Managing Capital Flows and Exchange Rates

Perspectives from the Pacific Basin

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CHAPTER 5

Risk and financial development: A comparative case study of Mexico and Indonesia

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5.1 Introduction

Risk plays an important role in the allocation of the world capital stock and in the growth performance of individual economies. During recent years several economists have developed intertemporal stochastic models directed at investigating these issues. Early models by Solnik (1974), Stulz (1981, 1986, 1987), and Adler and Dumas (1983) focus on the implications of risk for international portfolio allocation. More recently, authors such as Grinols and Turnovsky (1994), Turnovsky and Grinols (1996), Turnovsky (1993), and Obstfeld (1994) have analyzed the implications of risk for economic growth and welfare. The framework adopted by these authors describes risk in terms of Brownian motion processes and generates an equilibrium in which the means and variances of relevant variables are jointly determined. This mean–variance equilibrium has formed the basis for important empirical work pertaining to interest parity relationships, and the determination of foreign exchange risk premia; see Frankel (1986), Lewis (1988), and Engel and Rodrigues (1993).

The prototype model adopted by these authors describes a highly developed, small open economy. However, risk is likely to be a more pervasive and influential phenomenon for the economies for less developed countries (LDCs). These countries are typically exceedingly vulnerable to external stochastic influences, such as terms-of-trade shocks and oil shocks. Also, by their very nature, LDCs' internal economic conditions are inherently volatile, because of shallow capital and financial markets, and excessive amounts of government regulations, as

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well as being subject to greater domestic political instability. Thus, one might argue that stochastic general equilibrium models may indeed be more relevant to the analysis of LDCs.

But despite this there has been little formal assessment of risk on the performance of such economies. One issue that has attracted the attention of development economists is that of the effect of export instability on growth. The empirical analyses of Kenen and Voidodas (1972), Voidodas (1974), Yotopoulos and Nugent (1976), and Ozler and Harrigan (1988) have resulted in a multitude of seemingly conflicting correlations between measures of export instability and growth. Brock (1991) and Turnovsky (1995, chap. 15) have employed a simple stochastic growth model to provide a conciliation between these diverse findings in terms of the sources of the underlying stochastic disturbances.

In this chapter we use the insights of the stochastic general equilibrium growth model to help understand the effects of risk on the real, risk-adjusted return to capital, capital flows, exchange rate policy, and economic growth in two Pacific Basin economies, Mexico and Indonesia, over the period 1973–95. Two important factors render the Mexican and Indonesian economies as interesting case studies to use as empirical applications of stochastic general equilibrium models. First, both countries are dynamically and rapidly developing, despite their exposure to (identical) severe world price shocks that affected their major export commodity (crude oil). Second, while the structures of these economies are quite similar, their economic experiences over the past twenty-five years have been markedly different.[1] While the 1970s were periods of solid growth in both economies, thereafter their experiences diverged. Through the 1980s, Mexico experienced hyperinflation and a debt crisis, whereas Indonesia continued as a model of economic development. In fact, it is a challenging task to subject the stochastic model to the varied experiences of the two countries and examine which parts of the model improve our insights into the performance of these economies.

Our analysis is based on a nominal model of exchange rate determination under stochastic conditions developed in Grinols and Turnovsky (1994) and, on its extension, Turnovsky and Grinols (1996). This model derives the equilibrium nominal exchange rate and growth rate in an intertemporal optimization framework of a small open economy subject to stochastic shocks of both domestic and foreign origin. The sources introduced include a domestic monetary shock, domestic fiscal and productivity shocks, and a foreign price shock. The model allows us to analyze in detail the effects of risk (as measured by vari-

[1] Not only the economic, but also the political structure of the countries is quite similar.

ances) on key macroeconomic variables such as the (1) rate of inflation, (2) nominal exchange rate, (3) portfolio allocation, (4) real returns and risk premia, (4) rate of growth, and (5) implied and optimal rates of exchange depreciation.

