Chapter 9

Policy Tools for Macroeconomic Analysis

Since the early 1950s, a variety of empirical techniques and quantifiable models have been developed and used in formulating macroeconomic and adjustment programs in the developing world. One of the main features of this chapter is its focus on the analytical foundations of some of these operational models and the assessment of their usefulness from a variety of perspectives—most notably, their ability to capture some of the key macroeconomic features identified in the previous chapters, their data requirements, and the ease with which they can be implemented.

The first part describes a simple empirical method for assessing business cycle regularities, based on cross correlation among macroeconomic variables. The second outlines a simple technique for evaluating the macroeconomic effects of external shocks, which tend to have a disproportionately large effect on macroeconomic fluctuations in developing countries. Part 3 presents the analytical framework (in both its basic and extended forms) that has been at the heart of stabilization programs designed by (or prepared with the assistance of) the International Monetary Fund (IMF), the financial programming approach. Part 4 presents the World Bank's basic model, which focuses on medium-term growth. In contrast to financial programming models, productive capacity and the rate of capital accumulation are endogenously determined; however, the demand and financial sides of the economy are completely ignored. Part 5 shows how the two models can be integrated to analyze jointly stabilization and medium-term growth issues. Part 6 discuses the three-gap model developed by Bacha (1990). Part 7 presents a static, computable general equilibrium model that has proved useful in assessing the medium- and longer-term effects of fiscal adjustment and tariff reform in developing countries. The last part discusses the role of various types of lags in the transmission process of policy shocks and their impact on short-term macroeconomic projections.

1   Assessing Business Cycle Regularities

Understanding and distinguishing among the various factors affecting the short- and long-run behavior of macroeconomic time series has been one of the main areas of research in quantitative macroeconomic analysis in recent years. However, much of the research on these issues has focused on industrial countries, with relatively limited attention paid to developing economies. At least two factors may help account for this.

- Limitations on *data quality* and *frequency* continue to be constraining factors in some cases. For instance, quarterly data on national accounts are available for only a handful of developing countries; even when they are available, they are considered to be of significantly lower quality than annual estimates.

- Developing countries tend to be prone to *sudden crises* and marked gyrations in macroeconomic variables, often making it difficult to discern any type of *cycle* or economic regularities.

At the same time, there are at least three reasons why more attention to the analysis of the stylized facts of macroeconomic fluctuations in developing countries could be useful.

- Determining the regular features of economic cycles in an economy helps to specify *applied macroeconomic models* that may capture some of the most important correlations.

- The sign and magnitude of *unconditional correlations* can provide some indication of the *type of shocks* that have dominated fluctuations in some macroeconomic aggregates over a particular period of time.

- Assessing the pattern of *leads* and *lags* between aggregate time series and economic activity can be important for the design of stabilization programs. For instance, as discussed later, the cross correlation between changes in private credit and domestic output may play an important role in the decision to allocate a given level of credit between the government and the private sector.

To characterize short-run fluctuations (measured as deviations of a variable from its long-run trend) in macroeconomic time series and analyze unconditional correlations between them and detrended output, the *first step* involves choosing a measure of real activity. Real GDP is often chosen in annual studies, whereas an index of industrial output is often selected in quarterly studies—usually because few developing countries produce consistent national accounts data at that frequency. However, it is important to note that using total GDP as a measure of output may not always be appropriate. The reason is that agricultural output, which depends on factors that may be unrelated to other macroeconomic

The *third step* is to assess the degree of co-movement of each series, y_t, with output, x_t. This is done by measuring the magnitude of the **contemporaneous correlation coefficient**, $\rho(0)$, between the filtered components of y_t and x_t. A series y_t is said to be

- *procyclical* if $\rho(0)$ is positive;

- *countercyclical* if $\rho(0)$ is negative;

- *acyclical* if $\rho(0)$ is zero.

To establish which correlations are significantly different from zero, it can be noted that the statistic

$$\ln[\frac{1+\rho(0)}{1-\rho(0)}]/2,$$

has an asymptotically normal distribution with a variance equal to $1/(T-3)$, where T is the number of observations (see Kendall and Stuart (1967, pp. 419-20)).. With about 30 observations, this implies that positive correlations of 0.32 or larger are significantly different from zero at the 10 percent level, and of 0.48 or greater are significant at the 1 percent level. Using a 10-percent significance threshold, for instance, the series y_t can be said to be

- *strongly contemporaneously correlated* with output if $0.32 \leq |\rho(0)| < 1$;

- *weakly contemporaneously correlated* with output if $0.1 \leq |\rho(0)| < 0.32$;

- *contemporaneously uncorrelated* with output if $0 \leq |\rho(0)| < 0.1$.

The last step is to determine the **phase shift** of y_t relative to output, by studying the **cross-correlation coefficients** $\rho(j)$, $j \in \{\pm 1, \pm 2, ...\}$. Specifically, y_t is said to

- *lead the cycle* by j period(s) if $|\rho(j)|$ is maximum for a negative j;

- *lag the cycle* if $|\rho(j)|$ is maximum for a positive j;

- be *synchronous* if $|\rho(j)|$ is maximum for $j = 0$.

The pattern of lead-lag correlations (in particular, the lag at which the peak positive correlation occurs) can be interpreted as indicating the speed at which innovations in variable y_t are transmitted to real activity x_t.

A comprehensive analysis of macroeconomic fluctuations in 12 developing countries based on the above approach and using quarterly data is provided by Agénor, McDermott, and Prasad (2000). Among other results, they found that private consumption, investment, and credit to the private sector tend to be *procyclical*. Consumption also tends to be *less volatile* than output (as would be expected from consumption smoothing behavior, discussed in Chapter 2) and tend to move synchronously with it. The fiscal stance (measured by the

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variables (such as weather conditions) may represent a large fraction of GDP. In such conditions, using *nonagricultural GDP* may be preferable.

The *second step* in the analysis consists in decomposing all macroeconomic series into nonstationary (trend) and stationary (cyclical) components, because most of the techniques that are commonly used to characterize the data empirically (including cross correlations) are valid only if the data are stationary. A common procedure to test for unit roots is to use the **Augmented Dickey-Fuller (ADF)** test, by running the following regression:

$$\Delta x_t = \alpha + \beta t + (\rho - 1)x_{t-1} + \sum_{h=1}^{k} \Phi_h \Delta x_{t-h} + u_t,$$

where u_t is an error term and $k \geq 0$. The null hypothesis of nonstationarity (that is, that the *series contains a unit root*) is H_0: $\rho = 1$. For x_t to be stationary, $\rho - 1$ should be negative and significantly different from zero.

Suppose that the observed variable x_t has no seasonal component and can be expressed as the sum of a trend x_t^* component and a cyclical component, x_t^c:

$$x_t = x_t^* + x_t^c. \tag{1}$$

At period t, the econometrician can observe x_t but cannot measure either x_t^* or x_t^c. The second step is thus to estimate the trend component of x_t. A possible option is to use the **Hodrick-Prescott (HP) filter**. It consists essentially in specifying an adjustment rule whereby the trend component of the series x_t moves continuously and adjusts gradually. Formally, the unobserved component x_t^* is extracted by solving the following minimization problem:

$$\min_{x_t^*} \left[\sum_{t=1}^{T}(x_t - x_t^*)^2 + \lambda \sum_{t=2}^{T}[(x_{t+1}^* - x_t^*) - (x_t^* - x_{t-1}^*)]^2 \right]. \tag{2}$$

Thus, the objective is to select the trend component that minimizes the sum of the squared deviations from the observed series, subject to the constraint that changes in x_t^* vary gradually over time. The coefficient λ is a positive number that penalizes changes in the trend component. The larger the value of λ, the smoother is the resulting trend series.[1] It can be shown that the trend component x_t^* can be represented by a two-sided symmetric moving average expression of the observed series:

$$x_t^* = \sum_{h=-n}^{n} \alpha_{|h|} x_{t+h}, \tag{3}$$

where the parameters $\alpha_{|h|}$ depend on the value of λ.

