}$$

where k is the coefficient of adjustment and is expected to be positive and less than unity, and Δ is the first-difference operator.

The demand for real balances is specified as a function of real output (Y) and the domestic interest rate (r_d), with the latter measuring the opportunity cost of holding money:

$$\ln (M/P)_t^d = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 (r_d)_t, \tag{2}$$

[5]In analyzing the money demand in Singapore, Khan (1981) found that the empirical results rendered considerable support for this type of dynamic specification.

where α_1 denotes the income elasticity and is expected to be positive, and α_2 is the semi-interest-rate elasticity and is expected to be negative.

From the money supply identity, changes in the stock of money are equal to the sum of changes in net foreign assets (R) and changes in net domestic assets (D):

$$\Delta M_t = \Delta R_t + \Delta D_t. \tag{3}$$

This relation can be log-linearized about the sample means and expressed in terms of the rate of change of variables in real terms as

$$\Delta \ln (M/P)_t = m_0 + m_1 \Delta \ln (R/P)_t + m_2 \Delta \ln (D/P)_t, \tag{4}$$

where $m_1 = (\overline{R}/\overline{M})$ and $m_2 = (\overline{D}/\overline{M})$ are, respectively, ratios of the sample means of net foreign assets and net domestic assets to the money supply, lagged by one period.

Substituting equations (2) and (4) in equation (1) and rearranging terms result in an equation that expresses the rate of change of net foreign assets in real terms as a function of variables in the demand for money equation, the lagged level of real balances, and the rate of change of domestic assets in real terms:

$$\Delta \ln (R/P)_t = (m_0 + k\alpha_0)/m_1 + k\alpha_1/m_1 \ln Y_t + k\alpha_2/m_1 (r_d)_t - k/m_1 \ln (M/P)_{t-1} - m_2/m_1 \Delta \ln (D/P)_t. \tag{5}$$

According to equation (5), reserve accumulation occurs as long as the demand for money is left unsatisfied at the beginning of the period and is not met by domestic credit creation during this period.[6]

Exchange Rate

Exchange rate policy in Singapore should be viewed as an integral part of the authorities' financial management. By providing domestic liquidity to the commercial banks through swap arrangements or outright purchases of foreign exchange, the authorities have accumulated foreign assets to relieve the upward pressure on the exchange rate. At the same time, however, the authorities have had to consider the implications of the intervention policy for monetary stability and thus face a trade-off between the exchange rate and monetary objectives.[7]

[6]This formulation is consistent with the monetary approach to the balance of payments, as highlighted by Frenkel and Johnson (1976) and International Monetary Fund (1977), and as applied to small open economies by Otani and Park (1976) and Sassanpour and Sheen (1984).

[7]Branson (1981) emphasized the importance of this type of t ade-off facing the policymakers in a small open economy such as Singapore.

It may be argued that the change in the exchange rate is a function of the gap between the authorities' desired level of the exchange rate (E^d) and the actual rate prevailing in the preceding period (E_{t-1}), as shown in equation (6):

$$\Delta \ln E_t = \phi[\ln E_t^d - \ln E_{t-1}], \tag{6}$$

where ϕ is the adjustment coefficient and is expected to be positive and less than unity; E is defined as the value of the domestic currency in terms of the foreign currency, such that an increase in E denotes an appreciation of the Singapore dollar.

The desired level of the exchange rate in a given period is assumed to be set by the authorities, who take into consideration the ratio of foreign assets to total assets at the end of the preceding period. As the level of foreign assets increases relative to domestic assets, reflecting the sales of domestic currency to the banking system, the desired level of the exchange rate would be lowered, other things being equal. In addition, the desired level of the exchange rate is assumed to respond to the discrepancy between the foreign inflation rate (Π_f) and the domestic rate (Π), with the lagged exchange rate as an anchor. This inflation rate differential can be interpreted as an indicator representing the premium or discount on the Singapore dollar, or as the *expected* rate of change in the exchange rate:[8]

$$\ln E_t^d = \beta_0 + \beta_1 \ln (R/D)_{t-1} + \beta_2[(\Pi_f - \Pi)_t + \ln E_{t-1}], \tag{7}$$

where β_1 is expected to be negative and β_2 to be positive. In this equation, if the role of foreign reserves becomes negligible in the authorities' exchange rate policy, the desired level of exchange rate would be influenced more by purchasing power parity, and thus the value of β_2 would be close to unity. In this case, the real exchange rate would be constant in the long run. In contrast, if the role of foreign reserves becomes significant, β_2 would be close to zero, and the real exchange rate may not be constant in the long run.