The method we adopt draws upon the calibration methods adopted by real business cycle theorists and others, though at a less formal level (see, e.g., Cooley, 1995). In some cases, in particular with respect to data relating to real rates of return, it is possible to calibrate the model against the data with reasonable precision. But for other aspects, in recognition of the limitations of such a small stochastic model, our focus is in using the insights it offers to help understand the qualitative empirical experiences of these countries. The model is used to examine four specific sets of issues: (1) real financial rates of return and real risk premia, (2) composition and stability of portfolio shares over time, (3) growth, and (4) implications for the rate of exchange rate depreciation.

The critical innovations introduced in this stochastic general equilibrium framework are the variances of those variables whose stochastic shocks influence key equilibrium relationships. These variances need to be constructed and this is done by considering the sum of squared residuals of these variables about their respective means. To do this requires a fairly long time period and we estimate the variance using annual data over the twenty-three year period 1973–95 (inclusive). The basic model assumes stationarity of the underlying stochastic structure, an assumption that is at best dubious for these two economies over this recent period. Accordingly, we also break down the overall twenty-three year period into three subperiods, 1973–81, 1982–88, and 1989–95, estimating the variances over each. These three periods roughly correspond to (1) periods of initial steady growth, (2) oil shocks and debt crisis (Mexico), and (3) recovery. This enables us to consider and compare the behavior of the two economies over various subperiods associated with different degrees of risk.

Our results suggest that LDCs do indeed provide appropriate applications for models that incorporate risk. Overall, the model does better in explaining nominal behavior than it does real growth. For example, we find that once real interest rates are amended to incorporate price shocks explicitly, the additional variance component, although unimportant for the United States, becomes a reasonably significant component of the rate of return in Indonesia, and is crucial in the case of Mexico. Both risk-adjusted real returns show clear patterns that reflect the variations in uncertainty in the two economies. The application of the model to exchange rate policy suggests that over the long run it tracks the actual rates of exchange depreciation of both Mexico and Indonesia reasonably well, particularly the latter. We examine the implied and optimal rates of exchange rate depreciation, and the model suggests that Mexico and Indonesia did not devalue sufficiently during times of macroeconomic instability. The models also suggest a path of more gradual devaluation should have been followed, in stark contrast to both countries' sporadic and dramatic devaluations during terms-of-trade crises.

The calibration of the portfolio shares is more problematic. As with other stochastic models, we run into issues related to the equity premium puzzle. In his numerical calibrations of a similar stochastic growth model, Obstfeld (1994) found that in order to obtain plausible portfolio shares he needed to assume a coefficient of relative risk aversion of at least six, and indeed other researchers have suggested values in excess of eighteen as being plausible; see Kandel and Stambaugh (1991). We find that in some periods the variances are simply too small relative to the differences in the real rates of return, making the portfolio share very sensitive to assumptions one chooses to make about the degree of risk aversion. In interpreting our results here it is probably better to focus on the patterns of shares across the time periods, rather than their absolute levels. With this caveat, we suggest that the stochastic model accounts quite well for changing portfolio distributions that reflect capital flow fluctuations into Mexico and Indonesia. For Mexico, the implied variation in portfolio shares clearly indicates (1) the positive effects of the Brady plan in terms of the resumption of private capital inflows, (2) the large volume of foreign borrowing by both the Mexican private and public sector, (3) the resumption of foreign financing, and (4) the deterioration of the current account. The Indonesian portfolio share instead reflects the country's easy and stable access to the world financial market. Again we find that the model captures the effects of financial and macroeconomic instability quite well.

