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Domestic Credit and Exchange Rates in Developing Countries: Some Policy Experiments with Korean Data 1/

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Summary

This paper analyzes the efficacy of alternative exchange rate and credit policies aimed at stabilization in response to disturbances from various sources. It begins by estimating a model, appropriate to a developing country in certain institutional respects, in which monetary disequilibria exert a pervasive influence. The model is subjected to shocks from three different sources--the domestic real economy, domestic financial circumstances, and the external terms of trade--and alternative policy reactions are evaluated with respect to each of these shocks. A few generalizations may be culled from the detailed results. First, in some circumstances, the most effective policies for stabilizing expenditure, income, or the trade balance entail unacceptably large fluctuations in exchange rates or prices so that less drastic measures may well be preferred. Second, the source of a disturbance is more important to determining the best policy response than the manifestation of the disturbance. Inflation that results from domestic monetary expansion might call for a completely different policy response from inflation owing to a change in the external terms of trade. Finally, some judgment about the duration of the disturbance is an essential element in deciding upon the appropriate policy response. The effects of discretionary policy actions often persist long after the circumstances that elicited them have disappeared.

I. Introduction

This paper models alternative policy responses to various sorts of disturbances--or "shocks"--to the steady state path of a developing economy. Its objective is to arrive at some generalizations about

1/ Comments and suggestions by Bijan Aghevli, David Burton, Padma Gotur, William Hemphill, Russell Kincaid, Malcolm Knight, Susan Schadler, V. Sundararajan, and Clifford Wymer have greatly improved this paper.

appropriate credit and exchange rate policies. 1/ The typical "developing" country with which the paper is concerned is small (that is, it exercises no monopoly power over its trade), its structure of production and finance is relatively undifferentiated, its external capital flows are restricted, and its trade is subject to some quantitative restrictions. The model, in terms of which the analysis is conducted, reflects these characteristics and, in line with the objective of modeling financial policy alternatives, assigns a central role to money. Monetary stock disequilibria affect trade, absorption, and prices directly, but the model cannot be characterized as a simple monetary approach to the balance of payments in that absorption and the restrictive system governing trade are modeled explicitly. 2/3/

The specification recognizes the importance of expectations in asset demand functions (that is, in this case, the demand for money) but expectations enter flow equations only indirectly via stock disequilibria. These expectations are Muth-rational insofar as they are consistent with the solution of the model. In modeling the policy alternatives, it is difficult, as usual, to claim complete immunity from the standard criticism of such exercises--namely that behavioral parameters adjust to incorporate any systematic information on economic policy. 4/ Such criticism may be even more trenchant insofar as behavioral relationships are estimated in a basic model upon which various counterfactual policy responses are then imposed. Nevertheless, the questions addressed are relevant and no other mechanism for examining them quantitatively is available. The results should be seen as illustrative rather than having precise numerical significance.

The policy analysis consists of two sets of counterfactual simulations: one testing the efficacy of various policy responses to temporary shocks, the other examining policy responses to permanent changes in the economic environment. In each set, three types of shocks (or sustained changes) are examined: a domestic supply shock, a money demand shock, and a terms of trade shock. In both sets of simulations, six different policy packages--ranging from very strict rules, such as a fixed exchange rate and a fixed rate of domestic credit expansion, to systematic adjustments in both the exchange rate and credit policy--are examined in response to each of the shocks.

1/ It builds upon earlier work by the author--Lipschitz (1978 and 1979)--and related work by Hemphill (1974) and Sundararajan (1983).

2/ Trade is extremely important--for example, in situations of export-led growth--but is difficult to model. A number of recent papers invoke the literature on the monetary approach to the balance of payments as a justification for ignoring trade and focusing exclusively on below-the-line reserve changes. Branson (1983) provides criticism of this approach.

3/ See Frenkel et al (1980) for a synthesis of the various approaches to balance of payments analysis.

4/ See Lucas (1976).

Among the general points that emerge from the analysis, it is worth mentioning a few at the outset. First, exchange rate changes are a powerful instrument of adjustment even when the estimated price elasticities of trade are small. Second, even in a country that does not have an open financial system integrated with the rest of the world, monetary conditions have a large and rapid effect on the balance of payments. Third, in many cases the most effective policies for stabilizing the external balance entail large fluctuations in exchange rates and prices. To the extent that these fluctuations are themselves regarded as unacceptably costly, less drastic measures may be preferred. Fourth, the source of a disturbance to the economy is often more important to determining the best policy response than the manifestation of the disturbance. So, for example, inflation that results from unwarranted monetary expansion might require a different policy reaction from that required by the same rate of inflation owing to a rise in import prices. Fifth, policy adjustment lags--that is, lags between disturbances and policy reactions--are very important. The length of these lags may significantly affect the path of the economy especially when the disturbance to the economy is of short duration. Finally, the appropriate policy response to any disturbance depends on the expected duration of the disturbance; forming a view on this is probably the most difficult element of policymaking.

II. Specification of the Model

The model focuses principally on the transmission mechanisms through which monetary stock disequilibria affect flow demand and supply. Monetary impulses can affect the economy via interest rates, prices, or monetary stock disequilibria entering directly into flow excess demand functions. The traditional (IS-LM) Keynesian models focussed exclusively on interest rate transmission, the early monetarists focussed chiefly on prices and the real balance effect. Both often worked in an equilibrium framework. This model allows monetary disequilibrium to persist and to affect the goods' market directly. 1/

Monetary disequilibria can be dissipated through changes in prices, output, or the balance of payments. The extent to which monetary equilibrium is restored through each of these mechanisms depends upon a number of other variables such as current capacity utilization, the restrictiveness of the trade regime, and relative price developments. These elements are modeled explicitly.

The basic model consists of four behavioral equations and two identities. It is estimated using quarterly Korean data for the period 1965 to 1978--a period of rapid economic development and political

1/ Other recent papers--for example, Blejer (1977)--have allowed monetary stock disequilibrium to have an effect on flow equations, but have not allowed the effect to be determined in so general a framework.

stability. 1/ The inflation rate, export volume, import volume, and real absorption are determined by behavioral equations, real income, and nominal money by identities. Subsequently, the model is expanded to include reaction functions for exchange rate policy and domestic credit policy. There is no explicit money demand equation, although the parameters of the money demand function are estimated implicitly. The behavioral equations are all loglinear and the identities are linearized in logarithmic form about the trend values of included variables. In the description of the model, lower-case letters refer to the logarithms of the variables represented by the corresponding upper-case letters.

1. The monetary disequilibrium

The desired stock of real money balances at the end of period t-1 is postulated to depend upon the nominal interest rate on alternative assets in period t (I_t) and expected real expenditure in period t. 2/ In the first, and simplest, version of the model, the nominal money supply is the sum of an exogenously set domestic credit counterpart and a net foreign assets counterpart that results from past external payments imbalances and can be adjusted through the balance of payments over the ensuing period. Prices too are endogenously determined by foreign prices, excess demand for domestic goods, and the exchange rate which is treated as exogenous in the first version of the model. The discrepancy between actual and desired real money balances at the beginning of the period affects flows during the period. 3/

The notation for expected variables is as follows: $E(abs_t;\ t-1)$ denotes the expected value of real absorption during period t on the basis of information available at the end of period t-1. Denoting the logarithm of the price index by p, the monetary disequilibrium term that affects flows in period t may be characterized as:

$$mdis_t = \alpha_0 + \alpha_1 E(abs_t;\ t-1) + \alpha_2 I_t - m_{t-1} + p_{t-1} \qquad (1)$$

1/ Obviously, there is no "typical" developing country, and the rapid growth in Korea is hardly typical. Even in the limited sense specified, Korea is more representative of the characteristics of a developing country in the early part of the sample period than toward the end. Nevertheless, the availability and reliability of Korean data, and the fact that no major modifications were required to fit the institutional characteristics of the country, encouraged the use of Korea as a test case. A detailed description of the data is provided in Appendix I.

2/ Broad money is used. This is consistent with the Bank of Korea exercising control over the entire banking system rather than only the monetary base, and with the empirical findings of Park and Ha (1982).

3/ In the sense of Foley (1975) and Buiter (1980), this is neither a pure stock (beginning-of-period) model nor a pure flow (end-of-period) model. But insofar as continuous stock equilibrium does not obtain and changes in the real money supply reflect disequilibria elsewhere in the system, it is a flow model.

In Korea, most official interest rates are either fixed by government fiat or subject to regulation. For this reason, the rate used in the model is that quoted in the unregulated, unofficial money market. 1/ Equation (1) is not estimated explicitly, but is incorporated into the flow equations of the model and estimated implicitly subject to the constraint that parameters α_1 and α_2 are the same across equations.

2. The price equation 2/

The price level is represented by a geometric index of home prices (p_h) and import prices (p_m):

$$p = \varepsilon p_h + (1-\varepsilon)\, p_m \tag{2}$$

or

$$p_h - p_m = \frac{1}{\varepsilon}\,(p - p_m) \tag{3}$$

Home prices are determined by domestic demand and supply. A disequilibrating increase in the money supply should affect prices more or less according to the capacity for increasing output or imports and thereby raising real absorption. The capacity for increasing output is captured by a capacity utilization variable (yrdis) characterized as the percentage deviation of real output (yr) from potential output (yr*), with the latter defined simply as a constant markup over trend. Besides the influence of money and capacity utilization on home prices, there is a separate relative price influence. If at the beginning of the period the relative price between home goods and imports is high compared with the long-run equilibrium value, there is a tendency for the rate of home price inflation to fall. Thus, the equation for home price inflation may be written:

$$\Delta p_{ht} = \delta_0 + \delta_1\alpha_0 + \delta_1\alpha_1\, E(abs_t;\, t-1) + \delta_1\alpha_2\, I_t - \delta_1 m_{t-1} + \delta_1\, p_{t-1} + \delta_2\, yrdis_t + \delta_3\, (p_h - p_m)_{t-1} \tag{4}$$

where the long-run equilbrium relative price is incorporated in the constant. From equations (2), (3), and (4), the price inflation equation may be written as:

1/ Note that I_t is the interest rate offered during period t-1 for deposits during period t, and is thus part of the information set at the end of period t-1.

2/ The specification of this equation draws on Aghevli and Rodriguez (1978).

$$\Delta p_t = \epsilon\alpha_0 + \epsilon\beta_1\alpha_0 + \epsilon\beta_1\alpha_1 E(abs_t;\ t-1) + \epsilon\beta_1\alpha_2 I_t - \epsilon\beta_1 m_{t-1} + \epsilon\delta_1 p_{t-1} + \epsilon\delta_2 yrdis_t + \epsilon\delta_3 (p-p_m)_{t-1} + (1-\epsilon) \Delta p_{mt} \quad (5)$$

3. The export equation

The export equation incorporates the small country assumption--that is, Korea is assumed to be too small to exert monopoly power over its exports. Thus, export prices (px) are determined in the world market and export volume (xv) depends upon the supply response. This response is governed by domestic prices (or costs), current output (yr), and domestic capacity utilizaton (yrdis). As is conventional, a partial adjustment model is employed with the adjustment parameter λ.

$$xv_t = \lambda\gamma_0 + \lambda\gamma_1 (px-p)_t + \lambda\gamma_2 yr_t + \lambda\gamma_3 yrdis_t + (1-\lambda)xv_{t-1} \quad (6)$$

The relative price term is made up of a foreign price, an effective (or weighted) exchange rate, and a domestic price. As such it is incomplete insofar as the economic price received by exporters ought to reflect various implicit and explicit subsidies. 1/ The relative price term used in estimating the equation may be regarded, therefore, at best, as a reasonable proxy for the actual economic relative price.