Combining equations (6) and (7), we can express the dynamic adjustment of the exchange rate as

$$\Delta \ln E_t = \phi\beta_0 + \phi\beta_1 \ln (R/D)_{t-1} + \phi\beta_2(\Pi_f - \Pi)_t + (\beta_2 - \phi) \ln E_{t-1}. \tag{8}$$

[8] Had information been available on the premium or discount of the Singapore dollar in relation to the currencies of Singapore's major trading partners and competitors, such information could have been used in place of the inflation rate differential. This information is available, however, only for the exchange rate between the Singapore dollar and the U.S. dollar.

This functional specification is the authorities' reaction function and reflects their foreign reserve management policy as well as other factors influencing the exchange rate.[9]

Prices

The wholesale price index in Singapore, which is composed entirely of price indices of traded goods, reflects price developments in the world markets as well as movements in the exchange rate. Therefore, variations of the wholesale price index (P_w) are specified as a function of changes in import prices (P_m) and export prices (P_x), both denominated in terms of domestic currency:

$$\Delta \ln (P_w)_t = w_0 + w_1 \Delta \ln (P_m)_t + w_2 \Delta \ln (p_x)_t, \tag{9}$$

where w_1 and w_2, respectively, measure the contribution of import and export prices to changes in P_w. Both P_m and P_x are exogenously determined world market prices of Singapore's imports and exports, adjusted for the exchange rate.[10]

The rate of change in the consumer price index—$\Pi = \Delta \ln P$—has diverged from that in the wholesale price index, mainly because of changes in prices of nontraded goods in response to domestic demand and supply conditions. Thus the rate of change in the consumer price index is specified in equation (10) below as a function of the excess supply of domestic liquidity, which may serve as a counterpart to excess demand for nontraded goods. The domestic rate of inflation is also expected to respond positively to the excess of real output above its potential level. The potential output path, in logarithms, is defined as $Y_0 e^{\mu T}$, where Y_0 is the initial output level, μ is the potential (or steady-state) growth rate, and T is the time-trend term. In addition to demand and supply forces described above, the rate of change in the wholesale price index is included as an explanatory variable to capture the influence of traded-goods prices on the consumer price index:

$$\begin{aligned} \Delta \ln P_t = {} & \gamma_1 [\ln (M/P)_{t-1} - \ln (M/P)_t^d] \\ & + \gamma_2 \ln (Y/Y_0 e^{\mu T})_t + \gamma_3 \Delta \ln P_w)_t, \end{aligned} \tag{10}$$

[9]Equation (8) could be only one of many plausible specifications to represent the authorities' reaction function. It is not the purpose of this paper, however, to identify their true reaction function; such an attempt would require testing alternative reaction functions.

[10]That is, $P_m = P_m^*/E$ and $P_x = P_x^*/E$, where P_m^* and P_x^* are world market prices of imports and exports, respectively.

where γ_1, γ_2, and γ_3 are expected to be positive. Combining equations (2) and (10) and rearranging terms result in

$$\begin{aligned}\Delta \ln P_t = &-(\gamma_1\alpha_0 + \gamma_2 \ln Y_0) + \gamma_1 \ln (M/P)_{t-1} \\ &+ (\gamma_2 - \gamma_1\alpha_1) \ln Y_t - \gamma_1\alpha_2(r_d)_t \\ &+ \gamma_3 \Delta \ln (P_w)_t - \gamma_2\mu T. \end{aligned} \tag{11}$$

Real Output

Given the openness of the economy and the limited size of the domestic market,[11] overall economic activity in Singapore is dominated by the activity in the external sector, which in turn is influenced in large part both by external demand conditions for Singapore's output and by domestic supply factors. As a result, the behavioral equation for real output needs to be derived from the demand and supply functions.

The world demand for Singapore's output could be posited as a function of the world real income (Y^*) and the real exchange rate, representing the ratio of Singapore's output price relative to that of its competitors in the world market ($E \cdot P/P^*$):[12]

$$\ln Y_t^d = \lambda_1 + \lambda_2 \ln Y_t^* + \lambda_3 \ln (E \cdot P/P^*)_t, \tag{12}$$

where λ_2 is assumed to be positive and λ_3 to be negative.