Our calibrations for the growth rate suggest that investors were not properly compensated for the added risk in Mexico, because the high variance is also associated with high risk and in a free market this would cause domestic investors to reduce their holdings of domestic capital in their portfolios. Alternatively, with the restrictions on capital movements, investors are not free to adjust their portfolios in ways predicted by the theory and consequently we get this overstatement of the growth rate. In comparing the implied growth rate and the respective depreciation for Mexico and Indonesia, we find evidence for Rodrik's (1996) assertion that the positive correlation between government size and openness is driven by the fact that larger governments can better insure and smooth external shocks.

The remainder of the chapter is set out as follows. Following this introduction we provide some background on Mexico and Indonesia. Section 5.3 then summarizes the important aspects of the stochastic general equilibrium models we shall employ for our analysis. Section 5.4 applies the model to the recent experiences of Mexico and Indonesia, while section 5.5 draws some conclusions.

5.2 Background on Mexican and Indonesian economic conditions

After discovering oil in the early 1970s, Mexico and Indonesia shared similar growth paths with 6.3 and 7.2 percent annual growth rates, respectively, between 1970 and 1980.[2] The average annual growth rates of the 1980s (1980–93) show, however, a wide disparity with Mexico's 1.6 percent annual growth being only a fraction of Indonesia's 5.8 percent. This marked bifurcation of the growth paths in the early 1980s occurred despite the fact that the countries' comparable development strategies were rocked by identical exogenous shocks. Mexico banked its initial phase of development on skyrocketing oil revenues in the 1970s, as also did Indonesia. In the early 1980s, however, oil prices declined sharply and tight fiscal policies in the United States and Britain increased world interest rates abruptly. Around 1986, both countries faced a second dramatic oil shock (due to a depreciating dollar), which was also accompanied by a major earthquake in Mexico. Both countries pegged their real exchange rate to the dollar, by allowing some gradual nominal depreciation accompanied by large, intermittent discrete devaluations.

Table 5.1 summarizes the mean annual inflation rates and the mean per capita growth rates of output and consumption for the two countries over the full period 1973–95, as well as the three subperiods, 1973–81, 1982–88, and 1989–95. These are annual averages and the standard deviations reflect the fluctuations in these averages over the various periods. These figures conveniently summarize the divergent growth paths followed by the two economies. Overall, Mexico is seen to be a higher-inflation, lower-growth, and higher-variability economy (as measured by the coefficient of variation). Whereas Indonesia reduced its inflation rate steadily since the 1973–81 period, in Mexico the period 1982–88 was one of hyperinflation, with inflation gradually declining more recently. Indonesia sustained positive growth throughout, whereas in Mexico the period of hyperinflation was also one of steady decline in output and

[2] The data in this chapter are based on *International Financial Statistics*; the brief and selected survey of the Mexican events is based on Dornbusch and Werner (1994), Gould (1995), and Aspe (1993). The brief review of events in Indonesia is drawn from Bhattacharya and Pangestu (1992).

Table 5.1. *Background statistics (in percent)*

	Inflation		Output Growth[a]		Consumption Growth[a]	
Year	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Mexico						
1973–81	18.1	6.2	5.0	3.2	3.7	12.6
1982–88	88.0	29.0	–4.6	5.8	–3.6	5.1
1989–95	19.5	9.7	2.2	2.9	2.5	3.5
1973–95	39.3	35.9	1.2	5.8	1.1	5.3
Indonesia						
1973–81	18.3	10.0	9.2	6.5	5.7	6.9
1982–88	8.5	2.3	2.6	4.9	2.9	3.0
1989–95	8.4	1.2	4.9	7.0	4.3	10.5
1973–95	12.5	8.4	5.9	6.6	4.4	7.1

[a] Real per capita growth.

consumption. Finally, although recently prices have become quite stable in Indonesia, the growth rates of output and consumption, while greater than those of Mexico, are also more variable.