4. The import equation

During our sample period, imports in Korea were subject to a considerable degree of control via a restrictive licensing system. 2/ It is assumed that import policy has two competing objectives: (a) to maintain real reserves as close as possible to the desired real level (R*) and (b) to allow the volume of imports to be as close as possible to the desired level (IMP*). By minimizing a quadratic cost function in these two objectives subject to the balance of payments identity, we derive a linear decision rule for the optimal issuance of licenses (IMPL) which depends upon the desired volume of imports, and also upon exports (X), net capital inflows (K) and the difference between actual and desired reserves all measured in terms of imports.

1/ Unfortunately, the greater part of these subsidies is implicit and difficult to measure. Earlier estimates of this equation incorporated attempts to adjust px for export subsidies. However, because data on export subsidies were incomplete and inadequate, in the current exercise these subsidies are ignored. Clearly, to the extent that there have been significant changes in subsidies there is an error-in-variables problem in the equation.

2/ See Westphal (1975). The effects of this system are incorporated in the specification of the import equation in the manner suggested in Hemphill (1974) and Sundararajan (1983).

$$IMPL = \eta IMP^*_{t-1} + (1-\eta)\ [X_t + K_t - (R^*_t - R_{t-1})] \qquad (7)$$

The desired real reserve level is determined by running a trend through peaks of imports, 1/ multiplying the resultant peak-import series by the average reserve/import ratio over the sample period, and deflating by import prices. The authorities' perception of the desired import volume is based on the most recent data--that is, last periods' desired import volume as reflected in last periods' license applications. The desired volume of imports (imp*) is specified as a loglinear function of total expenditure, that is, real absorption (abs), the domestic price level relative to import prices ($p-p_m$), exports calibrated in terms of imports (xvm), to reflect the imported component in exports, and the excess demand for money. The concerns about the relative price term, expressed in connection with the export equation, are equally applicable in this equation.

$$imp^*_t = \sigma_o + \sigma_1 abs_t + \sigma_2 (p-p_m)_t + \sigma_3 xvm_t + \sigma_4 \alpha_o + \sigma_4 \alpha_1\ E(abs_t;\ t-1)$$
$$+ \sigma_4 \alpha_2\ I_t - \sigma_4 m_{t-1} + \sigma_4\ p_{t-1} \qquad (8)$$

To maintain the loglinearity of the system, equation (7) was rewritten using the logarithms of the variables involved; equation (8) was substituted into equation (7) and, on the assumption of serial correlation in exports, the export terms were gathered into one. It was assumed that import arrivals adjust partially--by a proportion in each quarter--to licenses issued. These simplifications resulted in the following equation for estimation:

$$imp_t = \phi(\sigma_o + \sigma_4 \alpha_o) + \phi\eta\sigma_1 abs_{t-1} + \phi\eta\sigma_2 (p-p_m)_{t-1}$$
$$+ \phi(\eta\sigma_3 + 1 - \eta) xvm_{t-1} + \phi\eta\sigma_4 \alpha_1\ E(abs_{t-1};\ t-2)$$
$$+ \phi\eta\sigma_4 \alpha_2\ I_{t-1} - \phi\eta\sigma_4\ m_{t-2} + \phi\eta\sigma_4\ p_{t-2} +$$
$$- \phi(1-\eta)(k_t - r^*_t + r_{t-1}) + (1-\phi)\ imp_{t-1} \qquad (9)$$

5. The absorption equation

Expected absorption is an important argument in the monetary disequilibrium term. In order to close the model satisfactorily, it is preferable to specify an absorption equation that does not require data on exogenous contemporaneous variables or on future expected variables in

1/ This was preferred to simply using a constant markup over trend because it gives greater weight to exceptional peaks on the grounds that reserves are held to accommodate such occurrences.

the set of explanatory variables. For this reason, and because the model seeks to highlight financial influences on the real sector, a very simple real absorption equation is specified. The growth of real absorption (Δabs) is assumed to tend toward some steady state rate determined by real factors. Absorption, however, is deflected from its long-run growth path by monetary disequilibrium as captured by the excess demand for money variable. In the absence of any current disturbance, there is assumed to be a natural tendency for deviations from trend absorption (tabs) in the last period to be reversed in the current period.

$$\Delta abs_t = \mu_0 + \mu_1\alpha_0 + \mu_1\alpha_1 E(abs_t;\ t-1) + \mu_1\alpha_2 I_t - \mu_1 m_{t-1}$$
$$+ \mu_1 p_{t-1} + \mu_2 abs_{t-1} - \mu_2 tabs_{t-1} \qquad (10)$$

All variables in this equation except for current absorption are effectively lagged and hence part of the information set available at the end of the period t-1. While I_t appears to be contemporaneous, in effect it is the interest rate offered in period t-1 for deposits during period t and is therefore information available at the end of period t-1. It is, thus, possible to equate abs_t and $E(abs_t;\ t-1)$ for the purpose of estimation. 1/

6. The identities

Two identities are included: a real income identity,

$$YR_t = ABS_t + XV_t - IMP_t + TS_t \qquad (11)$$

where TS is the (assumed exogenous) balance of trade in services as recorded in the national income statistics, and a broad money identity,

$$M_t = DC_t + NFA_{t-1} + (XV_t \cdot PX_t) - (IMP_t \cdot PM_t) + K_t \qquad (12)$$

where PX and PM are respectively export and import unit value indices and K represents the net nontrade receipts in the external accounts. For conformity with the other equations of the model, these identities were linearized in logarithmic form about trend growth rates. 2/

1/ It should be noted that, while combinations of variables have been expressed by a single symbol--e.g., yrdis or xvm--in some equations, in all cases, for estimation, the equations have been written out in terms of the individual variables with the parameters and constants attached to each variable expressed as a nonstochastic function.

2/ Appendix II provides details on the linearization.

III. Estimation and Simulation Results

The constraints embodied in the theoretical specification of the model--both across-equation restrictions on parameters and constraints imposed by the linearization of the identities--were imposed during estimation of the model. The estimation program and the properties of the estimator are discussed in Wymer (1977).

In general, the parameters of the model are very well determined. Table 1 sets out the equations of the model as estimated, while Table 2 provides estimates of all the parameters of which some are presented only in composite form in Table 1. Of the 18 parameters estimated, all had the expected sign, 11 were significantly different from zero at the 99 percent level of confidence, and 3 at the 95 percent level. The other four coefficients, which were not as well determined, were those attached to capacity utilization in the price equation (β_2), the export ([illegible]) and import (σ_2) relative price variables, and the parameter (σ_3) attached to the volume of exports in the desired import equation. There is no good a priori explanation for the poor determination of β_2, except perhaps the rather crude characterization of capacity utilization. Reservations with respect to the reliability of the export and import price data were expressed in section 1, and unreliable data may be the reason for the poor determination of the relative price coefficients. The poor determination is, however, an important negative result. 1/ In a pure elasticities framework it would cast doubt on the efficacy of an exchange rate change for correcting a trade imbalance. As indicated in Section IV, however, these doubts are dispelled once the other expenditure effects of an exchange rate change are taken into consideration. With respect to the coefficient on export volume in the desired import function, it should be noted that it is disentangled from a complicated composite coefficient (see equation (9)) derived by simplifying the licensing rule (equation (7)) and ignoring lags in the export variable. This is the most brutal simplification in the model and it casts some doubt on the interpretation of the coefficient σ_3 as estimated. For this reason, the large standard error on this coefficient is not surprising.

Most of the coefficients in the model seem quite reasonable, although they are rather different in some cases from those obtained in other econometric models of Korea. In the inflation equation, the share of domestically generated inflation is about 72 percent, that of imported inflation about 28 percent; these results are plausible although some other estimates show a slightly larger share for imported inflation. 2/ In addition to the direct effect of import prices ($1-\varepsilon$) on the wholesale price index, there is an indirect relative price effect (β_3). Insofar as inflation is led by domestic prices, this relative price effect acts as a constraint on inflation by redirecting domestic demand toward imports.

1/ See Otani and Park (1976) for a similar problem with the significance of relative prices.

2/ See, for example, Nam (1980).

Table 1. Korea: The Stochastic Equations 1/

(Sample period first quarter 1965 to fourth quarter 1978)

(i) Price inflation

$$\Delta p_t = -0.2341 - 0.0540 mdis_t + 0.1035 yrdis_t - 0.1633(p-pm)_{t-1} + 0.2841 \Delta pm_t$$
$$(1.39) \quad (3.86) \quad (1.8) \quad (6.65) \quad (5.18)$$

(ii) Exports

$$xv_t = -18.6934 + 0.1509(px-p)_t + 0.2699 yr_t - 2.4069 yrdis_t + 0.8653 xv_{t-1}$$
$$(3.65) \quad (0.66) \quad (1.98) \quad (3.66) \quad (14.11)$$

(iii) Imports

$$imp_t = 1.8547 + 0.4010 abs_{t-1} + 0.0906(p-pm)_{t-1} + 0.2025 xvm_{t-1}$$
$$(1.63) \quad (2.23) \quad (0.83) \quad (3.30)$$

$$- 0.1494 mdis_{t-1} + 0.0963(k_t - r^*_t + r_{t-1}) + 0.4786 imp_{t-1}$$
$$(2.58) \quad (2.01) \quad (5.11)$$

(iv) Absorption

$$\Delta abs_t = -4.0638 - 0.0656 mdis_t - 0.4829(abs_{t-1} - tabs_{t-1})$$
$$(4.50) \quad (2.90) \quad (4.50)$$

Note:

In equations (i), (iii), and (iv), the monetary disequilibrium term was estimated as: 2/

$$mdis_t = constant + 1.0834\, E(abs_t;\, t-1) - 3.6574\, I_t - m_{t-1} + p_{t-1}$$
$$(3.87) \quad (4.46)$$

Carter - Nagar $R^2 = 0.9969$

1/ t-ratios are given in parentheses under parameter estimates. The term t-ratio denotes the ratio of a parameter estimate to the estimate of its asymptotic standard error and does not imply that this ratio has a student's t-distribution. As the model was estimated by a full information maximum likelihood procedure, the distribution of the estimated parameters is asymptotically normal. In a sufficiently large sample, this ratio is significantly different from zero at the 5 per cent level if it lies outside the interval $\pm$ 1.96 and significantly different from zero at the 1 per cent level if it is outside the interval $\pm$ 2.58.

2/ The constant terms in the equations were unrestricted and they incorporate the constant in the monetary disequilibrium term in equations (i), (iii), and (iv) and the constant in the trend (or potential output) estimate in equations (ii) and (iv).

Table 2. Korea: Detailed Parameter Estimates 1/

(Sample period first quarter of 1965 to fourth quarter of 1978)

(i) Price inflation equation

Parameter	ε	β_1	β_2	β_3
Estimate	0.7159	-0.0754	0.1446	-0.1633
t-ratio	13.05	3.98	0.60	6.65

(ii) Export equation

Parameter	λ	γ_1	γ_2	γ_3
Estimate	0.1347	1.1203	2.0036	-17.8870
t-ratio	2.20	0.80	10.93	2.22

(iii) Import equation

Parameter	ϕ	η	σ_1	σ_2	σ_3	σ_4
Estimate	0.5214	0.8154	0.9432	0.2130	0.2498	-0.3514
t-ratio	5.57	9.14	2.56	0.87	1.81	2.89

(iv) Absorption equation

Parameter	μ_1	μ_2
Estimate	-0.0656	-0.4829
t-ratio	2.90	4.50

Note:

The parameters of the monetary disequilibrium term in equations (i), (iii), and (iv) were estimated as follows:

Parameter	α_1	α_2
Estimate	1.0834	-3.6574
t-ratio	3.87	4.46

1/ The term t-ratio denotes the ratio of a parameter estimate to the estimate of its asymptotic standard error and does not imply that this ratio has a student's t-distribution. In a sufficiently large sample, this ratio is significantly different from zero at the 5 per cent level if it lies outside the interval ± 1.96 and significantly different from zero at the 1 per cent level if it is outside the interval ± 2.58.