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[1] In general, the choice of the value of λ depends on the degree of of the assumed stickiness in the series under consideration. The usual practice is to set, for instance, λ to 100 with annual time series, and 1600 with quarterly time series. However, it should be noted that this choice is somewhat arbitrary; a more appropriate procedure would be to choose a value of λ using a data-dependent method. See Agénor, McDermott, and Prasad (2000).

ratio of government spending to tax revenue) is *countercyclical* in some countries and *procyclical* in others, suggesting in the latter case that fiscal policy may exacerbate output fluctuations. Broad money does not appear to have a significant correlation with output, and often seems to lag movements in activity. The terms of trade (the ratio of export prices to import prices) tend in general to have a *procyclical* effect.[2] Finally, in a number of countries, both prices and their rate of change (inflation) tend to *countercyclical*. A negative cross correlation between (detrended) prices and (detrended) output is generally viewed as indicating the predominance of *demand shocks*, whereas a positive cross correlation is indicative of *supply shocks*.[3]

One limitation of the procedure outlined above relates to the use of the HP filter, which remains the subject of much criticism. In particular, it has been argued that it removes potentially valuable information from time series and that it may impart *spurious cyclical patterns* to the data (see Cogley and Nason (1995)). It also assumes, as indicated in Equation (1), that the trend and cyclical components are *independent*. In reality, the choice of the relationship between the trend and cyclical components is arbitrary. Nevertheless, the HP filter remains widely used. One reason might be that *any* detrending filter is, to some extent at least, arbitrary and is bound to introduce distortions that may affect the robustness of reported business cycle regularities or so-called *stylized facts*. Used concurrently with other detrending techniques for robustness checking, the HP filter—or improvements over the standard specification, such as the variant based on the optimal choice of the smoothing parameter (see Agénor, McDermott, and Prasad (2000))—remains a useful tool for applied macroeconomic analysis.

2 Assessing the Effects of External Shocks

Because they are so vulnerable to external shocks, developing countries often face the issue of quantifying the effects of these shocks, during a given period, on the economy's performance. In the absence of a fully specified and estimated macroeconomic model, a useful method to do so is the three-step methodology developed by McCarthy, Neary, and Zanalda (1994).

The *first step* involves estimating the effects on the balance of payments of three components of external shocks—changes in the trade-weighted terms of trade, changes in global demand, and changes in international interest rates—all

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[2]The importance of terms-of-trade shocks on output fluctuations is emphasized by Kose and Riezman (2001), in a study based on a general equilibrium model of a small open economy calibrated with data for sub-Saharan Africa.

[3]Supply shocks are usually defined as those shocks that have *permanent* effects on output (and possibly other real variables); whereas demand shocks are those that have only *temporary*, but often persistent, effects on output. This terminology is somewhat misleading because most shocks perturb both demand and supply. More sophisticated methods, based on *structural vector autoregression techniques*, have been used to identify demand and supply shocks; see, for instance, Fung (2002), Hoffmaister and Roldós (2001), Hoffmaister, Roldós, and Wickham (1998), Rogers and Wang (1995), and Shaghil (1999).

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measured in percentage of output.[4]

- The *terms-of-trade shock* is measured as the *net import effect*, that is, the change in export prices multiplied by the volume of exports minus the change in import prices multiplied by the volume of imports.

- The *interest rate effect* is calculated as the change in world interest rates (approximated by changes in the London interbank offered rate, LIBOR) multiplied by the estimated stock of interest-sensitive external debt in the previous year.

- The impact of *changes in global demand* is calculated as the deviation of the growth of world export volumes from its estimated trend multiplied by the initial volume of the country's exports.

In the *second step*, the economy's response to these shocks is disaggregated into various measures of adjustment:

- Reductions in the *level of demand* affecting economic activity. The adjustment in imports induced by the reduction in aggregate demand is calculated as the difference between import volumes expected on the assumption of the historical import elasticity of GDP using the trend growth rate versus the actual GDP growth rate.

- *Expenditure-switching* measures. These are captured by changes in export performance (measured as the initial export volume multiplied by the excess of actual export volume growth over world export volume growth) and the degree of import intensity (calculated as the difference between import volumes expected on the assumption of historical import elasticity of GDP and actual import volumes).

The *third step* involves calculating the additional net external financing as the difference between the effect of all shocks and the economy's responses.

McCarthy, Neary, and Zanalda (1994) used the above procedure to explore the response of the Philippines to external shocks during the period 1972-91. The average value of these shocks over the period amounted to 2.6 percent of GDP during the 1970s and 1.8 percent during the 1980s. The terms-of-trade effect was the dominant source of external shocks in the first period, whereas the interest rate effect predominated in the second. In terms of the economy's response, net external financing was the dominating factor during the 1970s, whereas reductions in aggregate demand represented the main adjustment mechanism during the 1980s.

The procedure outlined above suffers from several limitations. In particular, the decomposition of the effects of external shocks on the balance of payments takes everything else equal (*ceteris paribus* assumption), and may provide incorrect orders of magnitude. In addition, the fact that the domestic economy's

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[4]The three measures are based on a strong *ceteris paribus* assumption, and should be viewed as yielding broad orders of magnitude.

responses are evaluated in terms of deviations from historical trends implies that they cannot be attributed solely to changes in policies; other factors may have played a significant role, including indirect effects of the shocks themselves on the balance of payments through their impact on income and wealth. Nevertheless, without a complete macroeconomic model at hand, the McCarthy-Neary-Zanalda procedure provides broad orders of magnitude of the economy's response to external shocks that may be useful to policymakers.

3 Financial Programming

Financial programming is at the core of macroeconomic policy exercises conducted by the International Monetary Fund. The first model of financial programming was developed by Polak (1957); essentially, the model can be viewed as a systematic attempt to integrate *monetary* and *credit* factors in discussions of balance-of-payments issues. The first part of this section presents the Polak model, and the second considers a more elaborate financial programming framework.

3.1 The Polak Model

The Polak model considers a small open economy operating a fixed exchange rate regime. It is specified in *nominal terms* and consists of two identities, one behavioral equation, and an equilibrium condition.

- The first equation defines changes in the *nominal money supply, M^s*. Suppose, for simplicity, that all foreign assets are held by the central bank.[5] M^s is thus the sum of *domestic credit, L*, and *official foreign exchange reserves, R*:[6]

$$\Delta M^s = \Delta L + \Delta R. \tag{4}$$

- The second equation relates changes in official reserves to the *current account* (which is identical to the trade balance, assuming for now that there are no interest payments on foreign debt), and *capital inflows, ΔF*, which are treated as exogenous:

$$\Delta R = X - \alpha Y + \Delta F, \quad 0 < \alpha < 1, \tag{5}$$

where *exports, X*, are taken as exogenous, and *imports* are a constant fraction, α, of nominal income, Y. Given the earlier assumption that all net foreign assets are held by the central bank, the change in net official reserves is identical to the balance of payments.

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[5]This assumption can be rationalized by either assuming that there are no commercial banks operating in the economy, or commercial banks are required to surrender all their foreign exchange receipts to the central bank. Accounting explicitly for net foreign assets held by commercial banks can be done by straightforward modifications to Eqs. (4) and (5).

[6]More precisely, R is the book value, in domestic currency terms, of official reserves. Of course, with a fixed exchange rate normalized to unity, the foreign- and domestic-currency values of official reserves are the same.

- The third equation specifies changes in the nominal demand for money, ΔM^d, as a function of changes in nominal income, ΔY:

$$\Delta M^d = \nu^{-1}\Delta Y, \quad \nu > 0, \tag{6}$$

where ν, the *income velocity of money*, is assumed to be constant over time.

- The fourth and last equation assumes that the money market is in *flow equilibrium*:

$$\Delta M^s = \Delta M^d. \tag{7}$$

The structure of the Polak model is summarized in Table 9.1. The change in net official reserves, ΔR, is the *target* variable. The change in the nominal money stock and nominal output, ΔM and ΔY, and imports, $J = \alpha Y$, are *endogenous* variables. Exports and capital inflows, X and ΔF, are *exogenous* variables. ΔL is the *policy instrument*. It is important to note that in the model there is no explicit decomposition of changes in nominal output into changes in prices and changes in real activity.

Table 9.1
Structure of the Polak Model

Variables	Definition
Target	
ΔR	Change in official foreign reserves
Endogenous	
$J = \alpha Y$	Imports
ΔM	Change in nominal money balances
ΔY	Change in nominal output
Exogenous	
X	Exports
ΔF	Change in net capital flows
Policy instrument	
ΔL	Change in domestic credit
Parameters	
ν	Income velocity of money
α	Marginal propensity to import

Source: Adapted from Polak (1957).