5.2.1 *Mexico*

Until the mid-1970s, Mexico was a low-inflation country. During that period Mexico pursued inward-looking policies, increased government spending, and price controls. The 1973 oil price rise brought expansionary fiscal and monetary policies. A balance-of-payments crisis developed and Mexico devalued the peso by 60 percent in 1976, the year of huge oil discoveries. Instead of structural adjustment after the oil discoveries, the Portillo government implemented a massive fiscal expansion largely financed by external borrowing, leading to the debt crisis with the fall of oil prices in the early 1980s.

In response to this first oil price decline, a widening current account deficit, and tripling external debt (49 percent of GDP), the Mexican government devalued the peso by 260 percent, announced the suspension of debt service, nationalized the banking system, and imposed strict capital controls. With the aid of an IMF-sponsored reform package, the Mexican government embarked on a sequence of tentative public sector reforms. Despite the fact that Mexico averaged net transfers of 5 percent of GDP per annum between 1982 and 1988, official institutional lending (largely by the World Bank) was the only source of foreign capital during that time period. Inflation and money growth did not slow, however, because the initial reduction in the fiscal deficit, and renewed fiscal expansion in 1984, were financed by inflation tax.

During the period 1985–86, Mexico was hit hard by the second negative oil shock in conjunction with the sharp depreciation of the dollar, shortly after a major earthquake in Mexico City. The economy degenerated into hyperinflation, until the government announced a credible program to cut inflation through tight monetary policy and wage and price controls in November 1987 (Pacto 1987). The Pacto between unions, business, and government would see fifteen subsequent extensions and amendments, well into the 1990s. While inflation was soon brought under control, large sums of capital did not start to flow back into the country until the Brady Plan was announced in 1989. Private lending subsequently increased faster and in larger amounts than expected. Capital flows were further aided by a banking reform, financial deregulation, and a booming stock market that rose by 125, 25, and 50 percent in 1991, 1992, and 1993, respectively.

An increase in the tax base and greater public savings did not offset, however, the sharp decline in private savings between 1989 and 1992. Consumer credit increased 50 percent per annum and commercial bank credit to enterprises increased by 25 percent. With massive capital inflows the current account deteriorated from a \$3.5 billion surplus in 1987 to a \$24 billion deficit in 1992. The bonanza of the post-Brady years was also accompanied by an increasing overvaluation of the Mexican peso. Shortly before the peso collapse in December 1994, Dornbusch and Werner (1994) argued (somewhat clairvoyantly) for at least a 20 percent devaluation, largely to reverse a period of negligible growth and significant demand shifts toward foreign goods.

5.2.2 *Indonesia*

During the oil boom of the 1970s the financial system of Indonesia was still in the early stages of development. There was a gradual increase in regulatory government control in order to prevent looming "Dutch disease" problems associated with the adverse effects of real exchange rate appreciation on nonoil exports. Distortions and rent seeking were rampant, as was the expansion of government enterprises.

In Indonesia, the external shocks in the form of declining oil prices constituted an average of 3 and 15 percent of GDP in 1982 and 1986, respectively.[3] Both shocks were followed by drastic adjustments. The rupiah was devalued 28 percent in March 1983, and public expenditures were curtailed significantly. The reduction of the inflation rate below 5 percent was achieved at the cost of negative growth in 1982 and declining investment until the mid-1980s. Just when the economy had recovered to a solid 5 percent growth and continued low inflation, the second oil shock brought about a 34 percent deterioration in the terms of trade. The government immediately devalued the rupiah by 31 percent and cut fiscal investment by 25 percent. The fiscal deficit was reduced from 4.1 to 1.3 percent of GDP by 1990.

While the first adjustment period was characterized by increased fiscal control and regulation, the second oil shock brought a period of widespread economic liberalization. Another devaluation proceeded widespread trade and financial liberalizations in 1988 and 1989, respectively. These reforms were the impetus for increased economic activity, with growth and inflation stable at around 7 percent. The liberalizations also introduced uncertainty into the macroeconomic landscape, which manifested itself in roller-coaster stock market performances and bankruptcies of large financial institutions. However, with a low foreign debt ratio of about 30 percent of GDP, private investment and lending remained strong. The introduction of private financial institutions and fully liberalized interest rates generated some instability in the money multiplier and resulted in strong money growth, a surge in external borrowing, and a surging current account deficit between 1990 and 1992.