Thus, as expected, the coefficient ([illegible]$_3$) on the relative price term in the inflation equation is negative, but that ([illegible]$_2$) in the import equation is positive. The effect of the monetary disequilibrium term on price inflation is small but well determined. A 10 per cent discrepancy between the demand for and supply of money will add (or subtract) half a percentage point to (or from) the inflation rate.

The estimated long-run relative price elasticity of exports (γ_1) is of reasonable magnitude although, probably for reasons discussed already, not very well determined. However, the extent to which exports actually rise in response to a change in demand, as reflected in relative prices, depends critically on the output response which is affected to a considerable extent by the relationship between output and potential output. The size of the parameter (γ_3) governing this relationship suggests that there is substantial substitution between production for the domestic market and production for export. Domestic demand restraint, therefore, would have a strong direct effect on export supplies in addition to the indirect relative price effect that is usually observed. Notably, however, actual exports adjust to the determinants of export supply rather slowly. Only 13 percent of the adjustment takes place in the first quarter and the mean lag is over six quarters.

The import equation provides an interesting (although possibly naive) result with respect to the restrictiveness of the licensing system. The weight on desired imports (η) in the linear decision rule (equation (7)) is over 81 percent, that on desired reserves ($1-\eta$) less than 19 percent. This suggests that the import licensing regime is not as strict as it is often thought to be. However, there may be other reasons for this result. For example, the authorities may borrow to maintain the desired level of reserves (i.e., change K in equation (7)) and only resort to manipulating the restrictiveness of the import licensing system in extreme cases. Alternatively, the authorities may restrict imports of consumer goods in response to an increased demand for intermediate imports, thereby dampening the amplitude of fluctuations of aggregate import demand. The elasticity of import demand with respect to absorption is large ([illegible]$_1$), but not implausibly large, and is well determined. The relative price elasticity ([illegible]$_2$) is rather small, perhaps because a large part of the import bill is made up of intermediates that are necesssary to domestic production and are consequently not very price sensitive. The monetary disequilibrium effect on import demand ([illegible]$_4$) is highly significant and remarkably large; indeed, monetary disequilibrium seems to exert more of an effect on import demand than on the growth of absorption or the rate of inflation.

The adjustment of imports to licenses issued is rapid with over 52 percent ([illegible]) of the adjustment occurring in the first quarter. However, the two lag structures involved in the specification of the import demand equation are difficult to sort out. The equation is specified on the assumption that there is a one-period lag between desired imports and the issue of licenses and then, on this assumption, only 52 percent of licenses issued result in import arrivals in the same quarter. It is not unlikely

that the first lag--that is, one quarter between desired imports and licenses issued--may be overestimated and the second lag--that between the receipt of the license and the import arrival--may be underestimated. In any event, the general result that the lags attached to the realization of import demand are much shorter than the lag attached to changes in export supply seems quite reasonable. Supply invariably takes longer to adjust than demand. In addition, the fact that Japan, which is geographically very close to Korea, is the major supplier of Korean imports strengthens the argument for relatively short import delivery lags.

The parameters of the absorption equation are of plausible magnitude and are significantly different from zero at the 99 per cent level of confidence. A 10 percent discrepancy between the demand for and supply of money changes the growth of absorption by almost seven tenths of a percentage point. However, the effects of shocks are relatively short lived; if absorption exceeds trend absorption by 10 percent in any particular year, in the absence of any residual monetary imbalance the growth of absorption will be reduced by 4.8 percentage points in the following year.

Testing the validity of the structure of the model and of the restrictions on parameters is difficult. Various tests are discussed in Appendix III and the results are generally fairly favorable to the model.

IV. Reaction Functions and Policy Analysis

The estimated model contains no government policy reaction functions. While we are concerned with the efficacy of monetary and exchange rate policies for stabilizing an economy subject to various sorts of shocks, domestic credit (the monetary policy instrument) and the exchange rate are left exogenous. 1/ In this section the model is enlarged to include some a priori reaction functions. These are not estimated but are imposed as our concern is not with what was done but with what might have been done. 2/

The enlarged model is used to characterize six different policy regimes, each with a different mix of exchange rate and credit policy. These six different regimes are then each subjected to three shocks: an output shock that temporarily reduces production capacity; a monetary shock that temporarily reduces the demand for money; and a terms of trade

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1/ For a discussion of domestic credit as the monetary policy instrument, see Guitian (1973).

2/ In addition to the Lucas-type, rational expectations critique of counter-factual experiments discussed in Section I, this procedure is subject to the criticism that the parameter estimates may be distorted by a simultaneity bias in that variables treated as exogenous were really endogenous. This criticism may be leveled at virtually any estimated model, however, in that the modeler has always to draw a line between endogenous and exogenous variables in some arbitrary way.

shock induced by a short-lived rise in the foreign currency price of imports. The results are tabulated and discussed in a way that endeavors to throw light on the general subject of financial policies and stabilization.

1. The reaction functions and the six policy regimes

Both instruments of demand management--domestic credit and the exchange rate--are postulated to react to the two indices of excess demand, that is, inflation and the balance of trade. The reaction function for domestic credit is specified as

$$\Delta dc_t = \omega_0 + \omega_1 \Delta tb_{t-1} + \omega_2(\Delta p_{t-1} - \Delta p_{t-2}) \qquad (13)$$

where $\omega_1 \geq 0$, $\omega_2 \leq 0$

and where $tb = xv + px - imp - pm$

Domestic credit deviates from its long-run growth path (ω_0) to stabilize demand. Both a deterioration in the trade balance and an acceleration of inflation elicit a tightening of credit policy from the authorities. It is worth noting that there is a lag between the shocks that precipitate policy changes and these changes. This will be referred to as the information lag.

In order to endogenize the exchange rate, it will be necessary to abandon the shorthand that allowed us to represent variables denominated in foreign currency terms and converted into domestic currency terms by the exchange rate by a single symbol. In the model thus far, for example, we have written px for e+pxf, where e is the domestic currency price of foreign currency and pxf is the export price in foreign currency terms. For simplicity, and because over the period with which we are concerned almost all of Korea's trade-related payments were settled in U.S. dollars, e is the exchange rate vis-à-vis the U.S. dollar and foreign currency variables are measured in U.S. dollar terms. In the enlarged model with endogenized exchange rates, the exchange rate is put into the notation explicitly and an f is appended to foreign currency variables. The reaction function for the exchange rate in the managed exchange rate regimes is specified as

$$\Delta e_t = \pi_1 \Delta tb_{t-1} + \pi_2(\Delta p_{t-1} - \Delta pmf_{t-1}) \qquad (14)$$

where $\pi_1 \geq 0$, $\pi_2 \leq 0$

This reaction function allows some flexibility. Where the exchange rate is used as a general tool of demand management and adjusted in reaction to both changes in the trade balance and changes in the relative

rates of inflation at home and abroad, both π_1 and π_2 are nonzero. Where the authorities try to use the exchange rate to keep domestic prices in line with those abroad (specifically import prices), π_1 may be set at zero and π_2 at unity. Except for the lag, this gives us the familiar purchasing power parity condition or the condition for maintaining the real exchange rate. 1/

The model was not estimated using sample data from a period in which Korea allowed its currency to float freely, and so substantial a change in institutions might well alter behavior in some fundamental way. It is arguable, therefore, that it is even more risky to make inferences from a free floating exchange rate reaction function imposed on the model than from some of the other reaction functions. Technically, however, a free float could be characterized in the following way. Assume trade in services is relatively stable and that capital inflows are subject to official control, then the stochastic element in the balance of payments is the trade account. Given capital and services flows, export receipts have to cover a given proportion of import payments; deviations from this norm will not be financed by the authorities and will consequently precipitate exchange rate changes. In this system, there is no government intervention and consequently no information lag. It may be characterized as one polar extreme of the managed floating system in which π_2 is zero, π_1 is very large, and the lag on Δtb is eliminated--that is,

$$\Delta e_t = \pi_1 \Delta tb_t \qquad (15)$$

Clearly, as long as the exchange rate affects the trade balance in the normal way, as π_1 becomes very large, changes in the trade balance become very small. As one experiment, and subject to the caveats discussed, the pure floating system is included among the policy regimes considered. 2/

Using the specified reaction functions, six different policy regimes are set up:

(i) The first sets $\omega_1 = \omega_2 = \pi_1 = \pi_2 = 0$--that is, it is what we shall call a pure hands-off regime. The exchange rate is fixed and domestic credit growth is fixed. Neither are altered in response to our short-term shocks. Given the transitory nature of the shocks, this is arguably a well-thought-out policy alternative.

1/ As will be seen below, the choice of the import rather than the export price as the representative foreign price has important implications for the stability of this exchange rate policy.

2/ Ideally, the parameter π_1 should in this case be derived from the trade balance equilibrium condition. This would give it an enormously large value. Any large value for π_1, however, will suffice to characterize the floating system as compared to the other policy alternatives.

(ii) In the second regime, domestic credit is adjusted to reduce excess demand, but the exchange rate is fixed. Given the information lag and uncertainty about the duration of the shock, domestic credit is not adjusted to entirely offset excess demand pressures, but only to reduce them--that is, credit policy is to lean against the wind. The coefficient on the change in the trade balance (ω_1) is set at 0.5, that on the acceleration of inflation (ω_2) at -0.5. The effect is cumulative: as excess demand is likely to affect both the trade balance and the inflation rate, domestic credit expansion will be reduced by both terms. Nevertheless, this is a rather gentle leaning against the wind--for example, a 10 percentage point rise in the growth of exports minus the growth of imports coupled with a 10 percentage point increase in the rate of inflation would elicit a 10 percentage point reduction in the growth rate of domestic credit. Within three periods, this would lower price inflation by only about 1 percentage point and reduce the trade gap by about 1 1/2 percentage points.

(iii) In the third regime, domestic credit expansion is fixed, but the exchange rate is adjusted to contain excess demand. In equation (14), π_1 is set at -0.5, π_2 at 0.5. As in the second regime, the effects are cumulative and the coefficients of the reaction function constitute a very gentle leaning against the wind. Following a 10 percentage point deterioration in the trade balance and a deterioration in relative inflation rates of the same magnitude, the exchange rate depreciates by 10 percent. In response to this depreciation, prices rise sharply (by almost 3 percent) on impact, but only by about 1 1/2 percent over two periods; the correction of the trade balance brought about over the same time span by the depreciation amounts to about 1 1/2 percentage points--that is, substantially less than the deviation that precipitated the exchange rate change. As in the second policy regime, the objective of stabilization policy is to help the system back to equilibrium without sharp changes in policy that could themselves be disequilibrating.

(iv) The fourth regime combines the second and the third. Both the exchange rate and domestic credit are endogenized by the reaction functions with the same coefficients as in the two other regimes. This represents a sharper overall policy response to excess demand and a response on both fronts simultaneously.

(v) In the fifth policy regime, a real exchange rate, or a (rather rapidly) crawling peg, system is examined. 1/ Domestic credit is not allowed to react to disequilibria (that is, $\omega_1 = \omega_2 = 0$), but, in the exchange rate reaction function, coefficients are set so as to keep domestic prices in line with those abroad--that is, $\pi_1 = 0$ but $\pi_2 = 1$.