The supply of output in the short run is assumed to depend on the inverse of real wages (P/W) and the utilized capital stock (UK).

$$\ln Y_t^s = \delta_1 + \delta_2 \ln (P/W)_t + \delta_3 \ln (UK)_t, \tag{13}$$

where δ_2 and δ_3 are expected to be positive. Solving equation (13) for P, substituting the solution in equation (12), and assuming that the actual output equals the demand, we derive the output equation as

$$\ln Y_t = \psi_0 + \psi_1 \ln Y_t^* + \psi_2 \ln (E \cdot W/P^*)_t + \psi_3 \ln (UK)_t, \tag{14}$$

where

$$\psi_0 = \frac{\lambda_1\delta_3 - \lambda_3\delta_1}{\delta_2 - \lambda_3}, \quad \psi_1 = \frac{\lambda_2\delta_2}{\delta_2 - \lambda_3}, \quad \psi_2 = \frac{\lambda_3\delta_2}{\delta_2 - \lambda_3}, \quad \psi_3 = \frac{-\lambda_3\delta_3}{\delta_2 - \lambda_3}.$$

[11] The value of Singapore's exports has averaged about 140 percent of gross domestic product (GDP) in recent years.

[12] The domestic consumer price index was used as a proxy for the GDP deflator; although the latter would have been more appropriate in this equation, the former was chosen to limit the number of endogenous variables and provide a link with the rest of the model.

Given the sign conditions in equations (12) and (13), ψ_1 and ψ_3 are expected to be positive and ψ_2 to be negative. The term $E \cdot W/P^*$ is an indicator of external competitiveness and, for estimation purposes, is proxied by the relative unit labor costs adjusted for the exchange rate ($E \cdot RULC$), where $RULC$ is the ratio of Singapore's unit labor costs to that of its major trading partners.[13] The utilized capital stock is proxied by the real value of bank credit extended to the private sector (C_{ps}/P).[14] The first difference of equation (14), together with the proxy variables discussed above, yields the following equation:

$$\Delta \ln Y_t = \psi_1 \Delta \ln Y^* + \psi_2 \Delta \ln (E \cdot RULC)_t + \psi_3 \Delta \ln (C_{ps}/P)_t. \quad (15)$$

Government Finances

Government revenue has been increasing in Singapore because of high rates of economic growth and a buoyant tax structure. Public expenditure has also been rising in recent years, reflecting government efforts to meet the need for housing and infrastructure. Owing to budgetary discipline, however, expenditures have been maintained successfully within available domestic resources; indeed, since 1968 the government's fiscal operations have continuously resulted in surpluses.

Within this framework, the government expenditure (GE) function is formulated on the assumption that the government attempts to adjust its expenditure with a lag to increases in revenue. In other words, the more government revenue (GR) exceeds expenditure, the faster the latter rises:

$$\Delta \ln GE_t = g(\ln GR_t - \ln GE_{t-1}), \quad (16)$$

where g denotes the adjustment coefficient and is expected to be positive and less than unity. Rearranging terms in equation (16) leads to

$$\ln GE_t = g \ln GR_t + (1 - g) \ln GE_{t-1}, \quad (17)$$

which formulates government expenditure as a weighted average of current government revenue and the lagged level of expenditure.[15]

[13] Branson and Love (1988) also used the index of unit labor costs, adjusted for changes in the exchange rate, to represent external competitiveness.

[14] In many developing and newly industrialized countries, the availability of bank credit plays an important role in influencing the rate of capacity utilization. The role of credit in output functions has been emphasized by Kapur (1976) and Keller (1980).

[15] In the estimation process, a constant term was added to this equation to capture the budgetary surpluses that have been recorded.

Government revenue is specified simply as a log-linear function of nominal income:

$$\ln GR_t = q_0 + q_1 \ln (P \cdot Y)_t, \tag{18}$$

where q_1 measures the elasticity of total revenue with respect to nominal income.[16]

Domestic Assets

With the money supply identity defined as in equation (3), the monetary sector is completed by defining the net domestic assets (D) of the banking system. The change in net domestic assets is equal to changes in stock of credit to the private sector and changes in net credit to the government (GC), including other items (net):[17]

$$\Delta D_t = \Delta(C_{ps})_t + \Delta GC_t. \tag{19}$$

The change in net credit to the government (GC) is defined as

$$\Delta GC_t = (GE_t - GR_t) - GNBB_t, \tag{20}$$

where the first term represents budgetary operations and the second term indicates changes in net government borrowing from the banking system for nonbudgetary operations ($GNBB$). As a result of budgetary surpluses and funds generated by the social security scheme and other operations, the government has been a net depositor of funds with the banking system.

