IMF *Staff Papers*
Vol. 37, No. 1 (March 1990)

Shorter Papers and Comments

A Model of Adjustment and Growth

An Empirical Analysis

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A model that merges the monetary approach to the balance of payments and a neoclassical growth model into a unified framework in which inflation, growth, and the balance of payments are simultaneously determined is estimated. The tradeoff between the simplifying assumptions of the model and its ability to fit reality is assessed in terms of a diverse sample of seven capital importing developing countries for which the key parameters of the model are estimated, and the sensitivity of the implied policy multipliers is determined. [JEL 113, 121]

ANY ANALYSIS of the effects of policies on the targets for growth, inflation, and the balance of payments requires a consistent and unified framework. Further, in dealing with developing countries, it is desirable that the framework be both sufficiently simple, so as to allow its application where data are limited, and general, to ensure its applicability to a diverse set of countries. The model developed by Khan and Montiel (1989), which merges a variant of a neoclassical growth model with the monetary approach to the balance of payments, provides such an integrated framework.[1]

However, the simplicity that makes a model more tractable from an operational standpoint may limit its ability to describe reality. Using a diverse sample of seven capital importing developing countries, this

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[1] For a more detailed discussion of the building blocks of the model, see Khan, Montiel, and Haque (1986).

paper assesses the tradeoff between the simplifying assumptions of the Khan-Montiel model and its ability to fit reality. For each country, two questions are asked: (1) How sensitive are the policy multipliers to these parameter estimates—that is, how robust are the policy implications? (2) Are some target variables more vulnerable to forecast errors than others?

Section I outlines the theoretical framework and examines its properties, and Section II presents estimates of the key parameters. Section III contains comparative static exercises dealing with the shocks central to most adjustment programs—changes in domestic credit, changes in government spending, and devaluation. The section concludes with an analysis of the "robustness" of the policy implications of the model under varying parameter values. The final section reviews the key results and discusses the limitations of the approach followed in this paper.

I. Summary of the Theoretical Framework

The model described by Khan and Montiel (1989) connects a growth block, similar to that employed by the World Bank (see Khan, Montiel, and Haque (1986)), and a monetary block that is central to the monetary approach to the balance of payments associated with Fund-supported adjustment programs (see International Monetary Fund (1977, 1987)). The growth block of the model comprises (1) a neoclassical production function linking potential output growth to increases in productivity and the labor and capital stocks; (2) a saving function, which assumes that real private saving is proportional to real disposable income; and (3) an identity that sets saving equal to investment. Combining the growth block with changes in reserves, as described by the balance of payments equation for a country with a fixed exchange rate, results in a single relationship between domestic goods inflation and real output growth:

$$dy_t = [1 - s\alpha_1 - \alpha_1 be_t / P_{Dt}]^{-1}$$

$$\cdot \Big(\alpha_0 + \alpha_1 \{s(y_{t-1} - t_t) + (t - g)_t + e_t / P_{Dt}\,[B_0 - a(e_t / P_{Dt} - 1)]\}\Big) \qquad (1)$$

(see Table 1 for a definition of the variables).

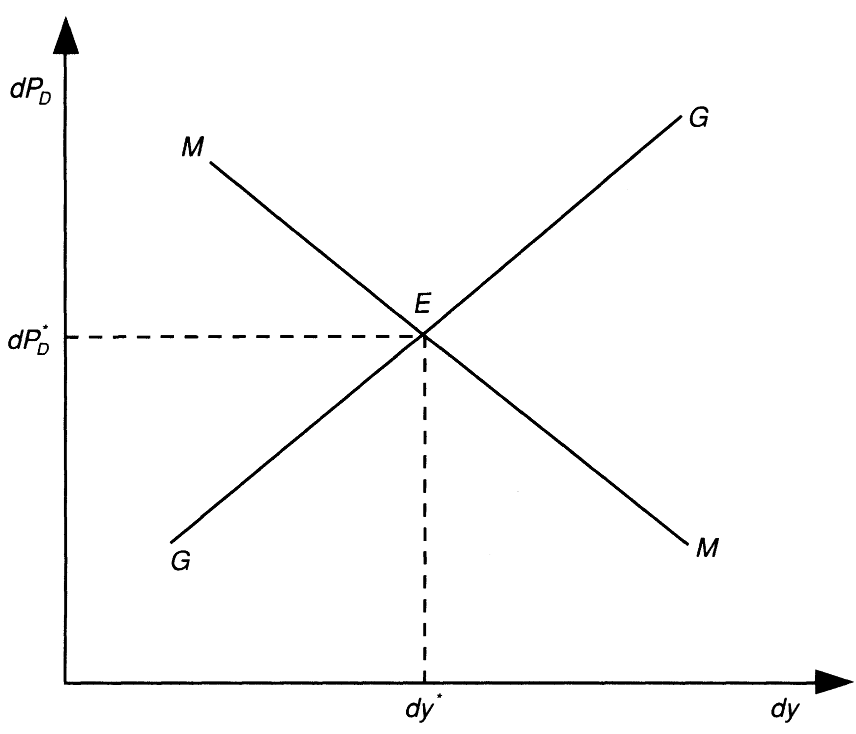
Graphically, this simplification of the growth block traces the locus in Figure 1 labeled GG. The slope and position of the GG schedule depend on initial conditions, the level of the fixed nominal exchange rate, the fiscal deficit, and the structural explanation of production and saving behavior. When evaluated at $dy_t = dP_{Dt} = 0$, the slope of the GG schedule is