(vi) Finally, in the sixth policy regime, domestic credit is again unresponsive, but the exchange rate is allowed to approximate a free float. In the second variant of the exchange rate reaction function--

1/ See Williamson (1965).

equation (15)--$_1$ is set at a large number, in this case -3.0. This number is large enough to elicit a rather dramatic price and demand response to a trade balance deviation.

2. The simulation experiments

The program for the simulation experiments is set up to produce percentage deviations from the base run--that is, the run without any shocks and with exchange rates and domestic credit given exogenously--for each of the shocks under each of the policy regimes.

The six enlarged models, one for each policy regime, are each subjected to the three different shocks. (i) An output shock is produced by a one quarter 30 percent reduction in capacity--that is, in potential output--so that capacity utilization increases sharply and demand exceeds potential output. (ii) A monetary shock is effected by a one quarter, one unit reduction of the constant term in the implicit money demand function. This depresses the demand for money relative to the supply and thereby creates excess demand for goods. (iii) A terms of trade shock is given by a one quarter 30 percent rise in the foreign currency price of imports. 1/

3. The results for temporary shocks to the system

In general, these experiments tend to confirm the view that financial policies do better at stabilizing the economy in response to financial disturbances than in response to real disturbances. 2/ Some results that seem to contradict this principle--for example, the relatively good performance of a policy to fix the real exchange rate in response to a terms of trade shock--derive essentially from the short duration of the shock and the particular lag structure of the model. Rigorous and quick-reacting financial policies--best characterized in this analysis by the pure flexible exchange rate regime--do best under all circumstances at containing the external payments deficit. When the economy is buffeted by real shocks, however, this external payments stability is won at a substantial cost in terms of absorption. In all cases, the more reactive the exchange rate, the more volatile are prices. Insofar as price stability is an important component of the authorities' objective function, it is unlikely that a high degree of nominal exchange rate variability will be allowed even in response to financial shocks unless there is a binding foreign exchange constraint.

If the authorities were constrained to choose one policy regime in response to all transitory shocks, the hands-off regime would probably

1/ It is, of course, significant that import prices rather than export prices change, and that one of the policy regimes is specifically set up to maintain parity between import prices in domestic currency and home prices. This shock and that policy regime are obviously chosen to illustrate potential dangers of a crawling peg.

2/ See Boyer (1978), Fischer (1977), and Lipschitz (1978).

be the best. This is an important consideration given the perennial difficulty of determining the origin of the principal shock to the economy at any time. The even more chronic difficulty of determining the duration of the disturbance is shown to be of critical importance. This leads to the examination of longer-term changes in the economic environment in section 4.

a. The output shock

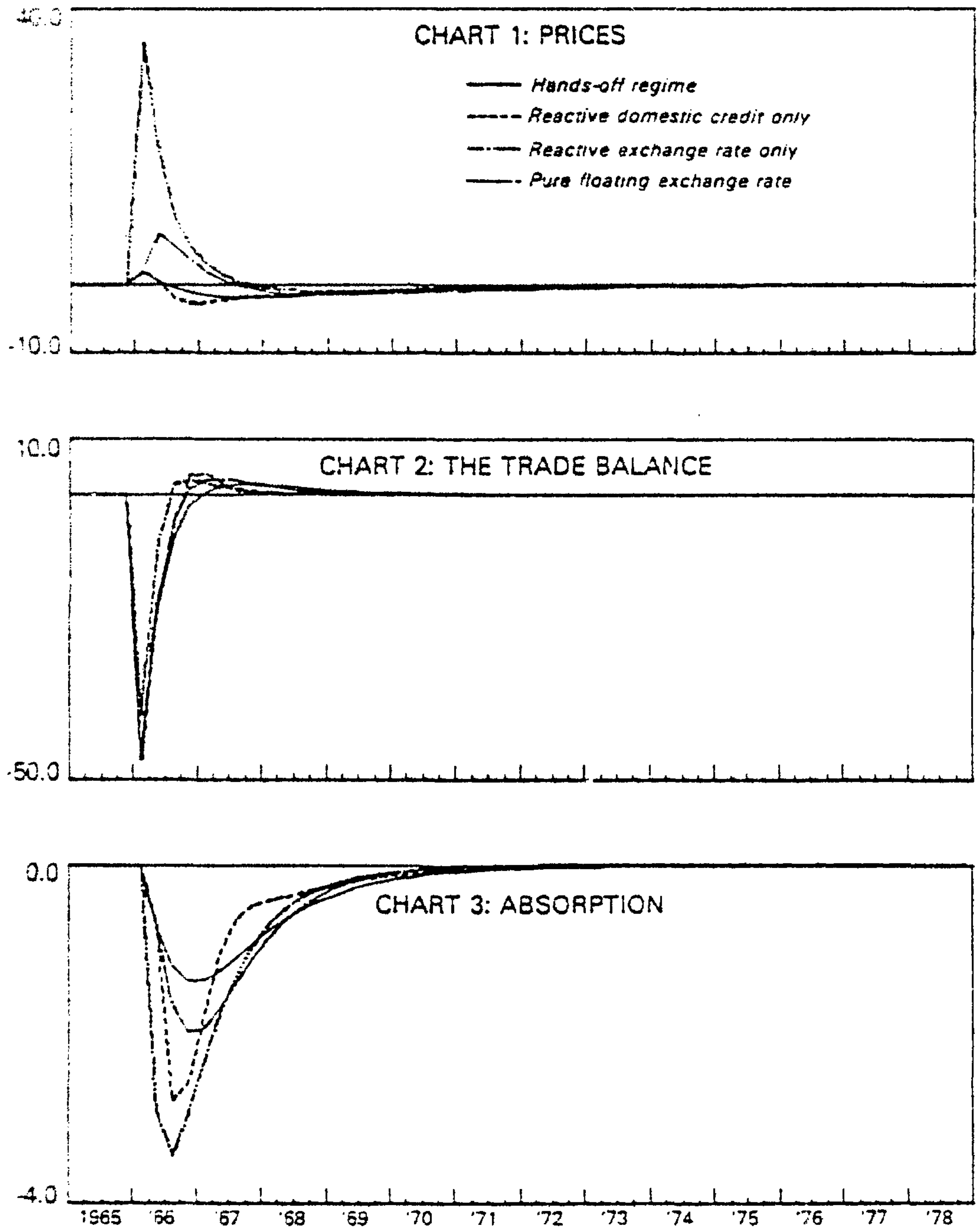
As may be expected, the optimal policy regime depends upon the objective function of the authorities: that is, no one regime is better in all respects than all the others. Insofar as the authorities seek to stabilize absorption and inflation, the hands-off regime is clearly best (Table 3 and Charts 1-3). The trade balance is allowed to play its normal role, under fixed exchange rates, of cushioning shocks to domestic absorption. It bears the brunt of the real shock with exports, in particular, reacting sharply to the reduced output capacity. The natural tendency to return to equilibrium--via both the relative price effect and the monetary squeeze--is allowed to operate smoothly. In all of the other managed regimes continuing trade imbalances and price changes elicit policy response that interfere with this tendency. The free-floating exchange rate regime is at the opposite end of the continuum to the hands-off regime. Greater stability in the trade balance is obtained at the cost of much sharper changes in the exchange rate and consequently in prices. The price changes, through their effect on the demand for money, destabilize absorption. In practice, the choice of regime might well depend on the financing ability of the country. A country with sizable foreign exchange reserves or easy access to capital markets might well opt for the hands-off policy, thereby choosing relatively stable absorption and prices at the cost of external current account volatility. A country with a binding external financial constraint might be forced to adopt flexible exchange rates.

In general, the more reactive the exchange rate, the more stable are income and the trade balance and the less stable are prices. The exception to this generalization is the fixed real exchange rate policy regime, in which absorption is stabilized--as the lagged response of the exchange rate allows for greater price movements in the aftermath of the shock to restore absorption to its initial level--but the trade balance is allowed to swing in response to the real shock. In the other regimes, reactive exchange rates are more effective a stabilization tool than reactive domestic credit with respect to all variables except the price level.

b. The monetary shock

The three essential elements in this set of simulations are the short duration of the disturbance, the information lag that impedes all but two of the policy regimes, and the financial nature of the shock. The first two of these characteristics are shared by the other experiments with temporary shocks but are well illustrated in this case by the policy regime that attempts to fix the real exchange rate. Although the system

RESPONSES TO AN OUTPUT SHOCK: FOUR POLICY REGIMES[1]



[1] Measured in percentage deviations from the base run

Table 3. Output Shock: Mean-Squared Deviations from the Base Run Under Different Policy Regimes 1/

Variable	Fixed Exchange Rate and Fixed Domestic Credit	Fixed Exchange Rate and Reactive Domestic Credit	Reactive Exchange Rate and Fixed Domestic Credit	Reactive Exchange Rate and Domestic Credit	Fixed Real Exchange Rate and Fixed Domestic Credit	Flexible Exchange Rate and Fixed Domestic Credit
Prices	0.70	0.88	2.32	1.69	6.33	31.46
Export volume	69.68	67.95	66.62	65.46	69.86	53.45
Import volume	14.47	17.46	17.69	20.75	14.13	26.28
Trade balance	47.65	47.27	46.01	46.70	47.40	28.43
Money stock	19.86	44.00	17.87	45.10	20.92	12.93
Exchange rate	--	--	14.27	14.13	6.29	255.86
Real absorption	0.20	0.37	0.33	0.54	0.20	0.73
Domestic credit	--	12.29	--	13.81	--	--
Real income	3.25	3.34	3.13	3.22	3.25	2.26

1/ Deviations from the base run are measured in percent.

does eventually settle back to the same real exchange rate, attempts to fix the real exchange rate are counterproductive. The lagged effects of the exchange rate changes on trade exacerbate the information lag and undermine stabilization policy.

As the shock to the system is a financial shock, it is amenable to financial remedies. The pure floating exchange rate provides the quickest acting financial remedy in that it does best at stabilizing the trade balance and not badly with respect to income and absorption (Table 4 and Charts 4-6). These results, however, are achieved at the cost of substantially increased price volatility.

Of the other policy regimes, in general, the hands-off policy does best at stabilizing absorption and prices (although the reactive domestic credit policy does slightly better with respect to the latter variable) and reactive exchange rate policy does best at stabilizing income and trade balance. Once again the choice of policy regime depends upon the relative importance assigned to each of the endogenous variables and the extent to which the country's financial resources allow it to shun adjustment.