Working of the Model

The essence of the model,[18] which conforms with the variety of formulations suggested by the monetary approach to the balance of payments, is that reserve accumulation occurs as long as the demand for money is not satisfied by increases in net domestic assets (equation (5)). In this

[16] In this formulation, the actual and desired levels of revenue are assumed to be the same. Aghevli and Khan (1977) assumed that revenue adjusts with a lag to its desired level. This formulation was suggested for high-inflation countries because the authorities attempt to adjust revenue in the face of its declining value in real terms.

[17] Private sector credit is treated as an exogenous variable in this model. It could be assumed that the stock of credit to the private sector is, in principle, demand determined, and this demand is always met by the supply of credit from the banking system.

[18] The process described below is presented in a static framework, but the actual process should be viewed in a dynamic setting in which interactions among variables occur simultaneously. This is done in Section III.

model, the excess demand for money arises from the government's contractionary financial operations, which reflect traditional budget surpluses and sizable buildups of deposits by the government with the monetary authorities (equations (19) and (20)).

Because reserve accumulation reflects the monetary authorities' foreign exchange purchases from (or swaps with) the commercial banks, a significant reserve accumulation would prevent the exchange rate from appreciating (equation (8)). This effect would reinforce the direct influence of rising foreign prices on the traded-goods prices (equation (9)), which would in turn increase domestic consumer prices at a faster pace if they were rising, or decrease them at a slower pace if they were falling (equation (11)).

A more depreciated exchange rate would safeguard the external competitiveness and improve growth performance, provided that wage costs remain unchanged (equation (15)). A higher real output level, in turn, would increase the demand for money and reduce the pressure on domestic prices. Thus, the direct impact of exchange rate changes on these prices would be counteracted by the influence of output, and the net impact would depend on the relative size of the relevant coefficients.

Developments in domestic prices and real output have implications for the level of government revenue (equation (18)). To the extent that expenditure grows in line with revenue (equation (17)), however, the net monetary impact of budgetary operations should be minimal.

The upshot of the discussion is that a tight financial policy could trigger foreign exchange intervention that might induce a depreciation of the domestic currency and might lead eventually to an expansion of output. This possibility, however, depends on the values of the parameters of the behavioral equations and is thus an empirical question.

II. Empirical Results

Table 1 summarizes the estimates of the complete model, which comprises seven behavioral equations and three identities. The model is estimated by the two-stage least-squares method for the period 1979–86, using quarterly data.[19] The behavioral relationships are in general well estimated, and the model as a whole appears to capture the essential features of the Singapore economy.

[19]The beginning of the observation period corresponds to the first full year following the total liberalization of exchange controls in June 1978. Thus the structural equations specified in this model may not be suitable for the period before mid-1978.

Table 1. Estimated Model, 1979–86

Item	Estimated Equation
	Behavioral equations
Foreign reserves[1]	$\Delta \ln (R/P)_t = -4.55 + 1.01 \ln (Y)_t - 1.1 (r_d)_t - 0.81 \ln (M/P)_{t-1} - 0.39 \Delta \ln (D/P)_t$ (3.4)** (4.5)** (2.2)* (5.5)** (5.5)**
	$\bar{R}^2 = 0.73$ SEE = 0.04 DW = 1.86
Exchange rate[2]	$\Delta \ln (E)_t = 0.07 - 0.04 \ln (R/D)_{t-1} + 0.37(\Pi_f - \Pi)_t - 0.28 \ln (E)_{t-1}$ (5.4)** (5.2)** (6.7)** (3.4)**
	$\bar{R}^2 = 0.76$ SEE = 0.01 DW = 1.70
Wholesale prices	$\Delta \ln (P_w)_t = 0.001 + 0.20 \Delta \ln (P_x)_t + 0.90 \Delta \ln (P_m)_t$ (0.1) (2.4)* (8.2)**
	$\bar{R}^2 = 0.96$ SEE = 0.01 DW = 1.92
Consumer prices[3]	$\Delta \ln (P)_t = 0.45 + 0.07 \ln (M/P)_{t-1} - 0.09 \ln (Y)_t + 0.10 (r_d)_t + 0.07 \Delta \ln (P_w)_t - 0.001 T$ (1.6) (1.9) (2.2)* (1.0) (1.3) (1.1)
	$\bar{R}^2 = 0.65$ SEE = 0.01 DW = 1.97