The main use of the Polak model is to assess the effects of *changes in domestic credit* on the balance of payments—or, more precisely here, official reserves in foreign exchange. Using Equations (4), (6), and (7) yields

$$\Delta R = \nu^{-1}\Delta Y - \Delta L, \tag{8}$$

which indicates that the change in net official reserves will be positive only to the extent that the desired increase in nominal money balances exceeds the

change in domestic credit. The *structure* of the balance of payments (that is, the relative importance of trade flows and capital movements) plays no direct role in this relationship; it matters only for the *adjustment process* to credit shocks.

To illustrate this result and analyze how credit shocks are transmitted in this setting, consider a once-and-for-all increase in L at period $t = 0$ by ΔL_0. The adjustment process operates as follows.

- The increase in ΔL_0 expands on impact the nominal supply of money by the same amount [Equation (4)]. This brings about an identical increase in the demand for money, as implied by Equation (7). Because velocity is constant, this increase in money demand requires a rise in nominal income by $\nu \Delta L_0$ [Equation (6)], which in turn raises imports by $\alpha \Delta Y_0 = \alpha \nu \Delta L_0$. Official reserves therefore fall by $-\alpha \nu \Delta L_0$ on impact.

- Because the initial increase in domestic credit remains fixed at ΔL_0, the money supply, at the beginning of period $t = 1$, increases by only $(1 - \alpha \nu)\Delta L_0$. Nominal income therefore increases by $\nu(1 - \alpha \nu)\Delta L_0$ and the first-period increase in imports is $\alpha \nu(1 - \alpha \nu)\Delta L_0$. The *cumulated fall* in reserves at the end of the first period is consequently

$$\Delta R|_{t=1} = -\alpha \nu \Delta L_0 - \alpha \nu(1 - \alpha \nu)\Delta L_0,$$

and the *cumulated change* in the money supply at the end of the first period is

$$\Delta M^s|_{t=1} = \Delta L_0 - \alpha \nu \left[1 + (1 - \alpha \nu)\right] \Delta L_0 = (1 - \alpha \nu)^2 \Delta L_0,$$

which is also equal to the increase in the money supply at the beginning of period $t = 2$.

With the same reasoning, the cumulated fall of reserves over an infinite horizon ($t \to \infty$) is given by

$$\Delta R|_{t \to \infty} = -\left[\alpha \nu + \alpha \nu(1 - \alpha \nu) + \alpha \nu(1 - \alpha \nu)^2 + ...\right]\Delta L_0.$$

The term in brackets in the above expression can be written as

$$\alpha \nu \left[1 + (1 - \alpha \nu) + (1 - \alpha \nu)^2 + ...\right].$$

For the geometric series in brackets to converge, the term $1 - \alpha \nu$ must be less than unity; because $\alpha \nu > 0$, this condition is always satisfied. Thus, the above expression can be written as

$$\alpha \nu \frac{1}{1 - (1 - \alpha \nu)} = 1,$$

so that

$$\Delta R|_{t \to \infty} = -\Delta L_0.$$

The *cumulative fall in official reserves*, over an infinite horizon, is thus equal to the initial *increase in domestic credit*. Equation (4) therefore implies that

$$\Delta M^s|_{t \to \infty} = 0.$$

In the long run, the initial expansion in money supply through an increase in domestic credit is *completely offset* by the reduction in official reserves. Thus, nominal income and imports also return to their original levels after increasing initially. Put differently, in order to have $\Delta M^s = 0$, one also needs $\Delta Y = 0$.

Because the only long-run effect of a change in domestic credit is on foreign reserves, establishing a given target level of ΔR (given a projected path for money demand) allows the policymaker to estimate the *maximum allowable increase* in domestic credit, that is, a **credit ceiling**. Specifically, if $\Delta \tilde{R}$ denotes the reserve target, and ΔY^p the projected level of nominal income, the required change in credit is given by, using Equation (8):

$$\Delta L = \nu^{-1}\Delta Y^p - \Delta \tilde{R}.$$

Thus, controlling *domestic credit expansion* (in a setting in which exports, the income velocity of money, and capital flows can be treated as exogenous) is crucial in attaining a balance-of-payments objective. This implication of the model has been at the heart of the stabilization programs advocated by (or put in place with the support of) the IMF. The demand function, as shown in the foregoing example, plays a critical role in the analysis. The particular form used here is actually not essential for the main implication of the model; a more general function (involving, for instance, interest rates or inflation, as discussed in Chapter 4) can readily be specified—as long as it is assumed stable and independent of changes in domestic credit (International Monetary Fund, 1987, p. 14).

The importance of controlling domestic credit expansion for balance-of-payments performance is also the key message of the **Monetary Approach to the Balance of Payments** (MABP), which in its most popular form relies on the assumptions of a stable demand for money, purchasing power parity, and continuous *stock equilibrium* of the money market (Kreinin and Officer, 1978). There is, however, a key difference between the Polak model and the MABP: in the latter, any increase in domestic credit expansion (everything else equal) instantly crowds out official reserves by an equivalent amount.[7] In the Polak model, complete crowding out also occurs but only *in the long run*, and takes place through a series of adjustments in nominal income, imports, and the money supply. This adjustment process may be viewed as more realistic than the assumption underlying the MABP.

A key limitation of the Polak model is the assumption that changes in domestic credit have no effect (even in the short run) on the determinants of money

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[7]Specifically, an excess supply of real money balances brought about by an increase in domestic credit gives rise to an excess demand for other financial assets as well as goods and services. In an open economy, this excess demand translates immediately into changes in net foreign reserves.

demand, such as real income or domestic interest rates. As noted in previous chapters, in many developing countries the bank credit-supply side link is often a critical feature of the economy. Another problem with the model (as well as many of its extensions) is that it assumes a stable money demand function. In practice, especially *over short horizons*, the demand for money balances tends to be unstable—often as a result of volatile inflation expectations. In such conditions, it may provide an unreliable tool for macroeconomic projections.

3.2 An Extended Framework

The Polak model continues to be at the core of the financial programming framework that underlies IMF stabilization programs designed for economies operating under a fixed exchange rate. In practice, the model has been modified and expanded in several directions. This subsection examines one version of the model, adapted from Khan, Haque, and Montiel (1990), that distinguishes explicitly between changes in real and nominal output *and the sources of credit growth.*[8]

Consider an economy producing one good, which is an imperfect substitute for imported goods. Let nominal income, Y, be defined as

$$Y = Py, \tag{9}$$

where P denotes the *overall price index* and y *real output*, which is assumed exogenous. The change in nominal income is given by

$$\Delta Y = Py - P_{-1}y_{-1} = Py + P_{-1}(\Delta y - y) = Py + P_{-1}\Delta y - P_{-1}y,$$

that is,

$$\Delta Y = \Delta Py + P_{-1}\Delta y = \Delta P(\Delta y + y_{-1}) + P_{-1}\Delta y = \Delta Py_{-1} + P_{-1}\Delta y + \Delta y\Delta P.$$

Assuming that both ΔP and Δy are small, the last term on the right-hand side in the above expression can be ignored and so

$$\Delta Y = \Delta Py_{-1} + P_{-1}\Delta y. \tag{10}$$

Changes in the overall price index are a function of changes in domestic prices, ΔP_D, and changes in foreign prices measured in domestic-currency terms, $\Delta E + \Delta P^*$:

$$\Delta P = \delta\Delta P_D + (1-\delta)(\Delta E + \Delta P^*), \quad 0 < \delta < 1 \tag{11}$$

where E is the nominal exchange rate, P^* the price index of foreign goods measured in foreign-currency terms, and δ (respectively $1-\delta$) a parameter that

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[8]For other examples of extended IMF-type financial programming models, see Mikkelsen (1998). One limitation of these models is that it assumes that the economy produces only one domestic good, which is used for both domestic consumption and exports. A more appropriate framework for developing economies would distinguish between exportables, nontradables, and importables, as done in Chapter 7.

measures the relative weight of domestic goods (respectively imported goods) in the overall price index.

Domestic credit, L, consists now of *credit to the private sector*, L^p, and *credit to the government*, L^g:[9]

$$\Delta L = \Delta L^p + \Delta L^g. \tag{12}$$

Changes in credit to the private sector reflect demand for working capital (as discussed in Chapter 7) and, as such, are assumed proportional to changes in nominal output:

$$\Delta L^p = \theta\Delta Y, \quad \theta > 0. \tag{13}$$

The *money supply identity* is given as in the Polak model by

$$\Delta M^s = \Delta L + \Delta R, \tag{14}$$

where ΔR is equal to $E\Delta R^*$, that is, the change in the foreign-currency value of official reserves ΔR^*, valued at the current exchange rate.[10]

Changes in official reserves are again related to the trade balance and capital inflows, ΔF, assumed exogenous:

$$\Delta R = X - J + \Delta F. \tag{15}$$

X, J, and ΔF are all measured in domestic-currency terms. ΔF consists now of both private and public flows, ΔF^p and ΔF^g, which are both assumed to be given in foreign-currency terms, so that $\Delta F = E\Delta F^*$, or equivalently, assuming that $E_{-1} = 1$, $\Delta F = (1 + \Delta E)\Delta F^*$.