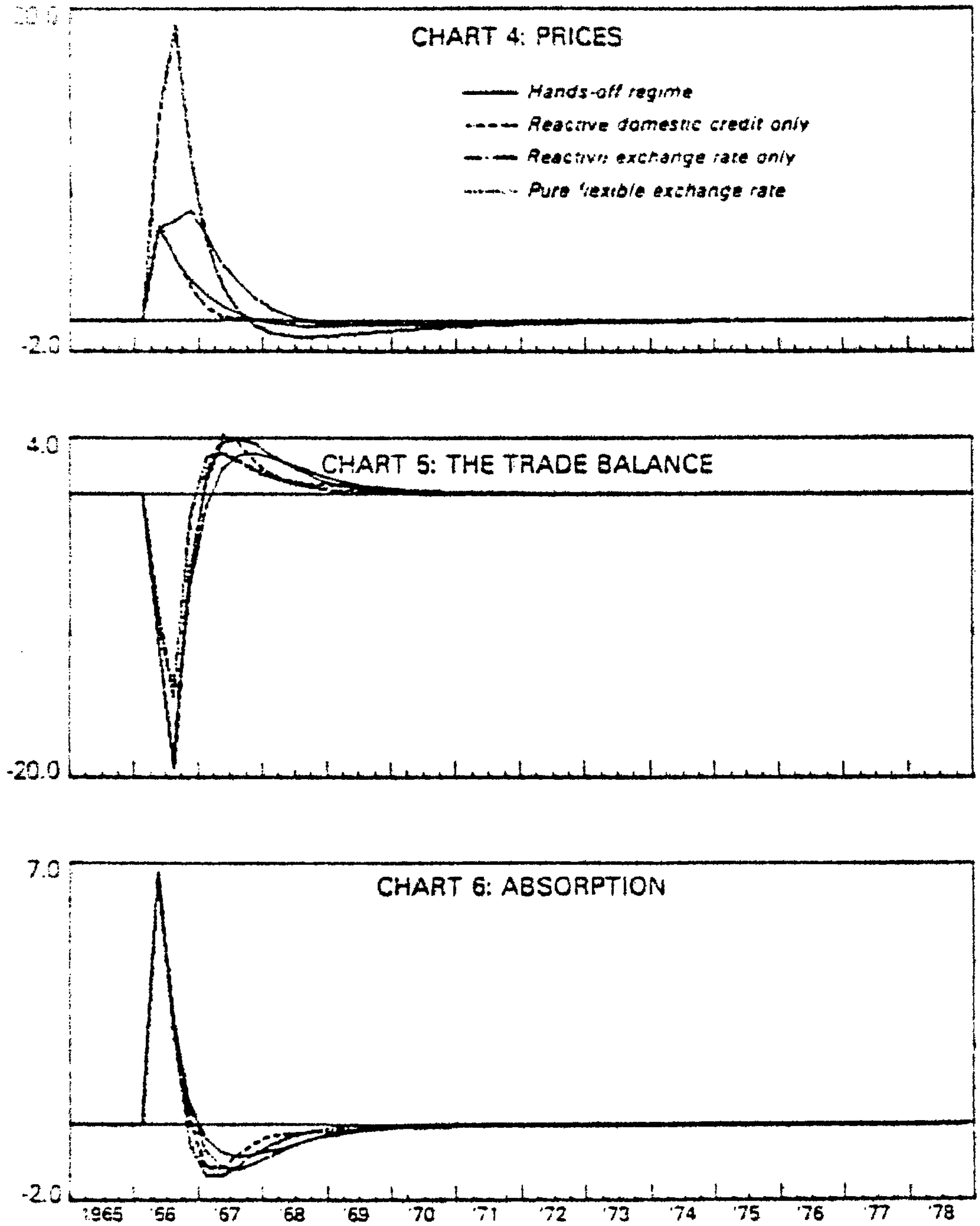
c. <u>The terms of trade shock</u>

Here again the hands-off regime is arguably the one that imparts most stability to the system as a whole. However, the fixed real exchange rate policy option does significantly reduce the variance of import volume and, as a result, the variance of absorption, income, and the trade balance is slightly lower under this regime than under the hands-off regime (Table 5 and Charts 7-9). The extra stability in these variables is obtained at a cost of an enormous increase in the variance of the nominal exchange rate and, more importantly, of the domestic price level.

The result that an attempt to fix the real exchange rate in response to a real terms of trade shock might be optimal, in the sense of minimizing fluctuations in income and absorption, seems counterintuitive. In fact, it derives entirely from the transitory nature of the shock. Under the hands-off regime, because of the lags in the system and the secondary effects of the shock, the intial reduction in import volume is corrected only slowly. However, under the fixed real rate regime, with the lagged adjustment of the exchange rate to deviations between domestic and import price inflation, imports are boosted sharply after the shock by an appreciation of the domestic currency that coincides with the return to the base value of the import price index. This process hastens the return to base run equilibrium. Clearly, if the shock were of a more permanent nature, the appreciation of the exchange rate would tend to delay necessary adjustment and maintain absorption at an unsustainable level.

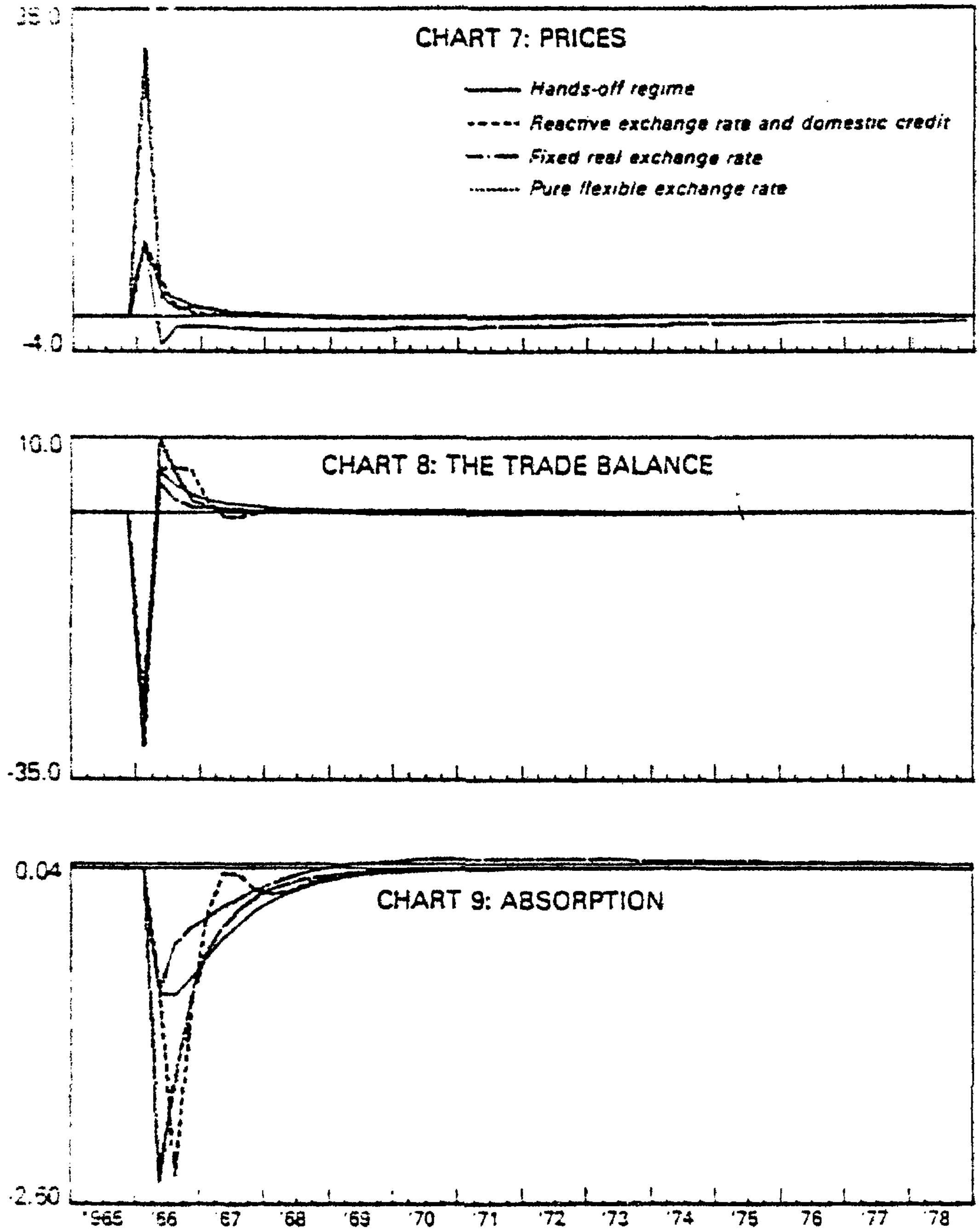
This result underscores the importance of the chronic difficulty of trying to determine the likely duration of any change in the economic environment. Obviously, at the extreme, temporary real changes may be financed while permanent ones require adjustment. But a host of other

RESPONSES TO A MONETARY SHOCK: FOUR POLICY REGIMES[1]



[1] Measured in percentage deviations from the base run

RESPONSES TO A TERMS-OF-TRADE SHOCK: FOUR POLICY REGIMES[1]



[1] Measured in percentage deviations from the base run

Table 4. Monetary Shock: Mean-Squared Percentage Deviations from the Base Run Under Different Policy Regimes 1/

Variable	Fixed Exchange Rate and Fixed Domestic Credit	Fixed Exchange Rate and Reactive Domestic Credit	Reactive Exchange Rate and Fixed Domestic Credit	Reactive Exchange Rate and Domestic Credit	Fixed Real Exchange Rate and Fixed Domestic Credit	Flexible Exchange Rate and Fixed Domestic Credit
Prices	1.14	1.04	3.17	2.65	2.96	12.08
Export volume	2.14	2.20	2.19	2.31	2.23	1.37
Import volume	6.10	6.05	6.13	6.21	6.32	4.64
Trade balance	10.09	9.97	9.73	9.87	10.31	5.40
Money stock	5.63	11.43	5.04	12.01	5.19	3.96
Exchange rate	--	--	4.86	4.67	2.95	48.57
Real absorption	1.00	1.01	1.05	1.05	1.05	1.01
Domestic credit	--	2.85	--	3.52	--	--
Real income	0.54	0.56	0.50	0.52	0.51	0.52

1/ Deviations from the base run are measured in percent.

Table 5. Terms of Trade Shock: Mean-Squared Percentage Deviations from the Base Run Under Different Policy Regimes 1/

Variable	Fixed Exchange Rate and Fixed Domestic Credit	Fixed Exchange Rate and Reactive Domestic Credit	Reactive Exchange Rate and Fixed Domestic Credit	Reactive Exchange Rate and Domestic Credit	Fixed Real Exchange Rate and Fixed Domestic Credit	Flexible Exchange Rate and Fixed Domestic Credit
Prices	1.55	1.49	1.74	1.63	2.65	16.63
Export volume	0.83	0.83	0.82	0.86	1.20	1.65
Import volume	3.36	3.98	3.45	4.08	2.52	5.52
Trade balance	17.93	18.62	18.04	18.78	17.33	13.85
Money stock	2.49	14.36	2.47	14.59	3.03	2.24
Exchange rate	--	--	0.43	0.64	9.61	124.67
Real absorption	0.07	0.13	0.08	0.14	0.04	0.18
Domestic credit	--	7.85	--	7.91	--	--
Real income	0.01	0.03	0.02	0.03	--	0.04

1/ Deviations from the base run are measured in percent.

questions on the efficacy of various policies and the best way to treat changes of a purely financial nature remain. Although the model is not strictly set up to examine permanent shifts--may they lead to much larger cumulative changes over time that may not be accurately represented in the linearized identities--some rough results may be instructive.

4. The results for permanent changes in the economic environment

In general, the model simulations of the various policy reactions to permanent changes in the economic environment produce reasonable results but no surprises. As expected, they illustrate the long-run neutrality of money (but underscore the fact that the long run is well beyond the time horizon of most policymakers), the differences between real and monetary phenomena and the folly of confusing the two, and the necessity of adjusting to sustained real changes.

a. A permanent reduction in capacity

In the case of a 30 percent reduction in capacity that occurs in the fifth quarter and is sustained for the remaining 13 years of the simulation period, absorption adjusts downward rapidly under all regimes but most rapidly under the pure flexible exchange rate regime and least rapidly under the hands-off regime (Chart 10). Not unexpectedly, of the managed regimes that in which both domestic credit and the exchange rate are allowed to react to disequilibria exhibits the fastest adjustment. After two years of reduced capacity, absorption has been reduced by 28.0 percent under the hands-off regime and by 29.8 percent under the flexible exchange rate regime. The other regimes fall within this range. Adjustment is not entirely completed even after the full 13 years of postshock simulation. In the flexible exchange rate case, it is virtually complete with absorption some 29.9 percent below the initial level. In the hands-off case, absorption still has about 1 1/2 percentage points to drop. Cumulated trade balance losses are almost 75 percent larger under the hands-off regime than under the flexible exchange rate regime. 1/

1/ This is measured, for each regime, simply as

$\Sigma[tb(i) - tb(i,o)]$ where i goes from 1966:1 to 1978:4; and o indicates the base run value.