Output[1]	$\Delta \ln (Y)_t = \underset{(3.2)^{**}}{-0.01} + \underset{(4.4)^{**}}{0.35}\, \Delta \ln (Y^*)_t - \underset{(3.1)^{**}}{0.14}\, \Delta \ln (E \cdot RULC)_t + \underset{(7.5)^{**}}{0.82}\, \Delta \ln (C_{pt}/P)_t$
	$\bar{R}^2 = 0.78 \quad SEE = 0.02 \quad DW = 2.10$
Government revenue[1]	$\ln (GR)_t = \underset{(5.5)^{**}}{-11.90} + \underset{(9.1)^{**}}{1.47} \ln (P \cdot Y)_t + \underset{(3.0)^{**}}{0.50}\, Dummy^2$
	$\bar{R}^2 = 0.78 \quad SEE = 0.18 \quad DW = 1.51$
Government expenditure	$\ln (GE)_t = \underset{(1.4)}{1.15} + \underset{(4.8)^{**}}{0.57} \ln (GR)_t + \underset{(2.5)^{*}}{0.28} \ln (GE)_{t-1} + \underset{(2.1)^{*}}{0.50}\, Dummy^2$
	$\bar{R}^2 = 0.76 \quad SEE = 0.19 \quad DW = 2.28$
	Identities
Money supply	$\Delta M_t = \Delta R_t + \Delta D_t$
Domestic credit	$\Delta D_t = \Delta C_{pt,t} + \Delta CG_t$
Credit to government	$\Delta CG_t = GE_t - GR_t - GNBB_t$

Note: $\bar{R}^2$ is the adjusted coefficient of determination; SEE is the standard error of estimates; DW is the Durbin-Watson statistic; ** and * indicate that the estimated coefficient is significantly different from zero at a critical level of 1 percent and 5 percent, respectively.

[1] Corrected for autocorrelation in residuals by the Cochrane-Orcutt method.

[2] The dummy variable takes a value of unity for the first quarter of 1986, and of zero otherwise, to capture the once-and-for-all change in the accounting entries that resulted from the transaction of land ownership.

The estimated equation for foreign reserve movements suggests that the extent of these changes is indeed systematically related to the excess demand for money that is not met by changes in domestic credit. From this equation, the long-run income and interest rate elasticities of the demand for money are calculated to be about 1.2 and −0.1, respectively. Furthermore, using the average sample value of $m_1 = 0.7$, the adjustment coefficient, k, is estimated to be about 0.6, which implies that about 60 percent of the excess demand for money would be satisfied by reserve accumulation within one quarter and over 80 percent of this excess would be met within two quarters. The estimated speed of adjustment of the money market is therefore rather fast, which is consistent with the observation that Singapore's financial markets are highly integrated with the foreign markets.

Although movements in foreign reserves are found to be the principal mechanism for meeting changes in the excess demand for money, the level of these reserves relative to domestic assets is a significant factor influencing the level of the exchange rate. The estimated coefficient of this explanatory variable suggests that, as the level of foreign assets increases relative to the domestic assets, the upward pressure on the exchange rate is relieved. At the same time, the estimated coefficient of the term for the inflation rate differential is found to be statistically significant, indicating that the authorities have implicitly taken into account changes in relative prices in managing the exchange rate. The coefficient of the lagged endogenous variable, together with the coefficient of the inflation rate differential term, suggests that about 76 percent of the gap between the desired level and the actual level of the exchange rate is adjusted within a given quarter, indicating a reasonably rapid exchange rate adjustment.[20]

The rate of change in wholesale prices, as expected, is explained almost entirely by changes in import and export prices denominated in the domestic currency, indicating the openness of the economy and the role of the exchange rate in the transmission of inflationary pressures from abroad.[21] The rate of change of consumer prices, however, is influenced more by overall domestic conditions, which suggests that the demand and supply conditions for nontraded goods are important determinants of consumer prices.

[20]The estimates of ϕ and β_2 involve a second-degree polynominal in β_2. The roots of the polynominal are −0.76 and 0.49. Because β_2 is assumed to be positive and less than unity, only the latter root is the meaningful solution. Given $\beta_2 = 0.49$, ϕ is calculated to be 0.76.

[21]Although the sum of the point estimates of w_1 and w_2 exceeds unity, the variance-covariance matrix for these estimates suggests that, with a 95 percent probability, one cannot reject the hypothesis that the sum of w_1 and w_2 equals unity.

The coefficients of the estimated output function have the expected signs and are statistically significant. It is noteworthy that the availability of credit to the private sector, as observed in many developing and newly industrialized countries, is a significant factor for influencing short-term fluctuations in output. Moreover, it is found that the relative unit labor costs adjusted for the exchange rate play an important role in growth performance, as expected for a highly open economy such as Singapore.