5.3 A stochastic general equilibrium model

This section briefly illustrates the analytical structure underlying our numerical analysis. It is based on the stochastic general equilibrium representative agent model developed by Grinols and Turnovsky (1994) and Turnovsky and Grinols (1996), where details are provided. Here we merely highlight the main equilibrium relationships that we shall consider.

5.3.1 *Prices and asset returns*

At each instant of time, the agent chooses his rate of consumption and allocates his portfolio of wealth among four assets: domestic money, M; domestic bonds, B, which are assumed to be nontraded; foreign bonds,

[3] In addition to declining oil prices, Indonesia suffered from declining tin, palm oil, and rubber prices.

B^*; and equity claims on capital, both of which are internationally traded.

The three prices in the model are P, the domestic price of the traded good; Q, the foreign price of the traded good; and E, the exchange rate, measured in terms of units of domestic currency per unit of foreign currency. These prices evolve according to:

$$\frac{dP}{P} = pdt + du_p \tag{1a}$$

$$\frac{dQ}{Q} = qdt + du_q \tag{1b}$$

$$\frac{dE}{E} = edt + du_e \tag{1c}$$

where pdt, qdt, and edt are the rates of change of P, Q, and E over the instant dt. The terms du_p, du_q, and du_e are temporally independent, normally distributed random variables with zero means and variances $\sigma_p^2 dt$, $\sigma_q^2 dt$, and $\sigma_e^2 dt$. With free trade, price movements must be tied to one another by the purchasing power parity (PPP) relationship

$$P = QE \tag{2}$$

which through stochastic differentiation implies

$$p = q + e + \sigma_{qe} \tag{3a}$$

$$du_p = du_q + du_e \tag{3b}$$

where $\sigma_{qe}dt$ is the instantaneous covariance between du_q and du_e. While the foreign price level Q is always assumed to be exogenous to the small open economy, the determination of P and E depends upon the policy of the monetary authority.

Domestic and foreign bonds are assumed to be short bonds, paying deterministic nominal interest rates of i and i^*, respectively. Given the stochastic structure of the economy, the real rates of return to domestic consumers on money, the domestic bond, and the foreign bond are respectively

$$dR_M = r_M dt - du_p; \quad r_M \equiv -p + \sigma_p^2 \tag{4a}$$

$$dR_B = r_B dt - du_p; \quad r_B \equiv i - p + \sigma_p^2 \tag{4b}$$

$$dR_F = r_F dt - du_q; \quad r_F \equiv i^* - q + \sigma_q^2. \tag{4c}$$

The understanding of how the variance contributes to the return is crucial to the understanding of the modeling of risk in a Brownian motion stochastic framework. The real rates differ from the well-known deterministic quantities by two terms, the stochastic component and the variance. Consider the rate of return on money, which can be defined as $dR_M = d(1/P)/(1/P)$. If we take the second-order differential, this expression yields $dR_M \approx -dP/P + (dP/P)^2$, where the second term equals $\sigma_p^2 dt$. Due to the convexity of $1/P$ in P, the variance of the stochastic component in P contributes positively to the expected rate of return. The intuition is analogous to standard portfolio frontier analysis, where higher risk requires higher return to render the investor indifferent between assets of various risks.

An immediate, but important, consequence of considering the rates of return in a stochastic context is that the variance of the price level is introduced as a component of the real rate of return. As will become evident in our numerical analysis, this additional term is unimportant for the United States. In a macroeconomic environment where prices are relatively stable, the variance component is negligible compared to the usual measure $(i - p)$ and can safely be ignored. In contrast, in both Mexico and Indonesia, periods of rapidly changing prices were associated with large variances in prices, to such a significant extent that the variance is comparable in magnitude with the conventional rate of return and indeed dominates it in some cases.