It is worth noting that a deterioration in tb in any period might not have a negative effect on the money supply and that a constant tb could be consistent with a positive external influence on the money supply. This is because tb is measured as the logarithm of the ratio of exports to imports relative to its value in the base period. For example, assume domestic credit is fixed, the external net capital inflow is unchanged at a base period value of 50, exports fall from 100 in the base period to 80, and imports fall from 150 in the base period to 120. tb is unchanged as both exports and imports have fallen by the same proportion:

The nature of the shock--that is, a once-and-for-all reduction in capacity--requires that the adjustment be a reduction in expenditure rather than a switching of expenditure. Relative price changes play virtually no role in the adjustment, which relies chiefly on reduced real money balances (Chart 11), together with a change in the perception of permanent income (or absorption). This is a rather unusual case in the sense that a depreciation of the real exchange rate--defined as p-e as traded goods prices in foreign currency are fixed--does not increase production or capacity by improving profit margins in the traded goods sector.

In a richer model, changes in the real exchange rate would presumably either facilitate or impede adjustment, so it is worth observing the real exchange rate behavior in the different regimes. In all of the fixed exchange rate regimes, the real exchange rate appreciates with the rise in domestic prices in response to supply shortages. In the regime that attempts to offset changes in the real exchange rate, the rate also appreciates, albeit by somewhat less, as there is a lag between price changes and offsetting exchange rate changes. However, because price inflation is checked by the decline in the money supply, in all of these cases the appreciation is modest reaching a maximum of 2.8 percent (in the hands-off regime) and in no case exceeded 2 percent by the end of the simulation period.

In the regimes where the exchange rate is allowed to react to lagged price and trade balance changes, there is a depreciation of the real rate by 8-9 percent immediately after the cut in capacity, but the rate subsequently returns to the initial level. In the pure floating regime, there is a sharp--that is, almost 50 percent--initial real depreciation that is eroded within one year; for the last seven years of the simulation period, the real rate is about 1.7 percent below its initial level.

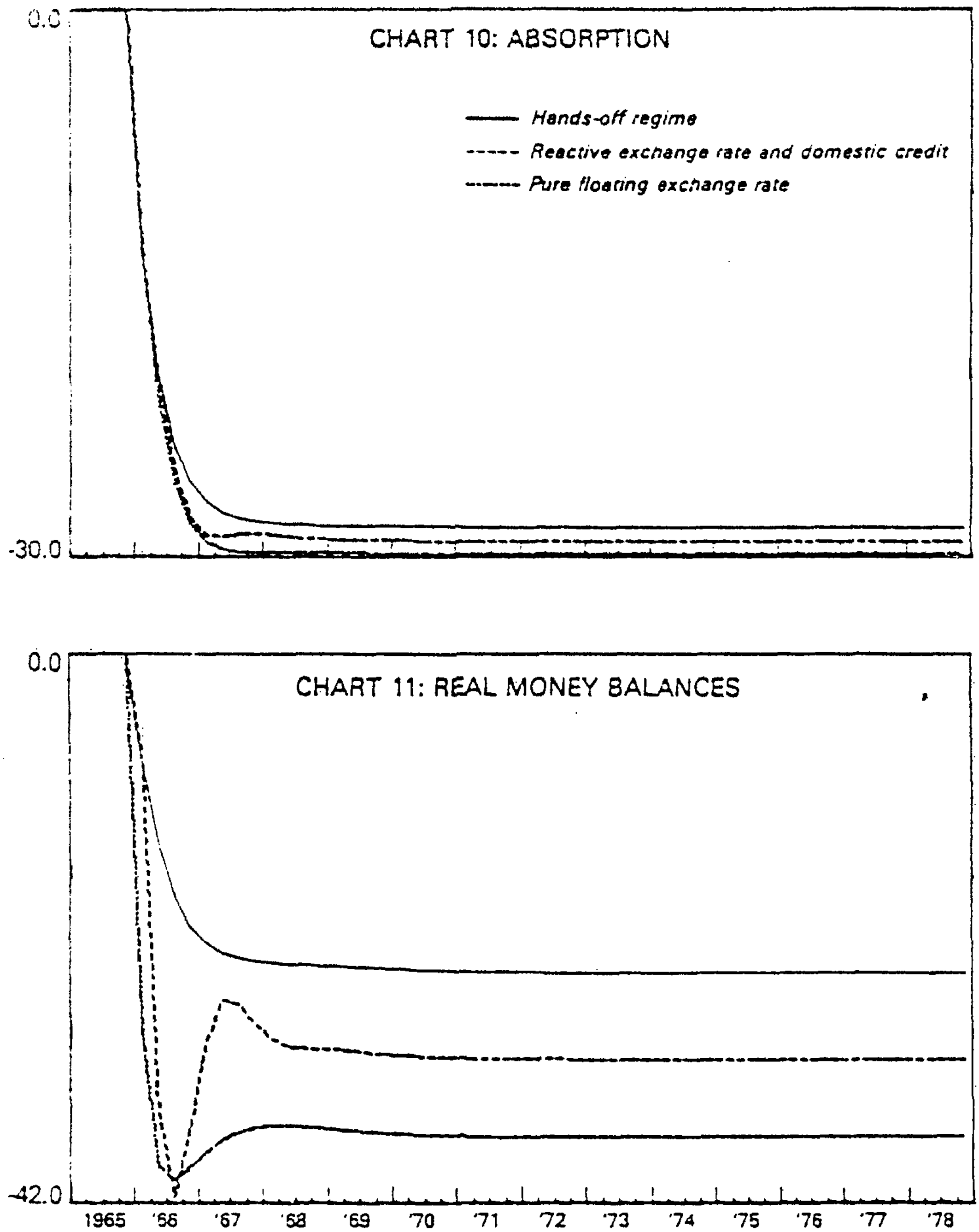
Within the limitations of the present model, the differences in adjustment speeds between regimes is due to different real balance effects. In the first year of reduced capacity, real balances are only 15 percent lower on average in the hands-off regime, but 37 percent lower on average in the flexible exchange rate regime. The other regimes fall within these limits. Reactive domestic credit policy substantially increases the initial fall in real balances, but reactive exchange rates lead to a larger fall over the entire period.

1/ (cont'd from p. 23)

$$tb = \ln\left(\frac{100}{150}\right) = \ln\left(\frac{80}{120}\right) = -0.4055$$

However, the monetary effect of external transactions has changed. In the base period, the external accounts were balanced and, consequently, had no effect on the money supply. In the new period, there is a surplus of 10--that is, exports (80) plus the net capital inflow (50) minus imports (120)--on external transactions that adds to the money supply.

RESPONSES TO A SUSTAINED REDUCTION IN CAPACITY: THREE POLICY REGIMES[1]



[1] Measured in percentage deviations from the base run.

b. A permanent reduction in the demand for money

In theory, the model, subjected to a permanent monetary shock, should exhibit long-run neutrality with respect to relative prices (or the real exchange rate) and all other real flow variables. On this basis, the fixed real exchange rate policy option should be particularly effective at promoting adjustment. In the simulation results, these a priori notions are, by and large, borne out, but the long run proves to be much longer than the time horizon of most policymakers.

The hands-off policy regime and the fixed real exchange rate regime are the two extremes in terms of speed of adjustment (Charts 12 and 13). In the hands-off regime, by the end of the simulation period, 13 years after the initial shock, only two thirds of the excess real balances have been dissipated, absorption is still 4 1/2 percent above the base run level (although real income is only half of 1 percent higher), and the real exchange rate is 10 1/2 percent higher than its full equilibrium level. While all variables are still moving in the right direction, they are moving very slowly. At the other end of the spectrum, the fixed real exchange rate policy regime shows almost complete adjustment: 95 percent of the excess real money balances have been dissipated and absorption, income, and the real exchange rate are all less than 1 percent away from their full equilibrium levels and are moving in the right direction.

The second most complete adjustment occurs under the free floating exchange rate regime and after that the regime in which both the exchange rate and domestic credit are allowed to react to disequilibria. The fixed real exchange rate regime, however, shows considerably more complete adjustment than either of these. Properly characterized, of course, a pure flexible exchange rate regime would adjust more rapidly than the fixed real exchange rate regime, insofar as the latter is subject to information lags. Given capital flows and initial overall external balance, the exchange rate would have to adjust to ensure that the gap between absorption and income did not exceed the initial current account deficit. In terms of the estimated model, however, this would require even larger fluctuations in the nominal and real exchange rate than those that occur in our characterization of the pure float and would probably not be acceptable to policymakers insofar as large price and exchange rate fluctuations are generally thought to be costly. 1/ More simply, in theory, a domestic credit policy capable of immediately reducing the money supply by the full extent of the reduction in the demand for money would ensure costless continuous equilibrium. This, however, would require perfect information on the source, size, and duration of the shock.

1/ In the floating rate regime as presently characterized, the nominal exchange rate depreciates by 68 percent in the first three quarters after the shock, while the real rate depreciates by 30 percent. Nevertheless, the trade balance deteriorates by 23 percent over this period. A substantially larger adjustment coefficient (π_1) in equation (15) could stabilize the external accounts but at the cost of much greater price and exchange rate volatility.

While the simulation results show fastest adjustment in the fixed real exchange rate regime, this is at the cost of greater inflation. The annual inflation rate is, on average, almost 5 percentage points above the base run in the postshock sample in this policy regime, compared with 3 percentage points in the flexible exchange rate regime and less than 1 percentage point in the hands-off regime. However, while the fixed real rate policy leads to a fairly steady increase in prices over the sample period, in the hands-off regime prices rise by 14 percent in the first year after the shock before declining and in the flexible exchange rate regime prices rise by almost 50 percent in the first 18 months before embarking on a steady decline. Also, while the real exchange rate oscillates in the pure flexible exchange rate regime and in the other reactive exchange rate regimes, it rises and then declines steadily in the fixed real rate regime. Unless higher prices per se are negatively weighted in the authorities' objective function, the fixed real rate policy would seem to be best. In general, these simulations tend to confirm the view that sustained financial shocks can effectively be offset by financial policies even if the policymaking authorities have limited information about the size of the shock.