The estimated equations for government revenue and expenditure capture the essential characteristics of the budgetary operations. The large and statistically significant elasticity of revenue with respect to nominal income reflects the progressive income tax structure in Singapore. The sum of two estimated coefficients in the expenditure equation is not significantly different from unity.[22] This finding indicates that attempts have been made to keep the level of expenditure in line with total revenue. The coefficient of adjustment for the expenditure equation is estimated to be in the order of 0.7, implying that about 90 percent of adjustment occurs within two quarters.

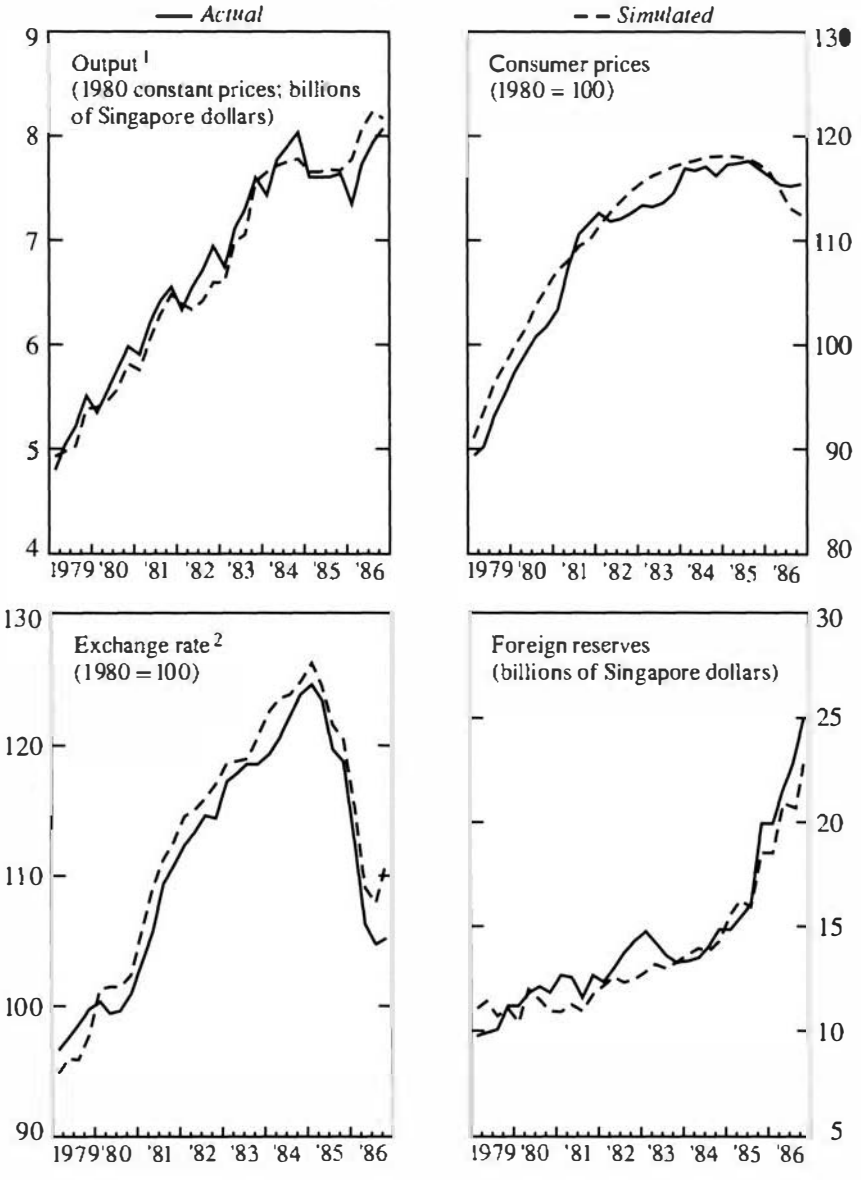
III. Simulation Results

This section analyzes the results of various simulation exercises. The major objectives are, first, to examine the overall explanatory power of the model and, second, to explore the impact of alternative policy scenarios on key macroeconomic variables.

For the purpose of investigating the overall performance of the model, the system of the estimated behavioral and the definitional equations were simulated dynamically during the observation period, 1979–86. The simulation results for the key variables are depicted in Chart 1. The comparison between the actual and the simulated values of real output, consumer prices, the exchange rate, and foreign reserves all suggest that the model as a whole tracks the recent developments rather well, capturing even major turning points—that is, the decline of output in 1985, the decline in consumer prices from mid-1985, and the sharp turnaround in the exchange rate in late 1984. The gaps between the actual and the simulated values for the consumer prices and the exchange rate are serially correlated for certain periods, but they do not seem to be excessive, given the tendency that the errors in a dynamic simulation are accumulated over time and hence are more magnified than in a static simulation.