The flow of output, dY, is produced from capital, dK, by means of the stochastic constant returns (A-K) technology

$$dY = \alpha K dt + \alpha K dy \tag{5}$$

where α is the (constant) marginal product of capital and dy is a temporally independent, normally distributed, stochastic process with zero mean and variance $\sigma_y^2 dt$. In the absence of adjustment costs, the real return on equity (capital) is

$$dR_K = r_K dt + du_k \equiv \alpha dt + \alpha dy. \tag{4d}$$

Equation (4d) establishes a relation between the real rate of return on equity and the marginal physical product of capital that depends solely on the magnitudes of α and dy.

5.3.2 *Consumer optimization*

The representative agent is assumed to select portfolio of assets and a rate of consumption to maximize expected lifetime utility. Utility depends upon consumption $C(t)$ and real money balances $M(t)/P(t)$, as represented by the isoelastic utility function

$$E\int_0^{\infty}\frac{1}{\gamma}\left(C(t)^{\theta}\left(\frac{M(t)}{P(t)}\right)^{1-\theta}\right)^{\gamma}e^{-\rho t}dt,\quad -\infty<\gamma<1;\ \ 0\le\theta\le 1 \tag{6a}$$

subject to the wealth constraint:

$$W=\frac{M}{P}+\frac{B}{P}+\frac{EB^*}{P}+K \tag{6b}$$

where W denotes real wealth, and the stochastic wealth accumulation equation:

$$dW=W\left[n_1 dR_M+n_2 dR_B+n_3 dR_K+n_4 dR_F\right]-C(t)dt-dT \tag{6c}$$

where portfolio shares are: $n_1\equiv(M/P)/W$ = share of portfolio held in money; $n_2\equiv(QB/P)/W$ = share of portfolio held in government bonds; $n_3\equiv K/W$ = share of portfolio held in equity (capital); $n_4\equiv(EB^*/P)/W$ = share of portfolio held in foreign bonds; dT = taxes paid. Note that we permit n_4 to be negative, interpreting that as a net debtor.

Taxes are endogenously determined to satisfy the government constraint, specified in equation (9a), and therefore include a stochastic component reflecting the changing need for taxes. Because in a growing economy taxes and other real variables grow with the size of the economy, measured here by real wealth, we relate total taxes to wealth according to

$$dT=\tau W dt+W dv \tag{7}$$

where dv is a temporally independent, normally distributed random variable with zero mean and variance $\sigma_v^2 dt$. The parameters τ and dv must be set so as to ensure that the government's budget constraint is met.

The first order optimality conditions to this problem can be written in the form:

Consumption: $$\frac{C}{W}=\frac{\theta}{1-\gamma\theta}\left[\rho-\beta\gamma-\frac{1}{2}\gamma(\gamma-1)\sigma_w^2\right] \tag{8a}$$

Money holdings: $$n_1=\left(\frac{1-\theta}{\theta}\right)\frac{C/W}{i} \tag{8b}$$

Equities and bonds: $$(r_K-r_B)dt=(1-\gamma)\mathrm{cov}\left[dw,\ du_k+du_p\right] \tag{8c}$$

$$(r_F-r_B)dt=(1-\gamma)\mathrm{cov}\left[dw,\ -du_q+du_p\right] \tag{8d}$$

where

$$dw \equiv -(n_1 + n_2)du_p + n_3du_k + n_4du_q - dv$$

denotes the stochastic component of dW/W, and

$$\beta \equiv n_1r_M + n_2r_B + n_3r_K + n_4r_F - \tau$$

$$\sigma_w^2 \equiv \frac{E(dw)^2}{dt} = (n+n_2)^2\sigma_p^2 + n_3^2\alpha^2\sigma_y^2 + n_4^2\sigma_q^2 + \sigma_v^2$$
$$-2(n_1+n_2)n_3\alpha\sigma_{py} - 2(n_1+n_2)n_4\sigma_{pq} + 2(n_1+n_2)\sigma_{pv}$$
$$+2n_3n_4\alpha\sigma_{yq} - 2n_3\alpha\sigma_{yvK} - 2n_4\sigma_{qv}.$$