Table 1. *Variables of the System*

Variable	Definition
Yt	Gross domestic product
T_t	Taxes from the private sector
C_t	Private consumption
S_{pt}	Private saving
P_{Dt}	Price of domestic output
dk_t	Change in capital stock (= Investment)
dD_{pt}	Change in domestic credit to the private sector
dD_{gt}	Change in domestic credit to the public sector
G_t	Government purchases of domestic output
F_t	Foreign currency value of government foreign debt
i_t	Interest rate on foreign debt
e_t	Nominal exchange rate—number of domestic currency units per unit of foreign currency
dM_t^S	Change in the money stock
R_t	Foreign currency value of reserves held by the central bank
dD_t	Change in total domestic credit
T_{Bt}	Portion of central bank profits transferred to the government

Note: The d's denote changes from time $t-1$ to time t; that is, $dx_t = x_t - x_{t-1}$; the lowercase letters denote real magnitudes.

Figure 1. *Macroeconomic Equilibrium*



$$\left.\frac{(dP_D)}{(dy)}\right|_{GG} = -\beta/\alpha_1\eta,$$

where $\eta = B_0 - a \lesseqgtr 0$, and $\beta = 1 - \alpha_1(s + b) > 0$.

The monetary block of the model comprises (1) a flow money-supply equation linking money creation to the change in foreign reserves and to domestic credit creation; (2) a money-demand equation, which assumes that the income velocity of money is constant; and (3) a market-clearing condition that sets the supply equal to the demand for money. When augmented with the balance of payments equation, the monetary block can also be reduced to a relationship between inflation and output growth:

$$dP_{Dt} = [\nu(1-\theta)(y_{t-1} + dy_t)]^{-1}\{[dF_t - B_0' - i'(F_{t-1} - R_{t-1}) + dD_t] - (b' + \nu)\,dy_t - \nu\theta y_{t-1}\,de_t - \nu\theta de_t dy_t + a'(e_t/P_{Dt} - 1)\}, \quad (2)$$

where $a' = a/(1-i)$, $b' = b/(1-i)$, $i' = i/(1-i)$, and $B_0' = B_0/(1-i)$. Equation (2) traces a negatively sloped locus, labeled MM in Figure 1. The slope and position of the MM loci depend on initial conditions, the level of foreign reserves, domestic credit growth, and the income velocity of money and the importance of importables in the domestic price index. When evaluated at $dy_t = dP_{Dt} = 0$, the slope of MM is given by

$$\left.\frac{(dP_D)}{(dy)}\right|_{MM} = -(b' + \nu)/\gamma < 0,$$

where $\gamma = a' + \nu(1-\theta)y_0 > 0$.

The intersection of the GG and MM schedules at E in Figure 1 depicts the equilibrium values of output changes and domestic inflation. It is this theoretical description that will be tested against the reality of a sample of seven countries in the next section.

II. Estimating the Parameters of the System and Testing the Underlying Assumptions

To test the empirical validity of the Khan-Montiel model, the model is applied to a set of seven diverse developing countries: Chile (1976–87), Ghana (1969–87), Honduras (1969–87), the Republic of Korea (1969–87), Myanmar (1969–87), Pakistan (1976–87), and Tanzania (1969–87). The sample, representative of a larger set of developing countries, includes low- and middle-income countries, manufacturing and primary exporters, as well as service and remittance countries, and one heavily indebted country.