[22]The variance-covariance matrix for the two coefficients in the government expenditure equation indicates that, with 95 percent probability, one cannot reject the hypothesis that the sum of the coefficient of ln (GR) and that of ln $(GE)_{t-1}$ equals unity.

Chart 1. Selected Macroeconomic Variables for Singapore, 1979–86



Note: Simulated values represent the results of dynamic simulation, taking as given the actual values of exogenous variables.

[1] Output measured in terms of real GDP.

[2] An increase indicates an appreciation of the Singapore dollar.

To examine the effects of policy actions and changes in exogenous factors on key macroeconomic variables, several simulation exercises were conducted.[23] One of the compelling issues facing the Singapore authorities in recent years has been the impact of the high-wage policy, pursued in the first half of the 1980s, on the performance of the economy in terms of output and employment. Although this is a complex issue, a partial answer may be provided by analyzing the results of a simulation exercise based on the assumption that the authorities' wage policy was rather conservative, such that the growth rate of nominal wages adjusted for changes in labor productivity was kept at the same rate as the weighted average of those in Singapore's major competitor countries. To capture this hypothetical case, it is assumed that the relative unit labor costs (unadjusted for the exchange rate) were fixed at the level of 1980 for the period 1981–86. Thus the assumed level of relative unit labor costs were, on average, about 16 percent below the actual level; all other exogenous variables take the actual values.

The results of this scenario (case 1) and that of the base run (dynamic simulation) are contained in Table 2. According to this simulation, the level of output would have been about 3 percent higher than the base-run outcome, mainly because this wage policy would have contributed directly to the improvement in Singapore's external competitiveness. A higher output level would have enlarged the excess demand for money and increased the need to supply domestic liquidity by purchasing foreign exchange. In turn, foreign reserves would have increased, the exchange rate would have declined, and external competitiveness would have improved. As indicated, compared with the base run, the level of foreign reserves would have been higher by about 6 percent and the nominal exchange rate would have been lower by about 1 percent. Primarily because of the output effect, consumer prices would have been slightly below the result suggested by the base-run simulation.

Another important issue facing the authorities has been the effectiveness of financial and exchange rate policies. To analyze this issue, consider case 2, which represents the hypothetical situation wherein the public sector financial institutions' deposits in the government's accounts with the MAS had been reduced by S$0.2 billion in each quarter. In other words, the equivalent of about 1 percent of total liquidity had been injected in the banking system in each quarter. In this situation, with the

[23] As suggested by Lucas (1976), however, the parameters of the behavioral relationships could change as the authorities pursue alternative policies. Thus, the results should only be interpreted as indicative of the direction of changes and of the rough magnitudes of the effects.

Table 2. Simulation Results, 1981–86

(Period average)

Simulation	Simulation Period	Foreign Reserves (In billions of Singapore dollars)	Exchange Rate (1980 = 100)	Consumer Prices (1980 = 100)	Output (In 1980 constant prices; billions of Singapore dollars)
Base run	1981–86	14.7	116.7	114.7	7.2
	1984–86	17.1	118.9	116.7	7.8
Case 1	1981–86	15.6	115.5	114.2	7.4
		(6.1)	(−1.0)	(−0.4)	(2.8)
Case 2	1984–86	15.7	120.8	116.8	7.8
		(−8.2)	(1.6)	(0.1)	(−0.3)
Case 3	1984–86	16.2	119.4	117.2	7.6
		(−5.3)	(0.4)	(0.4)	(−2.6)

Note: Figures in parentheses represent percentage differences from the base-run results. Case 1: relative unit labor cost is fixed at the level of end-1980 for the period 1981–86. Case 2: the government deposits with the Monetary Authority of Singapore (MAS) are reduced by S$0.2 billion in each quarter during 1984–86. Case 3: the quarterly growth rate of world income in real terms is reduced by 1 percentage point.

excess demand for liquidity being partially alleviated, the need for the monetary authorities to acquire foreign exchange would have been reduced, leading to a reduction in foreign reserves to a level about 8 percent below the base-run result. In the process, the domestic currency would have been allowed to appreciate by nearly 2 percent compared with the base-run outcome. This, in turn, would have contributed to stabilizing prices, but at the same time would have worsened external competitiveness and thus output performance. This scenario exemplifies the severe constraint that the authorities have been experiencing with their conduct of financial and exchange rate policies.