Exports are again exogenous. Imports in *nominal* terms are given by $J = EQ_J$, where Q_J is the volume of imports. Consequently, assuming that $\Delta E\Delta Q_J$ is small,

$$J = J_{-1} + \Delta EQ_{J-1} + E_{-1}\Delta Q_J.$$

Changes in the volume of imports are assumed to depend on changes in real output and changes in the price of domestic goods relative to the price of foreign goods:

$$\Delta Q_J = \alpha\Delta y + \eta[\Delta P_D - (\Delta E + \Delta P^*)],$$

where $\eta > 0$ measures the sensitivity of (the change in) imports to (changes in) relative prices. Substituting this result in the previous equation yields, noting that

$$J = J_{-1} + (Q_{J-1} - \eta E_{-1})\Delta E + E_{-1}[\alpha\Delta y + \eta(\Delta P_D - \Delta P^*)], \tag{16}$$

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[9]L^g is defined net of government deposits. In practice, the definition of government used for programming exercises varies across countries. In what follows *government* and *public sector* are used as synonymous.

[10]Equation (14) assumes that capital gains and losses on foreign exchange reserves associated with changes in the nominal exchange rate are not monetized, but rather are treated as an off-balance sheet. *These effects can be captured by adding the term* $R^*_{-1}\Delta E$ *on the right-hand side of* (14), as in Khan, Haque, and Montiel (1990).

which shows that, as long as η is sufficiently large, a devaluation of the nominal exchange rate ($\Delta E > 0$) will lower imports, improve the trade balance, and increase official reserves.[11]

As in the Polak model, the income velocity of money is taken to be constant, implying that

$$\Delta M^d = \nu^{-1}\Delta Y, \quad \nu > 0. \tag{17}$$

The money market is again assumed to be in *flow equilibrium*:

$$\Delta M^s = \Delta M^d. \tag{18}$$

Finally, the *government budget constraint* relates the budget deficit $G - T$, where G is total expenditure and T is total tax revenue, to changes in *foreign borrowing*, ΔF^g (which is exogenous), and changes in central bank credit:[12]

$$G - T = \Delta L^g + \Delta F^g. \tag{19}$$

With ΔL^g and ΔF^g given, the government budget deficit is thus given from "below the line" and must be met by adjusting either spending or tax revenue.

Table 9.2 summarizes the structure of the extended Polak model. The change in domestic prices, ΔP_D, and the change in net official reserves, ΔR, are *target* variables. Changes in the nominal money stock, ΔM, nominal output, ΔY, credit to the private sector, ΔL^p, the overall price index, ΔP, and imports, J, and the budget deficit, $G - T$, are *endogenous* variables. Changes in real output, Δy, foreign prices, ΔP^*, and exports and capital inflows, X and ΔF, are *exogenous* variables. y_{-1}, P_{-1}, $Q_{J,-1}$ and E_{-1} are *predetermined* variables. Changes in domestic credit to the government ΔL^g and the nominal exchange rate ΔE are the *policy instruments*. It is worth emphasizing that in this setting it is the government budget deficit *as a whole* that is considered endogenous. As discussed below, whether the adjustment occurs through movements in government spending (changes in G) or in taxes (changes in T) is left unspecified at this stage.

To relate targets, exogenous variables, and policy instruments in this setup, substitute first Equations (12), (13), (14), and (17) in (18) to give

$$\Delta R = (\nu^{-1} - \theta)\Delta Y - \Delta L^g,$$

where it is assumed that $\nu\theta < 1$, so that $\nu^{-1} - \theta > 0$.

Using Equation (10) to eliminate ΔY, and (11) to eliminate ΔP, yields

$$\Delta R - (\nu^{-1} - \theta)y_{-1}\delta\Delta P_D = \Lambda, \tag{20}$$

where

$$\Lambda = (\nu^{-1} - \theta)[y_{-1}(1 - \delta)(\Delta E + \Delta P^*) + P_{-1}\Delta y] - \Delta L^g.$$

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[11] The model can easily be modified to endogenize exports as a function also of relative prices. See Khan, Haque, and Montiel (1990).

[12] It is assumed that the government cannot borrow directly from the domestic private sector by issuing bonds. As noted in Chapter 4, this assumption has become particularly restrictive and untenable for a number of middle-income developing countries.

Similarly, substituting Equation (16) in (15) yields

$$\Delta R + \eta E_{-1}\Delta P_D = X + \Delta F - J_{-1} - (Q_{J-1} - \eta E_{-1})\Delta E + \eta\Delta P^* - \alpha E_{-1}\Delta y. \tag{21}$$

These two equations can be solved in two different modes.

- In the **positive mode**, Equations (20) and (21) are used to determine *simultaneously* ΔR and ΔP_D, for given values of X, ΔF, ΔP^*, Δy, the predetermined variables, and the policy instruments, ΔE and ΔL^g. This solution is obtained *independently* of Equations (11), (10), (13), (12), and (19), which determine, respectively, ΔP, ΔY, ΔL^p, ΔL, and $G - T$.

Table 9.2
Structure of the Extended Financial Programming Model

Variables	Definition
Targets	
ΔR	Change in official foreign reserves
ΔP_D	Change in domestic prices
Endogenous	
ΔY	Change in nominal output
ΔL^p	Change in private sector credit
ΔM	Change in nominal money balances
ΔP	Change in the overall price index
ΔJ	Change in imports
$G - T$	Fiscal deficit
Exogenous	
Δy	Change in real output
ΔP^*	Change in foreign prices
X	Exports
$\Delta F = \Delta F^p + \Delta F^g$	Change in net capital flows
Policy instruments	
ΔL^g	Change in domestic credit to government
ΔE	Change in the nominal exchange rate
Predetermined	
y_{-1}	Real output in previous period
P_{-1}, E_{-1}	Price level and exchange rate in previous period
Q_{J-1}	Volume of imports in previous period
Parameters	
ν	Income velocity of money
δ	Share of domestic goods in the consumer price index
α	Marginal propensity to import
θ	Response of private sector credit to output
η	Response of imports to relative prices

Source: Adapted from Khan et al. (1990, p. 163).

- In the programming mode, ΔR and ΔP_D are policy targets, denoted $\Delta \tilde{R}$ and $\Delta \tilde{P}_D$, in Equations (20) and (21). These two equations are now solved for the two policy instruments, ΔE and ΔL^g. Again, this solution is obtained *independently* of Equations (12), (13), and (19). Given the value of the instrument ΔL^g, and values for the exogenous variable ΔF^g, Equation (19) determines residually (from *below the line*) the government fiscal deficit, $G - T$. This *programmed deficit* is achieved by adjusting either tax revenue, T, or public expenditure, G. The target for domestic prices (given the assumption that real output is exogenous) generates endogenously a programmed value for the change in the overall price index, ΔP, the change in nominal output, ΔY, and thus private sector credit, ΔL^p through Equations (10), (11), and (13).

The solution of the extended model is illustrated in Figure 9.1, in the ΔR-ΔP_D space. Curve MM is given by Equation (20) and has a positive slope. Curve BB is derived from Equation (21) and has a negative slope. The intersection of the two curves (at point E) defines the solution values for ΔR and ΔP_D in the positive mode (that is, for given values of the exogenous variables and the policy instruments). To see how the model operates in programming mode, suppose, for instance, that the policymaker's objectives are to lower inflation and increase official reserves, by moving from the initial position at E to a point such as E'. This outcome can be achieved through a combination of two policy actions:

- by reducing domestic credit to the government, ΔL^g, which implies a leftward shift in MM, with no change in BB, thereby moving the economy to point A;

- by depreciating the nominal exchange rate, ΔE, which implies a rightward shift in both MM and BB, thereby moving the economy to point E'.