Owing to data limitations, a variety of methods were used to obtain estimates for the seven parameters that characterize the system. The simple behavioral equations of the Khan-Montiel model make it possible to use each country's sample averages of the saving rate, velocity, and share of foreign goods in the domestic price index to proxy s, v, and θ, respectively. To obtain values for the other key parameters, a production function and disaggregate trade equations were estimated for each country, using either ordinary or generalized least squares, as was dictated by the data.[2] The individual equation approach allowed more efficient use of the limited data, particularly in cases where the available time series had uneven starting points. With the exception of the production function, which includes a proxy for the labor force, this empirical work includes as explanatory variables only those dictated by the theoretical model. In general, the specifications of the estimation equations allowed these explanatory variables to appear with a richer lag structure than that suggested by the theoretical model, with each specific case determined by the data. Details for each equation and each country are outlined in the remainder of this section.[3]

The Domestic Economy

To obtain estimates for the marginal product of capital, α_1, and the combined effects of changes in the size of labor and total factor productivity, α_0, a simple growth model was estimated that takes the form

$$Dy_t = \alpha_0 + \alpha_1(dk_t/y_{t-1}) + \alpha_2 DL_t, \tag{3}$$

where the uppercase D's indicate rates of change and L denotes the labor force, here proxied by population. The estimates presented in Table 2 were obtained by applying ordinary least squares to a form such as equation (3) and imposing constant returns to scale ($\alpha_2 = 1 - \alpha_1$). As indicated in the table, the estimates for the marginal product of capital are reasonable in sign and magnitude across countries (averaging about 0.29), but some caution in interpreting the results is in order, since this neoclassical production function does not explain much of the variation in actual output.

The theoretical model assumes that real private savings is proportional to real disposable income, implying that the marginal and average saving rates are equal. Thus, the *average* private saving rate, as reported in

[2] See Appendix for an explanation of the construction of this variable.
[3] See Reinhart (1989) for more detail on the estimation process.

Table 2, can be used as a measure of s. This technique makes the most of the limited data, since the presence of negative levels of private savings for some countries in the sample for some years precludes estimating a log linear savings function. Further, the problem of heteroscedastic errors makes the use of levels inappropriate.

The key behavioral relationship of the monetary block is the specification of money demand; Khan and Montiel (1989) assume that opportunity cost variables do not affect the demand for money, so that the income velocity of money is constant. As with the savings parameter, the historical averages of the ratio of money to income are used to approximate ν, the inverse of the income velocity of money, and are reported for the narrow definition of money in Table 2.

The External Sector

The remaining parameter in the monetary component of the model is θ, the weight of import prices in the general price level. This parameter

Table 2. *Domestic Parameters of the Model*

Country	Production Function				Average Saving Rate (s)[a]	Average Velocity Behavior (ν)
	α_0	α_1	R^2	D-W		
Tanzania	−0.07 (−2.25)	0.28 (2.60)	0.28	1.81	0.03	0.24
Ghana	−0.04 (−1.06)	0.12 (1.79)	0.14	1.40	−0.25	0.19
Pakistan	−0.07 (−1.35)	0.62 (5.01)	0.71	1.51	0.07	0.25
Republic of Korea[b]	0.08 (6.94)	0.08 (2.58)	0.34	1.12	0.31	0.10
Myanmar	−0.02 (−0.66)	0.23 (2.61)	0.17	1.38	0.16	0.25
Honduras	−0.05 (−2.10)	0.28 (2.01)	0.13	1.27	0.21	0.11
Chile	−0.07 (−2.61)	0.50 (6.08)	0.79	2.83	−0.06	0.07

Note: Figures in parentheses are the t-statistics; R^2 is the coefficient of determination, and D-W denotes the Durbin-Watson statistic.
[a] Sample period 1963–86, except for Chile (1973–86).
[b] The investment-output ratio for the Republic of Korea has been detrended.

Table 3. *External Sector Parameters of the Model*

			Weighted Real Exchange Rate Elasticity			
Country	Import Price Weight (share ≈ θ)	Imports	Exports	Trade Balance	Share of External Sector ≈ a[a]	Weighted Income Elasticity ≈ b
Tanzania	0.252	−0.89	0.09	−0.98	−0.37	0.69
Ghana	0.114	0.12	0.31	−0.20	−0.08	1.20
Pakistan	0.158	−1.38	−0.56	−0.81	−0.21	1.00
Republic of Korea	0.181	−4.92	3.73	−8.65	−0.83	0.64
Myanmar	0.096	−0.38	0.37	−0.75	−0.40	0.62
Honduras	0.306	−0.05	0.22	−0.26	−0.12	1.28
Chile	0.201	−3.20	−0.26	−2.30	−0.59	1.81

[a] Scaled by the size of the external sector, here measured as the sum of average imports and exports.

was approximated by average share of imports in total (public plus private) consumption and is reported in Table 3 with the other external sector parameters.