To highlight the impact of external demand conditions, case 3 examines the hypothetical situation wherein the growth rate of world income in real terms had been 1 percentage point less than the actual growth rate, or the average level of that income had been about 6.5 percent lower than the actual. In this case Singapore's output would have been about 3 percent lower than the base run, indicating that approximately half of the variation in the world economic activity would have been transmitted to Singapore. Because a lower output level would have reduced the demand for liquidity, the level of international reserves would have been about 5 percent below the level suggested by the base-run simulation. Lower foreign reserves would have contributed in turn to an appreciation of the Singapore dollar compared with the base-run result. Despite this appreciation, consumer prices would have risen, mainly as a result of a lower level of output relative to the liquidity position of the economy.

IV. Concluding Remarks

The purpose of this paper has been to examine the impact of financial, exchange rate, and wage policies in Singapore on key macroeconomic variables such as output, prices, and foreign reserves. Toward this end, a simple short-term model was formulated, estimated, and used to conduct several policy simulations. A few conclusions can be drawn from this analysis.

First, the exchange rate policy in Singapore has been largely influenced by the liquidity implications of the government's contractionary budgetary and other financial operations. As a result, there has been a trade-off that the authorities need to consider in their decision to adopt a particular mix of exchange rate and reserve levels.

Second, the authorities' high-wage policy pursued in the first half of the 1980s contributed to rapid increases in the domestic labor costs relative to those of Singapore's competitors. This, together with the sharp appreciation of the Singapore dollar, contributed to a significant loss of

external competitiveness and a severe recession in 1985. Had the authorities adopted a more moderate wage policy, the output would have been significantly higher than the actual, and the 1985 recession probably would have been avoided, or at least its severity would have been reduced. Now that the relative unit labor costs adjusted for the exchange rate have declined to a level prevailing in the early 1980s, reflecting both the depreciation of the domestic currency and the sharp decline in wages and other labor costs, growth prospects should improve noticeably over the medium term.

Third, considering the openness of the economy, economic activity has been influenced by the external environment, particularly the level of world income in real terms. The model estimates suggest that financial and exchange rate policies had relatively limited influence in insulating the domestic economic activity from external shocks, mainly because price stability was also one of the major objectives of the authorities.

The experience of Singapore, albeit unique in many respects, may offer some lessons for other countries with small and highly open economies and no impediments to international capital movements. Singapore's experience suggests that flexibility in financial, exchange rate, and wage policies is crucial in achieving noninflationary growth with external payments viability. Should exchange rate policy to improve external competitiveness jeopardize an inflation target, as is often the case in many open economies, other policy instruments merit consideration. As demonstrated in this paper, an appropriate wage policy may be an important complement to the exchange rate policy. Over the longer run, these policies could help to maintain external competitiveness and to adapt the structure of production to the changing pattern of external demand. The vulnerability of these economies to external developments would thus be lessened.

APPENDIX

Data Sources and Definitions

Data used for estimation were obtained from various issues of four primary sources:

A. International Monetary Fund, *International Financial Statistics* (Washington).
B. International Monetary Fund, *Direction of Trade Statistics* (Washington).
C. Singapore, Department of Statistics, *Monthly Digest of Statistics.*
D. Singapore, Monetary Authority of Singapore, *Monthly Statistical Bulletin.*

Variables were defined as follows (with data sources indicated as above):

R	Net foreign assets of the banking system (Source A)
M	Broad money--currency plus demand deposits plus quasi-money (Source A)
C_{ps}	Outstanding credit to the private sector by the banking system (Source A)
D	Domestic credit (Source A)
CG	Net claims on the government (Source A)
GE	Government expenditure including net lending (Source A)
GR	Government revenue (Source A)
$GNBB$	Government nonbank borrowing (Source A)
E	Nominal effective exchange rate (calculated from data provided in Sources A and B)
P	Consumer price index (Source A)
P_w	Wholesale price index (Source A)
P_x	Export price index (Source A)
P_m	Import price index (Source A)
$RULC$	Ratio of Singapore's unit labor costs to that of its major trading partners and competitors (calculated from data provided in Sources A, B, and C)
r_d	Three-month interbank deposit rate (Source D)
Π	Percentage change in P (Source A)
Π_f	Percentage change in the arithmetic average of export and import prices in foreign currency terms (Source A)
Y	Real GDP (Source C)
Y^*	Weighted average of real GDP or gross national product (GNP) in Singapore's major trading partner countries (Source A).

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