The actual solution values for ΔE and ΔL^g can be calculated *recursively*: Equation (21) can be used to obtain the appropriate level of ΔE, for given values of $\Delta \tilde{R}$ and $\Delta \tilde{P}_D$; substituting the solution for ΔE in Equation (20) yields the required value of ΔL^g. Graphically, the new equilibrium is obtained at point E' in Figure 9.1, where MM and BB intersect. By adjusting only L^g the economy could be moved to point A, at which inflation has fallen to the desired level, but reserves would remain below target. What this experiment suggests, therefore, is that it is necessary to use *two policy instruments* to achieve *two policy targets*, as suggested by the Meade-Tinbergen principle.

4   The World Bank RMSM Model

The World Bank currently uses for the macroeconomic projections that underlie some of its loan operations the RMSM-X model, which is discussed in the next section. The present section focuses on the precursor to that model, the

Revised Minimum Standard Model (RMSM), which was developed in the early 1970s.

The main objective of the model is to make explicit the link between *medium-term growth* and its *financing*. The basic model takes prices as given. It consists of five relationships.

- The first basic relationship relates the *desired level* of investment, I, to the *change* in real output, Δy:

$$I = \Delta y / \sigma, \quad \sigma > 0, \tag{22}$$

where σ is the inverse of the **incremental capital-output ratio (ICOR)**.

- The second relationship relates *imports*, J, and real output:

$$J = \alpha y, \quad 0 < \alpha < 1. \tag{23}$$

- The third relationship defines (as in the three-good model of Chapter 7) *private consumption*, C^p, as a fraction of *disposable income*, defined as income, y, minus taxes, T:

$$C^p = (1 - s)(y - T), \tag{24}$$

where $0 < s < 1$ is the marginal propensity to save.

- The balance-of-payments identity is defined, as above, by

$$\Delta R = X - J + \Delta F, \tag{25}$$

where X again denotes exports (assumed exogenous) and ΔF net capital inflows or net foreign borrowing.

- The last relationship is the *national income identity*, which is given by

$$y = C^p + G + I + (X - J), \tag{26}$$

where G is again government expenditure.

The structure of the RMSM model is summarized in Table 9.3. Changes in real output, Δy, and the change in net official reserves, ΔR, are *target* variables. Government spending, G, tax revenue, T, and the change in foreign borrowing, ΔF, are the *policy instruments*. Exports, X, are *exogenous*.

To see how targets, exogenous variables, and policy instruments are related in this setup, substitute Equations (23), (24) in (26) to give

$$I = (s + \alpha)y + (1 - s)T - (X + G),$$

that is, using (22) and noting that $y = y_{-1} + \Delta y$:

$$\Delta y = \frac{(s + \alpha)y_{-1} + (1 - s)T - (X + G)}{\sigma^{-1} - (s + \alpha)}. \tag{27}$$

Substituting (23) in (25) yields

$$\Delta R = X - \alpha(y_{-1} + \Delta y) + \Delta F. \tag{28}$$

The system consisting of Equations (27) and (28) can be solved in two different modes.

- In the **positive or policy mode**, Equations (27) and (28) are used to solve for Δy and ΔR. The system is in fact recursive: Equation (27) can first be used to determine Δy, for given values of X and the policy instruments, T and G. Given this solution, Equation (28) is then used to determine ΔR, for given values of X and ΔF.

- In the **programming mode**, the solution can again be obtained *recursively*: Equation (27) can be used to determine either the value of G or T for a given target value of Δy; and for given target values of Δy and ΔR, Equation (28) can be used to determine the value of net capital inflows, ΔF. With $\Delta \tilde{y}$ and $\Delta \tilde{R}$ denoting the target levels of output and reserves, this solution is

$$\Delta F = \alpha(y_{-1} + \Delta \tilde{y}) - X + \Delta \tilde{R}. \tag{29}$$

The solution of the RMSM model in the positive mode is illustrated in Figure 9.2, in the Δy-ΔR space. The horizontal curve YY is given by Equation (27). Curve BB is derived from Equation (28) and has a negative slope. The intersection of the two curves (at point E) defines the equilibrium values of Δy and ΔR, for given values of the exogenous variables and the policy instruments.

Because setting a target level of output is tantamount to fixing imports and thus the trade balance (recall that exports are exogenous), the programming mode of the RMSM model described above is often described as the **trade-gap mode**: for $X - J$ given, the model calculates the appropriate level of external financing, ΔF, that satisfies the balance-of-payments identity, Equation (25).

Ignoring the trade gap, and assuming that policymakers exert sufficient control over capital inflows to determine ΔF as in Equation (29) may not, of course, be warranted in all circumstances. In practice, countries do face *limits on foreign borrowing*. By treating external financing ΔF as given, the RMSM model—just as the RMSM-X model described later—can alternatively be closed by fixing, instead, the level of saving that is consistent with the programmed level of investment that is consistent with the targeted level of output, $\Delta \tilde{y}$; specifically, using Equation (22), the required level of saving is $\Delta \tilde{y}/\sigma$. This is what is referred to as the **saving-gap mode**. In this case, it is often assumed that total consumption ($C = G + C^p$) is determined *residually* from the national income identity, Equation (26). Assuming further that public consumption expenditure of the government is policy determined yields private consumption as the residual variable, that is, using Equations (22) and (23):

$$C^p = y_{-1} + \Delta \tilde{y} - \Delta \tilde{y}/\sigma - X - \alpha(y_{-1} + \Delta \tilde{y}) - G.$$

The trouble with this functioning mode, of course, is that there is no reason a priori to expect the level of private consumption derived from the above equation to be equal to the level consistent with (24).

In general, of course, both the trade gap and the saving gap may represent binding constraints on the determination of output and changes in official reserves, implying that either one or both of these targets may need to be adjusted to accommodate a shortage in foreign exchange restrictions. The version of the RMSM model in which a (possibly binding) foreign exchange constraint is added is the **two-gap mode**.[13] Neither constraint is suppressed a priori so that either one of the two gaps might be binding. In such a two-gap situation, depending on which constraint is binding, observed domestic saving (imports) may be different from desired or required saving (imports).

The main use of the two-gap version of the RMSM model in the programming mode is to determine the *financing requirements* for alternative target rates of *output growth* (given also a target for official reserves) or, equivalently, to determine the feasibility of a particular rate of output growth given alternative foreign financing scenarios. To illustrate, rewrite the national income accounting identity (26) as

$$I = (y - T - C^p) + (T - G) + (J - X). \tag{30}$$

This formulation now equates domestic investment, I, to the sum of private sector savings, $y - T - C^p$, public sector savings, $T - G$, and foreign savings (or the trade surplus), $J - X$. Using Equation (24) to substitute out for C^p and (25) to substitute out for $J - X$ in (30), and with target levels of output and reserves given by $\Delta\tilde{y}$ and $\Delta\tilde{R}$, Equation (30) implies that investment is constrained by total saving, that is,

$$I \leq \kappa_S + \Delta F, \tag{31}$$

where

$$\kappa_S = s(y_{-1} + \Delta\tilde{y}) + [(1-s)T - G] - \Delta\tilde{R}.$$

Equation (31) is the **saving constraint**. It is depicted (in equality form) in Figure 9.3 as curve SS in the I-ΔF space. The figure assumes that κ_S, which is in general ambiguous, is positive. Below curve SS the inequality (31) is satisfied, whereas above SS it is not. The constraint $I = \kappa_S + \Delta F$ is thus binding above SS. Changes in the policy instruments, T and G, and changes in the policy targets, $\Delta\tilde{y}$ and $\Delta\tilde{R}$, imply horizontal shifts in SS because they affect κ_S.

To derive the second constraint that operates in the two-gap version of the RMSM model requires rewriting the balance-of-payments constraint (25) in the form

$$J - X = \Delta F - \Delta\tilde{R}, \tag{32}$$

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[13] The two-gap model, with its focus on foreign exchange and domestic saving as alternative constraints on growth, was developed by Chenery and Strout (1966). See Taylor (1994) for a more recent treatment.

which gives the level of the trade account (or, again, imports) consistent with a given value of ΔF and a target level for reserves.

Substituting the import demand function, Equation (23), in the above equation and rearranging yields

$$\Delta y = (X - \Delta R + \Delta F)/\alpha - y_{-1}. \tag{33}$$

From Equation (22), $\Delta y = \sigma I$. Substituting Equation (33) for Δy in this expression implies that investment is also constrained by

$$I \leq \kappa_T + \Delta F/\alpha\sigma, \tag{34}$$

where

$$\kappa_T = (X - \Delta\tilde{R})/\alpha\sigma - y_{-1}/\sigma.$$

Table 9.3
Structure of the World Bank's RMSM Framework

Variables	Definition
Targets	
Δy	Change in output
ΔR	Change in official foreign reserves
Endogenous	
I	Investment
C^p	Private consumption
J	Imports
Exogenous	ΔF
X	Exports
Policy instruments	
G	Government expenditure
T	Tax revenues
ΔF	Change in net foreign borrowing
Predetermined	
y_{-1}	Real output in previous period
Parameters	
σ	Inverse of the incremental capital-output ratio
s	Saving rate
α	Marginal propensity to import

Source: Adapted from Khan et al. (1990, p. 169).