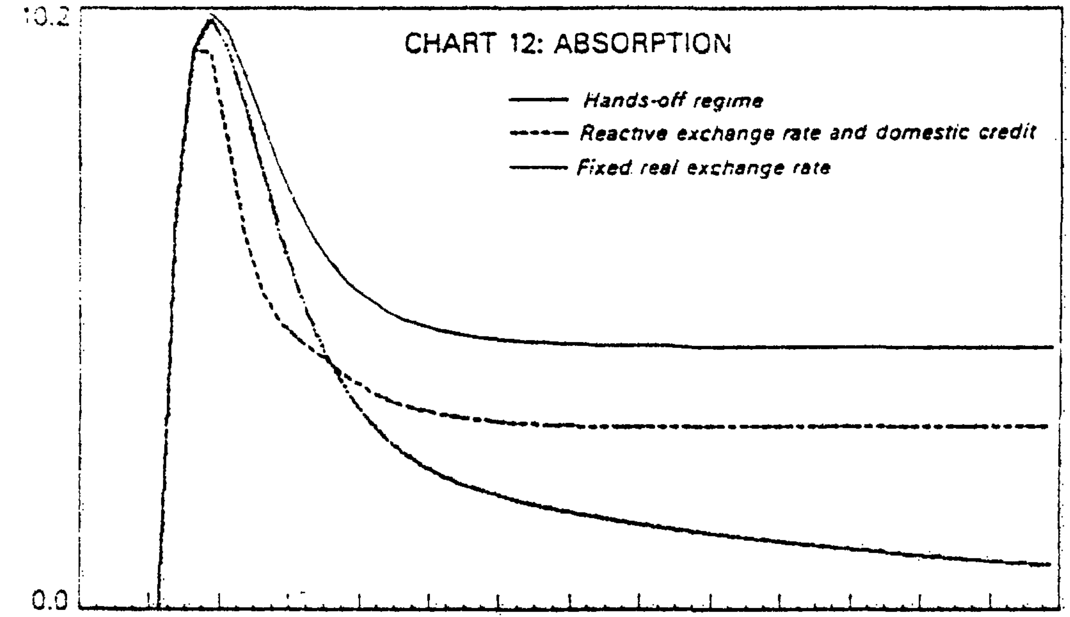
c. A permanent change in the terms of trade

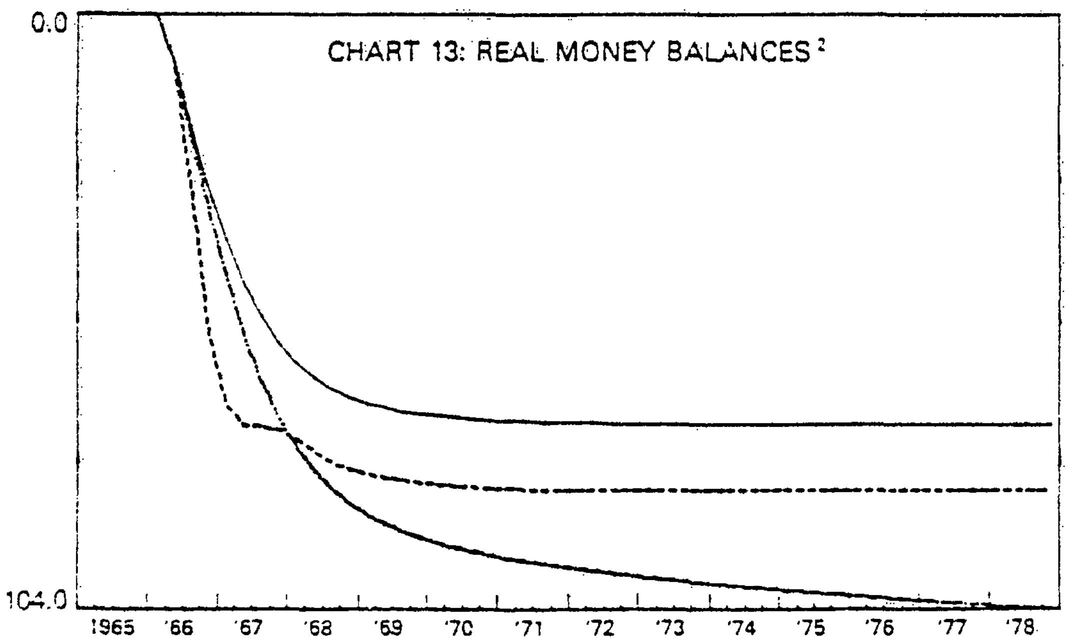
It is interesting to juxtapose the case of a permanent downward shift in the money demand function with that of a permanent deterioration in the terms of trade. In the former, the shock is financial, the resultant inflation is of domestic origin, and the long-term effect on real flows is negligible. In the latter, the shock is real, the resultant inflation originates abroad, and the change exerts a substantial long-run effect on real flow variables. Moreover, the juxtapositioning of the two different shocks underscores the enormity of the policy error of treating them in the same way.

While the policy of trying to fix the real exchange rate is most effective in response to the domestic monetary disturbance, it is near disastrous after a terms of trade deterioration. 1/ In trying to fix the import-related real exchange rate, the authorities are forced to appreciate the domestic currency in response to the deterioration in the terms of trade. This lowers domestic prices and leads to a vicious circle of currency appreciation and falling domestic prices. The process exacerbates the increase in the trade deficit and undermines the monetary squeeze that would normally curtail domestic expenditure. By the end of the simulation period, the deterioration in the trade ratio is four times as large as in the flexible exchange rate regime and more than twice as large as any of the other regimes; there has been virtually no reduction

1/ The problem of trying to fix real wage rates in the face of a deterioration of the terms of trade is strictly analogous and has been well researched. See, for example, Gray (1978). The particular reaction function here, which focuses on the import price rather than the export price, coupled with an import price shock is, of course, set up to illustrate the problem.

RESPONSES TO A SUSTAINED FALL IN THE DEMAND FOR MONEY: THREE POLICY REGIMES[1]





[1]Measured in percentage deviations from the base run.
[2]Percentage changes are measured as first differences in logarithms. A fall in real balances from 100 to 35 would therefore be recorded as a change of 105% while using the more conventional measure of percentage change it would be recorded as a fall of only 65%.

in real absorption and prices have fallen by about 50 percent (Charts 14 and 15). Clearly, a country following such a strategy would soon run out of foreign reserves and would create relative price distortions bound to severely hinder its export sector and prevent its import-competing sector from capitalizing on a relative price advantage.

Of the other policy regimes, the flexible exchange rate produces the largest increase in domestic prices and reduction in real balances and, as a result, does best at containing the trade deficit. It also leads to the smallest increase in the real exchange rate for exports. All of the other regimes produce very similar movements in prices, absorption, and the trade balance. Restrictive domestic credit alone does slightly better at hastening adjustment and containing the trade balance than the other reactive exchange rate regimes, because these regimes contain exchange rate reaction functions (equation (14)) with two terms that work against one another. The exchange rate adjusts to both the worsening trade balance and the deviations of the import-based real exchange rate from equilibrium. The former pushes the domestic currency down in value, the latter pushes it up; as they counterbalance each other, the exchange rate sees very little movement. Consequently, the real exchange rate for exports appreciates with domestic price inflation.

V. Conclusion

Rather than summarize the results of the analysis, it may be worth ending with three observations culled from the experiments conducted. While these are obviously subject to all of the caveats that are attached to the particular model employed and policy experiments in general, they are likely to be more generally applicable, especially as they are of a cautionary nature.

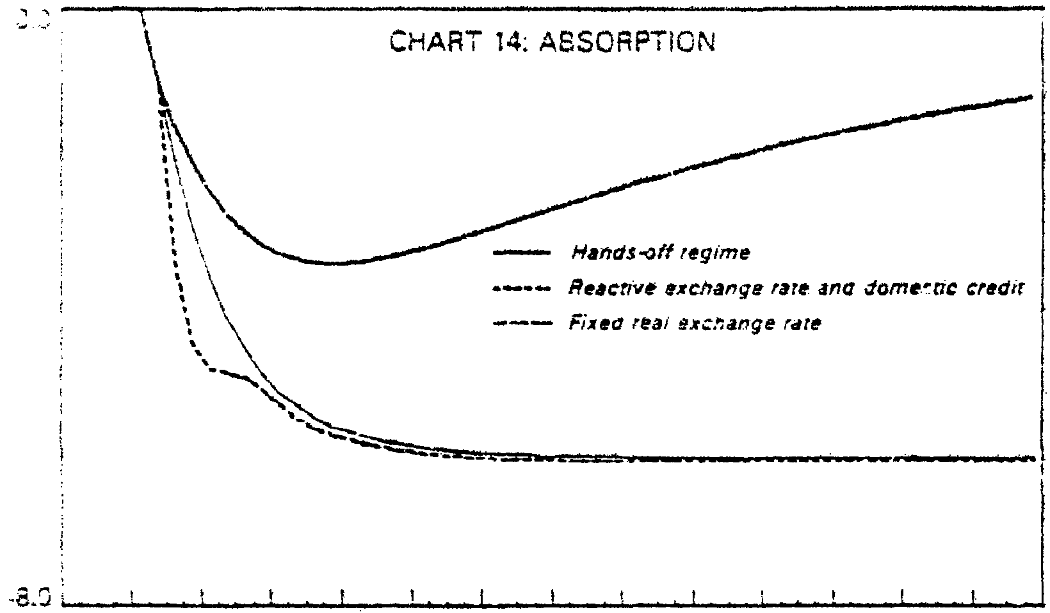
First, confusing real shocks with financial shocks may be very costly. Thus, a crawling peg exchange rate system, while well suited to dealing with fluctuations in domestically generated monetary inflation, may be disastrous in the face of sustained changes in the terms of trade.

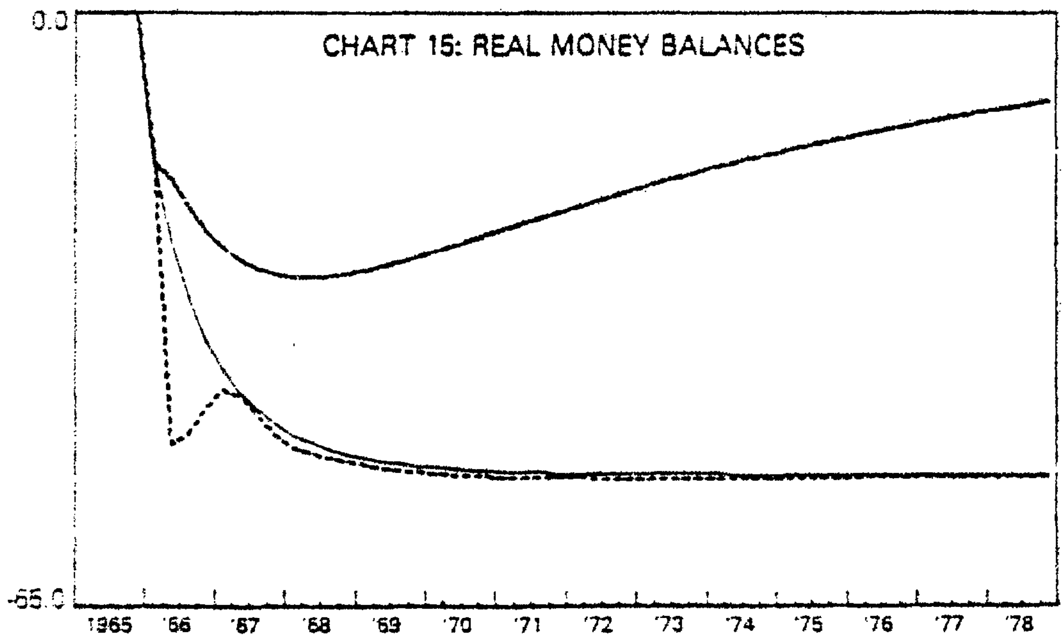
Secondly, the particular objective function of policymakers in developing countries is rarely well defined. Clearly, in many situations, it might be possible to stabilize absorption, income, or the trade balance by the selection of an appropriate set of policies. The fluctuations in prices and exchange rates required to do this, however, might in themselves be considered to entail unacceptably high costs in terms of the uncertainty that they produce and their effects on confidence, investment, and saving.

Finally, it may be costly to treat short-run reversible shocks as if they are permanent by adopting policy measures aimed at rapid adjustment. The effects of discretionary policy changes often persist long after the shocks that elicited them. Moreover, the difficulties of fine-tuning for disturbances of very short duration are greatly exacerbated by the

information lag that inevitably reduces the speed of policy adjustment. In a certain world there would usually be a strong case for financing short-run external payments imbalances rather than adjusting domestic demand to eliminate them. The weakness of this prescription is that uncertainty about the duration of any disturbance is fundamental to the problem of policy formulation. The benefits of avoiding excessive early adjustment, therefore, have to be set against the costs of a probable greater and more painful adjustment at a later stage. A prudent government might well decide that some modest adjustment at an early stage is the safest route.