Two external sector relationships are used in both the *GG* and *MM* schedules to close the system: the balance of payments identity and the trade balance responses to output and real exchange rate changes. The trade balance was decomposed into its components—exports and imports. The relative price and income elasticities of import demand and export supplies were estimated from simple trade equations:[4]

$$\log(z_t) = \delta_0 + \delta_1 \log(y_t) + \delta_2 \log(P_{zt}/P_{Dt}) \tag{4}$$

$$\log(x_t) = \epsilon_0 + \epsilon_1 \log(yf_t) + \epsilon_2 \log(P_{xt}/P_{Dt}). \tag{5}$$

For export demand, yf denotes real gross domestic product (GDP) of the industrial countries.

Proxies for a and b were constructed by weighting the "disaggregated" parameter estimates (obtained by applying generalized least squares to the above equations) by the sample period averages of imports and exports, respectively. The results of the estimation of import demand and export supply are reported in the Appendix; the "weighted" estimates for a and b are reported in Table 3. For all, the real exchange rate elasticity, $-a$, has the correct sign (negative), and an increase in domestic income worsens the trade balance—that is, b is positive.

III. Comparative Statics and Sensitivity Analysis

In this section, the model's usefulness for policymaking is evaluated using the policy multipliers associated with the estimated parameter values. Additionally, the sensitivity of these multipliers to varying parameter values is examined and the relative precision of the forecasts for the target variables is assessed. The three policy exercises considered are central to adjustment programs: an increase in domestic credit; an increase in government spending; and a devaluation.

Findings in the Cross-Country Comparisons

Only limited confidence can be placed on point estimates, since more detailed work suggests that some of the parameters are unstable (see

[4]The use of the relative price of exports, P_x/P_D, in this specification, in lieu of the real exchange rate, P_z/P_D, is justified by the assumption of constant terms of trade in the theoretical model.

Reinhart (1989)). Even in the instances in which the hypothesis of stability cannot be rejected, the precision of these point estimates tends to be quite low (that is, the standard errors tend to be large). For any analytical purposes, a band of parameter values must be considered. The upper and lower bounds of such a band were calculated, somewhat arbitrarily, by respectively adding to and subtracting from the point estimates one half a standard error.

Increase in Domestic Credit

An increase in the rate of domestic credit expansion (assumed to go entirely to the private sector) creates a flow excess supply of money on impact (in graphical terms, the *MM* schedule in Figure 1 shifts upward). At the initial level of output, this shift induces an increase in the price level, which, in turn, increases money demand. However, for a given level of import prices, the domestic price rise also produces a real exchange rate appreciation and a worsening in the current account deficit. The worsening current account is mirrored by an increase in foreign savings and an increase in investment and output growth. Ultimately, inflation rises, output growth increases, and the balance of payments worsens.[5]

These theoretical multipliers are presented in Table 4, using the estimated structural parameters; in keeping with the range of uncertainty attached to those structural estimates, the table also provides lower and upper bounds to assess the limits of the uncertainty. For example, a 1 percent increase in the rate of growth of domestic credit increases inflation by an average of about 1.5 percentage points (the range is 1.2 percent to 1.9 percent), increases output growth by 0.2 percentage point, and worsens the balance of payments by 0.6 percentage point.

Note the large discrepancy between the inflation multipliers, which are highly variable in most instances, and the relatively similar values for multipliers for growth and the balance of payments. This suggests that the usefulness of the model, or the desirability of using credit as a policy instrument, will depend, to a large degree, on the policymaker's objective function. If the primary objective of policy is to meet an inflation target, then this framework of analysis, given the underlying parameter values, may not be the best to employ. If, however, the primary policy objective is a balance of payments or growth target, the model is more useful.

[5] See Khan and Montiel (1989) for a detailed discussion.