Equation (34) is the **trade constraint**. It is represented in (equality form) in Figure 9.3 as curve TT, which is drawn under the assumption that $\kappa_T < 0$. In practice, the ICOR, $1/\sigma$, varies usually between 2 and 5; in general, therefore, $\alpha\sigma < 1$. Curve TT (whose slope is $1/\alpha\sigma$) is thus typically steeper than SS.

As before, the position of TT depends also on $\Delta \tilde{R}$. In addition, here, it also depends on the (exogenous) value of exports, X. But with X given, the only way to generate a shift in TT is through a revised target level for official reserves.

Both constraints, (31) and (34), provide an estimate of the level of investment. The constraint that yields the lowest level of the two is called the **binding constraint**. Curves SS and TT separate Figure 9.3 into four zones:

- Zone I, in which *no constraint is binding*;

- Zone II, in which only the *saving constraint is binding*;

- Zone III, in which only the *trade constraint is binding*;

- Zone IV, in which *both constraints are binding*.

Clearly, because TT is steeper than SS, the impact of foreign borrowing on investment, and thus output and growth, will be larger if the trade constraint is binding, as opposed to the saving constraint.

To see how the two-gap version of the RMSM model operates in the programming mode (that is, with target levels for both official reserves and output), suppose that foreign financing is the constraining factor. The values of investment, changes in output, imports and official reserves that are mutually consistent with each other (as well as with the policy instruments and the exogenous variables) are then determined through an *iterative process* which involves the following steps.

- *Step 1.* Specify values for a) the parameters σ, s, and α; b) the predetermined variable, y_{-1}; c) the exogenous variables, X and ΔF; d) the policy instruments, T and G; e) and the policy targets, $\Delta \tilde{y}$ and $\Delta \tilde{R}$.

- *Step 2.* Given the policy target $\Delta \tilde{y}$, determine the **required level of investment** as $I_R = \Delta \tilde{y}/\sigma$.

- *Step 3.* Determine the levels of investment, I_S and I_T, implied by the saving constraint [Equation (31)] and the trade constraint [Equation (34)]. Determine the **binding level of investment** given by the hatched area in Figure 9.3, as

$$I_{min} = \min(I_S, I_T). \qquad (35)$$

- *Step 4.* If the required level of investment does not exceed the minimum level, that is, if $I_{min} \geq I_R$, no constraint is binding, and the intersection of ΔF and I_R occurs in Zone I in Figure 9.3. Then proceed to step 6. If not, proceed to either step 4a, 4b, or 4c:

  - *Step 4a.* If $I_{min} \leq I_R$, and if the savings constraint is binding, the intersection of ΔF and I_R will occur in Zone II in Figure 9.3. Either increase taxes, T, and/or reduce public expenditure, G, and/or reduce the desired change in official reserves, $\Delta \tilde{R}$, until the constraint

is relaxed or until further changes in the policy or target variables are ruled out as unfeasible.[14] If the constraint is relaxed so that the required investment level can be achieved, proceed to step 6. If not, proceed to step 5.

  - *Step 4b.* If $I_{min} \leq I_R$, and if the trade constraint is binding, the intersection of ΔF and I_R will occur in Zone III in Figure 9.3. Reduce the desired change in official reserves, $\Delta \tilde{R}$, until the constraint is relaxed or until further changes in the policy or target variables are ruled out as unfeasible.[15] If the constraint is relaxed so that the required investment level can be achieved, proceed to step 6. If not, proceed to step 5.

  - *Step 4c.* If $I_{min} \leq I_R$, and if both constraints are binding, the intersection of ΔF and I_R occurs in Zone IV in Figure 9.3. Reduce the desired change in official reserves, $\Delta \tilde{R}$ and/or adjust policy instruments T and G, until both constraints are relaxed or until further changes in the policy or target variables are ruled out as unfeasible.[16] If both constraints are relaxed so that the required investment level can be achieved, proceed to step 6. If not, proceed to step 5.

- *Step 5.* If step 4 does not yield the required level of investment needed to achieve the desired level of increase in output, then the targeted change in output must be changed and a new (lower) value must be set according to

$$\Delta \tilde{y} = \sigma I_{min},$$

which by definition is consistent with the binding(s) constraint(s).

- *Step 6.* Determine the required level of imports, J_R, as

$$J_R = \alpha(y_{-1} + \Delta \tilde{y}).$$

- *Step 7.* Given the required level of imports and the exogenous levels of X and ΔF, reestimate the targeted change in official reserves as follows:

$$\Delta \tilde{R}[1] = X - J_R + \Delta F.$$

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[14] From Eqs. (31) and (34), it can be seen that an increase in T or a reduction in G (by raising κ_S) shifts only SS to the left, increasing the feasibility region (zone I). A reduction in $\Delta \tilde{R}$, by contrast, shifts *both* SS and TT to the left. The shift in TT, however, is inconsequential, because the trade constraint was satisfied in the first place.

[15] From Eqs. (31) and (34), it can be seen that an increase in T or a reduction in G (by raising κ_S) would shift SS to the left. This, however, would be inconsequential, because the saving constraint was satisfied in the first place. There must therefore be a leftward shift in TT in order to increase the feasibility region. In turn, this can occur only through a reduction in $\Delta \tilde{R}$ (because X is given), which shifts *both* SS and TT to the left.

[16] As indicated earlier, a change in $\Delta \tilde{R}$ is necessary to shift the TT curve. Because as a result of a reduction in $\Delta \tilde{R}$ both SS and TT shift to the left, there may be no need to adjust T or G to expand sufficiently the feasibility region.

For consistency reasons, this revised targeted change in reserves must be compared to the original target value used in the saving and trade constraints. If both estimates $\Delta \tilde{R}[1]$ and $\Delta \tilde{R}$ are identical (a very unlikely outcome after only one iteration), go to step 8. If not, go back to step 3 and re-solve the model again with the revised target $\Delta \tilde{R}[1]$. Continue iterations until the estimate of $\Delta \tilde{R}$ used in step 3 is almost identical to the one provided by step 7, that is, until the values obtained between iterations h and $h-1$, $\Delta \tilde{R}[h]$ and $\Delta \tilde{R}[h-1]$, are very close.

- *Step 8.* Once convergence has been achieved, the model yields inter-related consistent values of the levels of investment, the change in output, imports, and the change in official reserves.

- *Step 9.* Use Equation (24), along with the new value of output, (given by $y = y_{-1} + \Delta \tilde{y}$) and the (possibly modified) value of taxes to estimate private consumption, C^p.

Various criticisms have been offered of the two-gap version of the RMSM model. Two of the most important ones are the following.

- It is often difficult, in practice, to decide a priori which constraint is binding. The RMSM framework assumes that *imports are essential for investment* and that the availability of foreign exchange, by allowing such imports, raises the growth rate of output. However, it has been argued that the saving gap can be closed by *reducing imports* or *increasing exports* (or both), thereby freeing foreign exchange necessary for investment.

- The model is largely incomplete because it is essentially a growth-oriented model with emphasis on a small number of real variables and no financial side. For instance, relative prices and induced *substitution effects* among production factors (and their possible impact on exports, for instance) are neglected.

5   The Merged Model and RMSM-X

The RMSM model has been extended in recent years and has been superseded by the **RMSM-X** framework. Essentially, RMSM-X integrates into the RMSM framework the financial programming approach of the IMF, described earlier. The analytical structure of the merged IMF-World Bank model, which is at the core of RMSM-X, is described in the first subsection; The RMSM-X framework itself is presented in the second subsection.

5.1   The Merged IMF-World Bank Model

The merged IMF-World Bank model combines the extended financial programming model described earlier and the World Bank's RMSM model. As in the extended IMF model, which assumes imperfect substitutability between domestic and imported goods, relative prices (and thus the nominal exchange rate) affect the demand for imports and domestic absorption.