RESPONSES TO A SUSTAINED DETERIORATION IN THE TERMS OF TRADE: THREE POLICY REGIMES[1]





[1] Measured in percentage deviations from the base run.

Data Sources

The quarterly national accounts data were taken from The Quarterly GNP of Korea, The Bank of Korea. Most of the other data used were taken from the International Monetary Fund's Data Fund tapes, much of which is published in IMF, International Financial Statistics. These data are either reported directly to the IMF by the Korean authorities or taken from the Bank of Korea's Monthly Economic Statistics. Seasonally adjusted series were used wherever the unadjusted series showed evidence of seasonality. Interest rates (I) in the unofficial money market are unpublished survey data collected by the Bank of Korea.

In most cases, the series are fully described in the text; in what follows, therefore, only those series requiring further description are discussed.

Domestic credit (DC) is defined residually, from the consolidated balance sheet of the banking system, as money minus net foreign assets valued in local currency.

Net nontrade receipts in the external accounts (K) is defined residually from the balance of payments identity as the change in net foreign assets minus export receipts plus import receipts. This flow variable--which consists largely of the net capital inflow--is cumulated into a stock variable (KS) in the linearization of the identities in Appendix II.

The overall price index used (P) is the wholesale price index. The import and export price indices used (PX and PM) are unit value indices.

The desired stock of reserves (R^*) is determined by running a trend through peaks of imports, multiplying the resultant peak import series by the average reserve/import ratio over the sample period, and deflating by import prices. Initially, all these series are in terms of U.S. dollars, but both the desired reserve figure and the import price index are converted into domestic currency terms. As the dollar/won exchange rate enters both the numerator and the denominator, this variable is impervious to exchange rate changes.

Real trade data are the nominal domestic currency series, based on customs data, deflated by the unit value indices. Exports are measured f.o.b. and imports c.i.f.

Trade in services (TS) is defined as the difference between the trade data as described above, and the trade data for goods and services as measured in the national income statistics.

Linearizing the Identities

The two identities--that is, the real income and the money identities--are not in loglinear form. For estimation and simulation purposes they are linearized by means of a Taylor's series expansion. Second and higher order terms are omitted from the expansion. The identities are linearized about trend values of the variables with the time trend (t) set at zero in the third quarter of 1975 and changed by increments of one in both directions for each quarter deviation from the base date.

1. The income identity

$$YR_t = ABS_t - XV_t - IMP_t + TS_t \qquad (1)$$

Trend growth rates for variables are denoted by λ, such that the trend value of abs at time t is $\lambda_{abs}.t + abs_o$. The subscript (o) denotes the base period value of the relevant variable. Linearizing (1) about the trend yields:

$$\begin{aligned} yr = yr_o + \lambda_{yr}.t &+ (\frac{ABS}{YR})_o [abs_t - abs_o - \lambda_{abs}.t] \\ &+ (\frac{XV}{YR})_o [xv_t - xv_o - \lambda_{xv}.t] - (\frac{IMP}{YR})_o [imp_t - imp_o - \lambda_{imp}.t] \\ &+ (\frac{TS}{YR})_o [ts_t - ts_o - \lambda_{ts}.t] \end{aligned} \qquad (2)$$

Let

$c1 \equiv (\frac{ABS}{YR})_o$

$c2 \equiv (\frac{XV}{YR})_o$

$c3 \equiv (\frac{IMP}{YR})_o$

$c4 \equiv (\frac{TS}{YR})_o$

$c5 \equiv \lambda_{yr} - c1\lambda_{abs} - c2\lambda_{xv} + c3\lambda_{imp} - c4\lambda_{ts}$

$q \equiv$ the error due to the linearization

Substituting these definitions into (2) gives:

$$\begin{aligned} yr_t = c1.abs_t + c2.xv_t - c3.imp_t + c4.ts_t + c5.t \\ + \text{constant} + q_t \end{aligned} \qquad (3)$$

2. The money identity

$$M_t = DC_t + NFA_{t-1} + (XV_t \cdot PX_t) - (IMP_t \cdot PM_t) + K_t \qquad (1)$$

In the terms of changes in the money stock this may be written as

$$\Delta M_t = \Delta DC_t + (XV_t \cdot PX_t) - (IMP_t \cdot PM_t) + \Delta KS_t \qquad (2)$$

where Δ is the first difference operator and KS is the stock of indebtedness. This interpretation of KS is approximate as K represents the flow of both capital and nontrade current account receipts; however, KS should simply be interpreted as the summation of K over time. This is merely a device to eliminate negative values of K which would complicate the linearization. Dividing (2) through by M_{t-1} yields:

$$\Delta m_t = \Delta dc_t \left(\frac{DC}{M}\right)_{t-1} + \frac{XV_t \cdot PX_t}{M_{t-1}} - \frac{IMP_t \cdot PM_t}{M_{t-1}} + \Delta ks_t \left(\frac{KS}{M}\right)_{t-1} \qquad (3)$$

Linearizing equation (3) term by term by means of a Taylor's series expansion yields:

$$\begin{aligned}\Delta m_t = {} & \left(\frac{DC}{M}\right)_o [dc_t - dc_{t-1}] + (\Delta dc_o)\left(\frac{DC}{M}\right)_o [dc_{t-1} - dc_o - \lambda_{dc} \cdot t - m_{t-1} \\ & + m_o + \lambda_m \cdot t] + \left(\frac{XV \cdot PX}{M}\right)_o [1 + xv_t + px_t - xv_o - px_o - \lambda_{xv} \cdot t \\ & - \lambda_{px} \cdot t - m_{t-1} + m_o + \lambda_m \cdot t] - \left(\frac{IMP \cdot PM}{M}\right)_o [1 + imp_t + pm_t \\ & - imp_o - pm_o - \lambda_{imp} \cdot t - \lambda_{pm} \cdot t - m_{t-1} + m_o + \lambda_m \cdot t] \\ & + \left(\frac{KS}{M}\right)_o [ks_t - ks_{t-1}] + (\Delta ks_o)\left(\frac{KS}{M}\right)_o [ks_{t-1} - ks_o - \lambda_{ks} \cdot t \\ & - m_{t-1} + m_o + \lambda_m \cdot t] \end{aligned} \qquad (4)$$

Letting $k1 \equiv \left(\frac{DC}{M}\right)_o$

$k2 \equiv \Delta dc_o$

$k3 \equiv (\frac{XV \cdot PX}{M})_o$

$k4 \equiv (\frac{IMP \cdot PM}{M})_o$

$k5 \equiv (\frac{KS}{M})_o$

$k6 \equiv \Delta ks_o$

$v \equiv$ error due to linearization

Equation (4) may be rewritten as:

$$m_t = (1 - k1k2 - k3 + k4 - k5k6)m_{t-1} + k1dc_t + k1(k2 - 1)dc_{t-1}$$

$$+ k3(xv_t + px_t) - k4(imp_t + pm_t) + k5ks_t + k5(k6 - 1)ks_{t-1}$$

$$+ [(k1k2 + k3 - k4 + k5k6)\lambda_m - k1k2\lambda_{dc} - k3(\lambda_{xv} + \lambda_{px})$$

$$+ k4(\lambda_{imp} + \lambda_{pm}) - k5k6\lambda_{ks}]\ t + \text{constant} + v_t \qquad (5)$$

Notably, it is arguable that k1 and k5 should be evaluated at the period before the base period to be consistent with equation (3). However, as these ratios were relatively constant, all were simply evaluated at the base period.

The Structure of the Model

It is difficult to test the validity of the structure of the full model by means of any simple statistic. 1/ The likelihood ratio statistic, which is distributed asymptotically as a chi-square distribution allows a large sample test of whether the overidentifying restrictions are consistent with the data for the FIML estimator. But recent work suggests that even for samples of over 100 observations the likelihood ratio may not be a good approximation to the asymptotic chi-square distribution. For whatever it is worth, the chi-square value of the log-likelihood ratio is 334.89 with 111 degrees of freedom. The critical value of the distribution at the 5 percent level with 111 degrees of freedom is approximately 136.6. Thus, if one were to regard the likelihood ratio as a reasonable approximation to the asymptotic chi-square distribution, one would have to reject the hypothesis that the overidentifying restrictions are consistent with the sample data. 2/

In testing the hypothesis that the model is not consistent with the data, the opposite problem occurs. With a small sample, it is difficult not to reject the hypothesis. The Carter-Nagar statistic for the overidentified model, which has an asymptotic chi-square distribution with 21 degrees of freedom, is 72,110. The critical value of the chi-square distribution with 21 degrees of freedom at the 5 percent level is 32.7. Thus, if the difficulties related to small samples were ignored, the hypothesis that the model is not consistent with the data would be resoundingly rejected. This result is reflected in Carter-Nagar R^2 statistic of 0.9969.

While these formal tests are not of much use because of the inadequacy of the sample size, it may be of interest to examine the mean-squared errors of the estimated endogenous variables.

1/ Tests of the individual parameters do not present as great a problem. Parameter estimates are asymptotically normally distributed, but work by Phillips (1978) suggests that for small samples--20 to 30 observations in his case--the accuracy of the approximation depends critically on the stability of the model. If the model is unstable, the small sample parameter distribution will be slow to converge to the asymptotic distribution, as the number of observations is increased. The sample used in this model (56 observations) is about twice as large as those in Phillips' Monte Carlo studies, so that we have proceeded to test the parameter estimates with a normal distribution with the standard deviation given by the estimates standard errors.

2/ Most other models using the same or similar estimation programs have arrived at a similar rejection of the overidentifying restrictions. See, for example, Jonson et. al. (1976), Knight and Wymer (1978), and Brillembourg and Schadler (1979).

Appendix Table I. Korea: Estimation Errors

(Sample period first quarter 1965 to fourth quarter 1978)

Endogenous Variable	Variance	Mean-Squared Error of Estimate
p	0.2753	0.0003
xv	1.2876	0.0038
imp	0.5336	0.0062
abs	0.1457	0.0013
yr	0.1500	0.0007
m	1.7565	0.0004

As is clear from Appendix Table I, the in-sample tracking performance of the model is good, the mean-squared errors of estimates are very small relative to the original variances of the endogenous variables.

The simulation results go only one year beyond the sample period and therefore track actual performance rather well (Appendix Table II). In the post-sample period, however, the divergence between actual and simulated values does widen.

Appendix Table II. Korea: Simulation Errors

(Third quarter of 1965 to fourth quarter of 1979)

Endogenous Variable	Variance	Mean-Squared Error	
		Static simulation	Dynamic simulation
p	0.3164	0.0004	0.0007
xv	1.2524	0.0044	0.0171
imp	0.4992	0.0061	0.0096
abs	0.1586	0.0015	0.0021
yr	0.1606	0.0008	0.0010
m	1.7373	0.0004	0.0036

In general, it is somewhat surprising that the model specified fits the data as well as it does. In specifying the model, a demand-driven structure was chosen chiefly because of its familiarity. There are, of

course, persuasive arguments against this sort of model structure in light of the real--that is, relative price or terms of trade--shocks that occurred in 1973 and again soon after the end of the sample period. 1/ The structure chosen does, however, facilitate the concentration on typical instruments of demand management in the policy analysis of Section IV.

1/ See, for example, Van Wijnbergen (1981) and (1982).

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