Increase in Government Spending

An increase in government spending, maintaining taxes and the rate of change in domestic credit at initial levels, shifts the *GG* schedule in Figure 1 to the left. The rise in fiscal spending translates into a higher deficit and, therefore, less public savings. The decline in savings reduces capital accumulation and output growth. As output growth falls, reducing the flow demand for money and creating an excess supply, inflation must rise to ensure that the money market clears. With output falling and prices rising, the impact of the fiscal expansion on the balance of payments is theoretically ambiguous and must be determined by the data. (See Table 4 for a summary of the relevant policy multipliers.)

Once again, the fiscal multipliers for output and the balance of payments are bounded by a fairly narrow range. In the case of a change in credit—a monetary shock—the bulk of the adjustment falls on the nominal variable (inflation), with output growth and the balance of payments remaining relatively unaffected. A change in government spending—a real shock—has a greater (and more variable) impact on inflation than on real variables. For all seven countries, the balance of payments improved after the shock, indicating that the contractionary output effect dominated the relative price effect.

Devaluation

A devaluation is *both* a real and a nominal shock, and consequently shifts both schedules in Figure 1. At the initial price of domestic goods, a devaluation increases the aggregate price level through an increase in the price of imports. This increases the flow demand for money. At the same time, the shift in relative prices induces lower consumption of the importable and higher production of the domestic good, leading to an improvement in the balance of payments and an expansion in the flow supply of money. If substitution effects are dominant, then the increase in the flow supply of money more than accommodates the rise in demand, and the *MM* schedule shifts to the right—this effect is expansionary. In the "real" sector the foreign component of savings is lower, due to the improvement in the balance of payments; this reduces capital formation, shifting the *GG* schedule to the left—a contractionary effect. As shown in Khan and Montiel (1989), the latter effect dominates and, output falls (see Table 4 for the estimated multipliers for a devaluation).

Two general characteristics are worth noting. First, the multipliers of a devaluation are relatively low when compared to those associated with

Table 4. *Estimated Policy Multipliers*
(In percent)

Country	Increase in Domestic Credit			Increase in Government Spending			Devaluation		
	Inflation	Output	Balance of Payments	Inflation	Output	Balance of Payments	Inflation	Output[a]	Balance of Payments
Tanzania									
Point estimate	1.4	0.2	−0.6	0.5	−0.3	—	0.6	—	0.2
Lower bound	1.4	0.1	−0.6	0.3	−0.2	—	0.6	—	0.2
Upper bound	1.2	0.2	−0.6	0.7	−0.4	0.1	0.6	−0.1	0.2
Ghana									
Point estimate	3.1	—	−0.3	0.6	−0.1	0.1	0.2	—	0.1
Lower bound	3.8	0.1	−0.3	0.5	−0.1	0.1	0.3	—	0.1
Upper bound	2.6	—	−0.3	0.7	−0.1	0.2	0.1	—	0.1
Pakistan									
Point estimate	1.0	0.4	−0.6	2.4	−0.9	0.4	0.6	−0.1	0.2
Lower bound	1.3	0.3	−0.5	1.8	−0.7	0.3	0.6	−0.1	0.2
Upper bound	0.6	0.5	−0.6	3.3	−1.2	0.7	0.8	−0.1	0.3

Republic of Korea									
Point estimate	0.9	0.1	−0.8	0.1	−0.1	—	0.7	—	0.2
Lower bound	0.9	0.1	−0.8	0.1	−0.1	—	0.8	—	0.2
Upper bound	0.8	0.1	−0.7	0.1	−0.1	—	0.7	—	0.3
Myanmar									
Point estimate	1.3	0.1	−0.6	0.3	−0.2	—	0.6	—	0.2
Lower bound	1.4	0.1	−0.6	0.3	−0.2	—	0.6	—	0.2
Upper bound	1.2	0.1	−0.6	0.4	−0.3	—	0.6	—	0.2
Honduras									
Point estimate	2.9	0.2	−0.5	2.1	−0.4	0.2	0.4	—	0.1
Lower bound	3.6	0.1	−0.5	1.2	−0.2	0.1	0.4	—	0.1
Upper bound	2.0	0.2	−0.6	3.5	−0.6	0.5	0.5	—	0.1
Chile									
Point estimate	0.4	0.4	−0.9	1.4	−0.6	0.1	1.0	—	0.1
Lower bound	1.4	0.4	−0.9	1.1	−0.4	0.1	0.9	—	0.1
Upper bound	0.1	0.5	−0.9	1.9	−0.7	0.2	1.1	—	0.1
Average									
Point estimate	1.5	0.2	−0.6	1.1	−0.1	0.1	0.6	—	0.1
Lower bound	1.9	0.2	−0.6	0.8	−0.3	0.1	0.6	—	0.1
Upper bound	1.2	0.2	−0.6	1.5	−0.5	0.2	0.6	—	0.2