The merged model consists of the following equations:

- The *investment-real output* link is given by an equation similar to (22):

$$I/P = \Delta y / \sigma$$

where I is now nominal investment expenditure deflated by the price level, P. Assuming that $P_{-1} = 1$ in the above specification yields

$$\Delta y = \sigma I / (1 + \Delta P). \tag{36}$$

- The change in *nominal output* is given, as in Equation (10), by

$$\Delta Y = \Delta P y_{-1} + P_{-1} \Delta y, \tag{37}$$

- and changes in the *overall price index* are given by an equation similar to (11):

$$\Delta P = \delta \Delta P_D + (1 - \delta) \Delta E, \tag{38}$$

where, for simplicity, foreign prices are taken as constant ($\Delta P^* = 0$).

- *Domestic credit* consists again of credit to the private sector and credit to the government, as in Equation (12):

$$\Delta L = \Delta L^p + \Delta L^g, \tag{39}$$

with changes in private sector credit given by a relation similar to Equation (13):

$$\Delta L^p = \theta \Delta Y. \tag{40}$$

- Ignoring again capital gains and losses on official reserves due to exchange rate fluctuations, the *money supply identity* is given by an equation similar to (14):

$$\Delta M = \Delta L + \Delta R, \tag{41}$$

where ΔR is equal to $E \Delta R^*$.

- Changes in *official reserves* are given by an equation similar to (15):

$$\Delta R = X - J + \Delta F, \tag{42}$$

where X, J, and ΔF are all measured in domestic-currency terms, with ΔF consisting of private and public flows, ΔF^p and ΔF^g. Again, ΔF is assumed given in foreign currency terms, so that $\Delta F = (1 + \Delta E)\Delta F^*$.

Using Equation (37) to substitute for ΔY in the above expression, and multiplying both sides by $1 + \Delta P$ yields, assuming that $\Delta P \Delta y \simeq 0$ and setting $P_{-1} = 1$,

$$\Delta y = \frac{\kappa + \tau y_{-1} \Delta P}{\sigma^{-1} - \tau}, \tag{48}$$

where

$$\kappa = sY_{-1} + (1 - s)T - G + \Delta L^g + \Delta F, \tag{49}$$

and it is assumed that $\sigma^{-1} - \tau > 0$, that is,

$$\sigma \tau < 1.$$

Substituting Equation (38) for ΔP yields

$$\Delta y = \frac{\kappa + \tau y_{-1}[\delta \Delta P_D + (1 - \delta)\Delta E]}{\sigma^{-1} - \tau},$$

which can be rewritten as

$$\Delta P_D = \frac{-\kappa + (\sigma^{-1} - \tau)\Delta y}{\delta \tau y_{-1}} - (1 - \delta)\delta^{-1}\Delta E. \tag{50}$$

Table 9.4
Structure of the Merged IMF-World Bank Model

Variables	Definition
Targets	
ΔR	Change in official foreign reserves
ΔP_D	Change in domestic prices
Δy	Change in real output
Endogenous	
ΔY	Change in nominal output
ΔL^P	Change in private sector credit
ΔM	Change in nominal money balances
ΔP	Change in the overall price index
ΔJ	Change in imports
$G - T$	Fiscal deficit
Exogenous	
X	Exports
$\Delta F = \Delta F^p + \Delta F^g$	Change in net capital flows
Policy instruments	
ΔD^g	Change in domestic credit to government
ΔE	Change in the nominal exchange rate
G or T	Government spending or taxes
Predetermined	
y_{-1}	Real output in previous period
P_{-1}, E_{-1}	Price level and exchange rate in previous period
Parameters	
ν	Income velocity of money
δ	Share of domestic goods in consumer prices
α	Marginal propensity to import
θ	Response of private sector credit to output
η	Response of imports to relative prices

Source: Adapted from Khan et al. (1990, p. 172).

Second, as in the extended financial programming model, substituting Equations (39), (40), (41) and (44) in (45) yields

$$\Delta R + (\tau - s)\Delta Y = -\Delta L^g.$$

Using Equation (37) to eliminate ΔY, and (38) to eliminate ΔP yields, with $P_{-1} = 1$,

$$\Delta R + (\tau - s)(y_{-1}\delta \Delta P_D + \Delta y) = \Phi, \tag{51}$$

where

$$\Phi = -(\tau - s)y_{-1}(1 - \delta)\Delta E - \Delta L^g.$$

Third, substituting Equation (43) in the balance-of-payments Equation (42) implies

$$\Delta R = X - J_{-1} - (Q_{J-1} - \eta E_{-1})\Delta E - E_{-1}(\alpha \Delta y + \eta \Delta P_D) + \Delta F. \qquad (52)$$

Equations (50), (51), and (52) represent the condensed form of the model. Equation (50) can be rewritten as

$$\Delta P_D = \chi_{10} + \chi_{11}\Delta y, \qquad (53)$$

with

$$\chi_{10} = \frac{-\kappa}{\delta \tau y_{-1}} - (1-\delta)\delta^{-1}\Delta E, \quad \chi_{11} = \frac{\sigma^{-1} - \tau}{\delta \tau y_{-1}},$$

which can be substituted in (51) to give

$$\Delta R = (\Phi + (\tau - s)y_{-1}\delta \chi_{10}) - \chi_{21}\Delta y, \qquad (54)$$

and in (52) to give

$$\Delta R = \chi_{30} - \chi_{31}\Delta y, \qquad (55)$$

where

$$\chi_{21} = (\tau - s)(y_{-1}\delta \chi_{11} + 1),$$

$$\chi_{30} = X - J_{-1} - (Q_{J-1} - \eta E_{-1})\Delta E - E_{-1}\eta \chi_{10} + \Delta F,$$

$$\chi_{31} = E_{-1}(\alpha + \eta \chi_{11}).$$

Equations (53), (54), and (55) can be solved, as before, in two different modes.

- In the **positive mode**, the system is *recursive*: Equations (54) and (55) jointly determine Δy and ΔR, for given values of the policy instruments and the exogenous variables. Given the solution value for Δy, Equation (53) determines ΔP_D, again for given values of the policy instruments and the exogenous variables.

- In the **programming mode**, Δy, ΔR, and ΔP_D are policy targets (denoted $\Delta \tilde{y}$, $\Delta \tilde{R}$, and $\Delta \tilde{P}_D$) and the instruments are T or G, ΔE, and ΔL^g. All four possible instruments appear directly in all three equations—T and G, for instance, through κ, as shown in Equation (49), and thus χ_{10}. The system is thus *fully simultaneous*: values of three policy instruments (ΔE, ΔL^g and, say, G) must be solved at the same time from Equations (53)-(55) for given targets $\Delta \tilde{y}$, $\Delta \tilde{R}$, and $\Delta \tilde{P}_D$ and given values of X, ΔF, T and the predetermined variables.

Given the solution values for the instruments G and ΔL^g and for given values of T and ΔF^g, Equation (46) is always satisfied. The target values for changes in real output and the domestic price level—and thus, from Equation (38), the target value for the *overall* price level—generate from Equation (37)

a programmed value for nominal output and thus private sector credit, ΔL^p, through Equation (40).

The solution of the merged model is illustrated in Figure 9.4. In the panel on the right-hand side, two curves are shown in the Δy-ΔR space. Curve MM is derived from Equation (54) and its slope is given by

$$\left.\frac{\Delta y}{\Delta R}\right|_{MM} = -\chi_{21}^{-1} < 0.$$

The second curve is denoted BB and depicts the combinations of Δy and ΔR that satisfy Equation (55); its slope is assumed to be less than that of MM and is given by

$$\left.\frac{\Delta y}{\Delta R}\right|_{BB} = -\chi_{31}^{-1} < 0, \quad |\chi_{31}| > |\chi_{21}|.$$

In the panel on the left-hand side, the curve YY depicts the combinations of Δy and ΔP_D that satisfy Equation (53). Its slope is given by

$$\left.\frac{\Delta y}{\Delta P_D}\right|_{YY} = \chi_{11}^{-1} > 0.$$

In the **positive mode** (that is, for given values of the exogenous variables and the policy instruments), the intersection of MM and BB (at point E) yields the solution values for Δy and ΔR; the corresponding equilibrium value for ΔP_D is found at the intersection of the horizontal line originating from E and curve YY. In the programming mode, equations

Suppose, for instance, that the policymaker has three objectives, to increase output, lower inflation, and increase official reserves by moving from the initial position at E to a point such as E' in the panel on the right-hand side of Figure 9.4 and point A' in the panel on the left-hand side. This outcome can be achieved through a combination of three policy actions: a *reduction* in domestic credit to the government, ΔL^g; a *depreciation* of the nominal exchange rate, ΔE; and a *reduction* in government spending, G. In general, as can be inferred from Equations (53)-(55), a change in any of these instruments shifts all three curves, MM, BB, and YY; but as shown in Figure 9.4, all three curves must eventually shift to the right for all three objectives to be satisfied and this can only be achieved by using *simultaneously* all three policy instruments. This result illustrates once again the **Meade-Tinbergen principle**.

5.2   The RMSM-X Framework

The RMSM-X model is the expanded version of the RMSM model previously used by the World Bank for its macroeconomic projections (see World Bank (1997b)). Its conceptual basis is the merged IMF-World Bank model described earlier, which again essentially adds to the RMSM model a price sector, a monetary sector, and government accounts, along the lines of the financial programming approach.

Figure 9.2
The RMSM Model in the Positive Mode

Figure 9.3
The RMSM Model in Two-Gap Mode

Figure 9.1
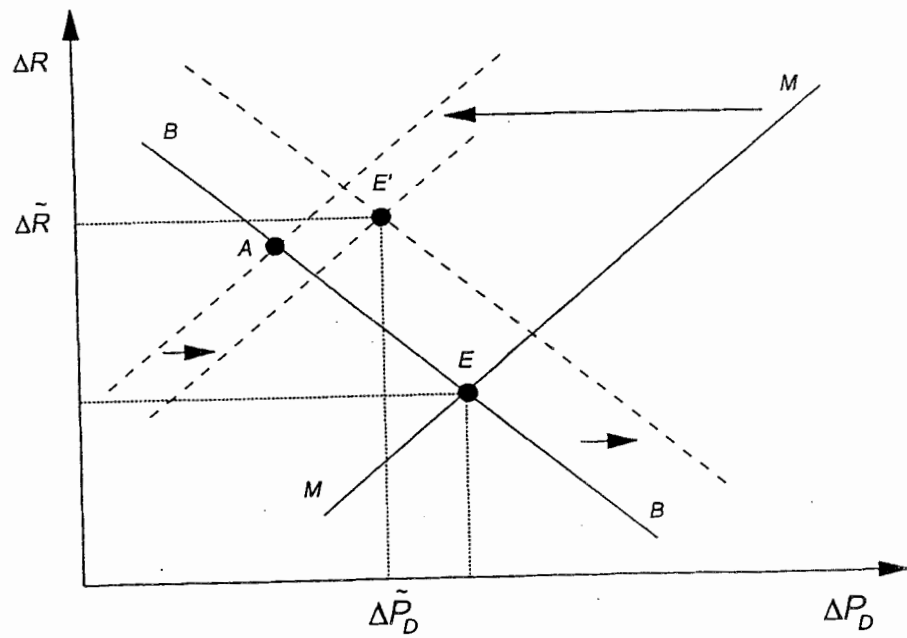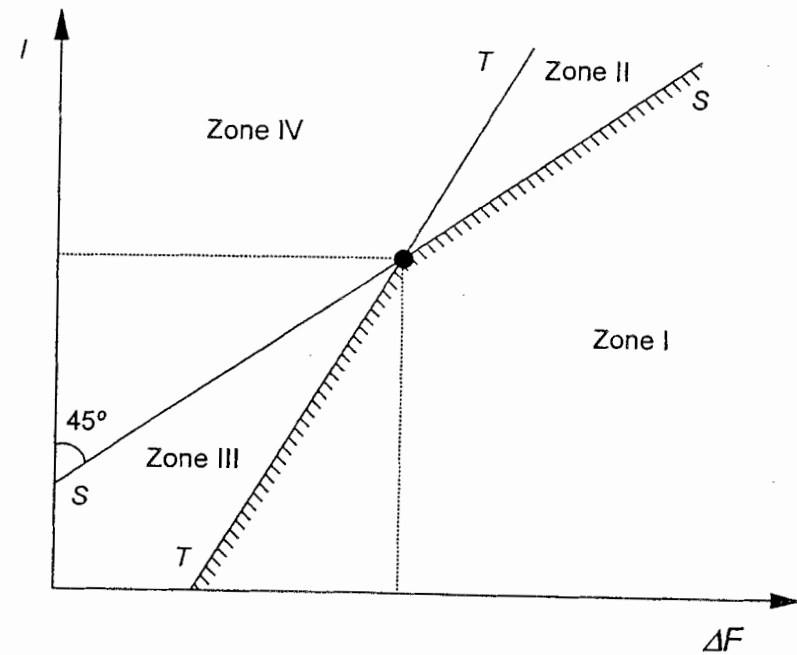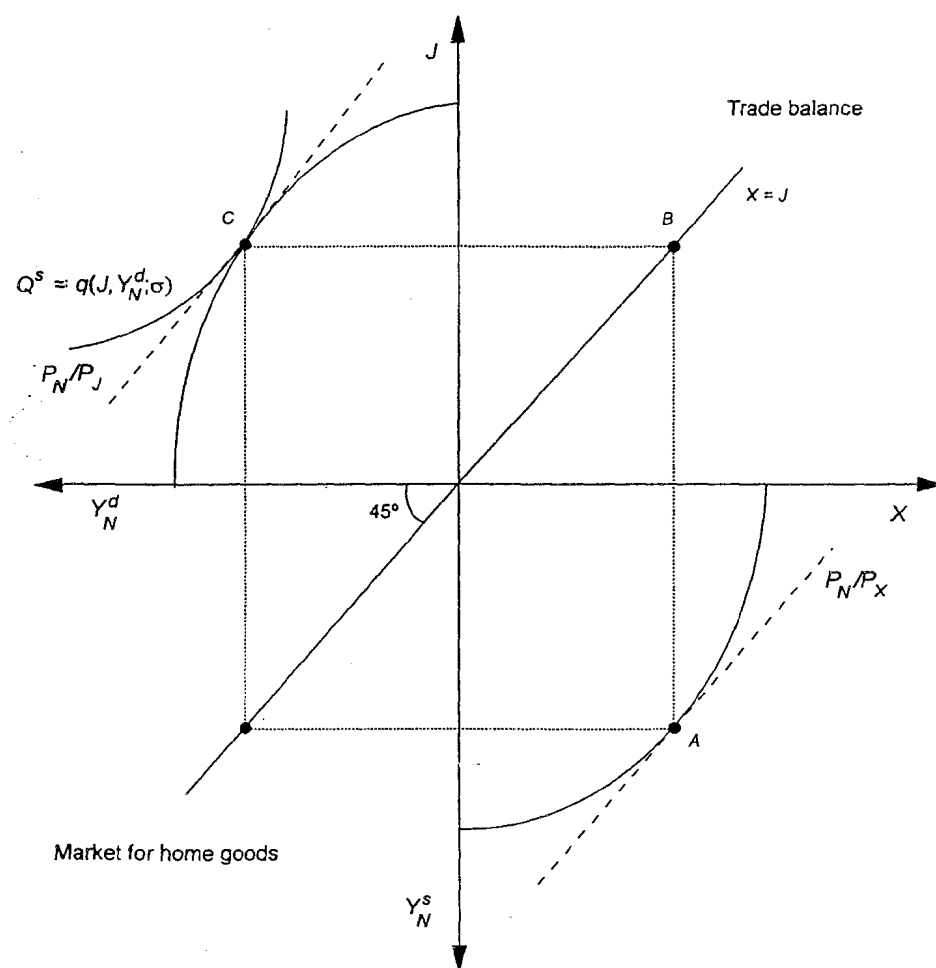The Extended Financial Programming Model

Source: Adapted from Khan, Montiel, and Haque (1990, p. 161).

Figure 9.4
The Merged IMF-World Bank Model

Figure 9.5
The Three-Gap Model

Source: Adapted from Bacha (1990, p. 291).

Figure 9.6
Equilibrium in the 1-2-3 Model

$$Q^s = q(J, Y_N^d; \sigma)$$

P_N/P_J

J

Trade balance

$X = J$

C

B

Y_N^d

45°

X

P_N/P_X

A

Market for home goods

Y_N^s

Figure 9.7
An Adverse Terms-of-Trade Shock in the 1-2-3 Model

$$Q^s = q(J, Y_N^d; \sigma)$$

P_N/P_J

J

Trade balance

$X = J$

C

C'

B

B'

Y_N^d

45°

X

P_N/P_X

A'

A

Market for home goods

Y_N^s