[a] A dash (—) in this column indicates the value is negligible but negative in sign.

credit and fiscal changes, suggesting it takes large devaluations to affect the target variables in any meaningful way. Second, as with monetary and fiscal policy, the effects of a devaluation on inflation are greater than, although not quite as pronounced as, on output or the balance of payments. Thus, the desirability of this framework or of using devaluation as a policy tool depends on the relative importance to policymakers of the inflation target.

IV. Conclusions

The objective of this paper was to apply to diverse countries a model that in principle is simple enough to be used operationally in countries where data availability is limited, and is comprehensive enough to enable a useful analysis and evaluation of growth-oriented policies to be undertaken. With the use of estimated parameter values to construct reduced-form multipliers, the robustness of the model's policy implications was found to depend heavily on two factors.

First, robustness varies with the target variable considered. For output growth and the balance of payments, the range for multipliers was narrow, despite sizable variation in parameter values. For inflation, the range of values the policy multipliers assumed was quite broad. This suggests that the forecast errors are likely to be large if this model is employed to forecast the effects of policy changes on inflation.

Second, the reliability of the policy implications depends on the policy instrument being considered. Based on the results here, the effects of fiscal policy (on all target variables) are less sensitive to parameter changes than the multipliers of a devaluation or changes in credit.

APPENDIX

Data Sources and Definitions

The source for the data set used in this paper was *World Economic Outlook* (International Monetary Fund, various years); for the average private saving rate, *International Financial Statistics* (International Monetary Fund, various years) was also used. The definitions are as follows:

y_t = real GDP

dk_t/y_{t-1} = investment-output ratio

l_t = population

s = average private saving rate—constructed by substracting government savings from gross savings

Table 5. *Trade Parameters: Estimation Results*

Country	Import Demand					Export Supply				
	δ_0	δ_1	δ_2	R^2	D-W	ϵ_0	ϵ_1	ϵ_2	R^2	D-W
Tanzania	−0.86	0.78	−0.38	0.66	2.06	−6.70	1.12	0.07	0.81	2.03
	(−0.60)	(2.68)	(−2.55)			(−0.65)	(0.83)	(0.41)		
Ghana	−8.42	1.76	0.07	0.73	1.61	2.93	−0.18	0.17	0.68	1.81
	(−1.94)	(2.39)	(0.59)			(1.23)	(−0.62)	(3.55)		
Pakistan	−3.72	1.07	−0.36	0.96	1.71	−10.31	1.68	−0.22	0.74	1.75
	(−4.10)	(8.27)	(−3.09)			(−2.54)	(3.14)	(−1.05)		
Republic of Korea	5.91	0.68	−0.50	0.99	1.71	−28.48	4.41	0.39	0.98	1.04
	(3.59)	(5.51)	(−3.83)			(−4.99)	(7.14)	(1.69)		
Myanmar	−3.56	0.93	−0.30	0.44	1.72	−10.24	1.35	0.32	0.41	1.36
	(−2.00)	(2.43)	(−0.71)			(−1.66)	(1.78)	(1.31)		
Honduras	−4.63	1.79	−0.03	0.82	1.54	−9.20	1.31	0.15	0.68	1.60
	(−2.48)	(3.04)	(−0.25)			(−4.68)	(5.14)	(0.84)		
Chile	−13.29	2.27	−1.00	0.97	1.29	−16.34	2.56	−0.26	0.97	2.02
	(−5.01)	(8.33)	(−4.70)			(−8.55)	(10.80)	(−1.92)		

Note: R^2 denotes the coefficient of determination; D-W denotes the Durbin-Watson statistic; the figures in parentheses are the t-values.

$(y - t)_t$ = nominal GDP less nominal taxes deflated by the consumer price index
M_t = nominal money stock—the analysis will indicate if narrow or broad money was used
P_t = consumer price index
z_t = nominal imports deflated by the unit value of imports
P_{zt} = unit value of imports
P_{Dt} = GDP deflator
x_t = nominal exports deflated by the unit value of exports
P_{xt} = unit value of exports
yf_t = real GDP for industrial countries.

The estimation results of the trade parameters are given in Table 5.

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