These relationships will eventually be embedded into our stochastic general equilibrium. Of particular relevance will be (8c) and (8d) that describe the differential real rates of return on the assets in terms of their respective real risk differentials, as measured by the covariance with the overall market return.

5.3.3 *Government policy*

Government policy is described by the choice of government expenditures, the printing of money and bonds, and the collection of taxes, all of which must be specified subject to the government's flow budget constraint:

$$d\left(\frac{M}{P}\right) + d\left(\frac{B}{P}\right) = dG - dT + \frac{M}{P}dR_M + \frac{B}{P}dR_B \tag{9a}$$

where dG denotes the stochastic rate of real government expenditure.

Government expenditure policy is specified by the stochastic relationship

$$dG = g\alpha Kdt + \alpha Kdz \tag{9b}$$

where dz is an intertemporally independent, normally distributed random variable with zero mean and variance σ_z^2dt.

Monetary growth is specified by the stochastic growth rule

$$\frac{dM}{M} = \mu dt + dx \tag{9c}$$

where μ is the mean monetary growth rate and dx is an intertemporally independently distributed, random variable with zero mean and variance σ_x^2dt. This equation reflects how monetary policy is chosen and encompasses a potentially rich set of policies some of which are discussed by Turnovsky and Grinols (1996). To be concrete, we shall assume that the monetary authority sets the mean growth rate, μ, directly

Debt policy is formulated in terms of maintaining a fixed ratio of domestic government (nontraded) bonds to money

$$\frac{B}{M} = \lambda \tag{9d}$$

where λ is a policy parameter set by the government. This specification can be thought of as being a stochastic version of a balanced-growth equilibrium assumption and has a well-established history in the monetary growth literature (see, e.g., Foley and Sidrauski 1971). In the present international context, the choice of λ also reflects sterilization policy. Given the policy specification (9b) – (9d), both the mean and the stochastic component of taxes dT must be set in order to meet the government budget constraint (9a).

5.3.4 *Product market equilibrium and balance of payments*

Net exports of the physical commodity are determined by the excess of production over domestic uses, $dY - dC - dK - dG$. Balance-of-payments equilibrium, in turn, requires the transfer of new foreign bonds (in excess of interest on earlier issues) to finance net exports of the domestic country. This is expressed in real terms by the relationship.

$$d\left(\frac{B^*}{Q}\right) = \left[dY - dC - dK - dG\right] + \left(\frac{B^*}{Q}\right) dR_F. \tag{10}$$

The solution can be characterized as one where risks and returns on assets are unchanging through time so that the same allocation of portfolio wealth is chosen at each instant of time.

In addition, there are some technical considerations such as the determination of initial price levels (through appropriate jumps) and certain feasibility conditions (such as intertemporal solvency conditions) to be met. These aspects are not discussed here.

5.3.5 *Equilibrium growth, consumption, and portfolio shares*

Sections 5.3.1–5.3.4 determine a macroeconomic equilibrium in which the deterministic and stochastic components of the relevant equilibrium variables are endogenously determined. The equilibrium determines both real and nominal quantities, and can be characterized as one where risks and returns on assets are unchanging through time so that the same allocation of portfolio wealth is chosen at each instant of time. With portfolio shares remaining constant over time, all real components of wealth must grow at the same stochastic rate. For our purposes, the equilibrium can be summarized by the following pair of equations that determine the share of capital in the traded portfolio of the consumer's portfolio, $\omega \equiv n_3/(n_3 + n_4)$, and the equilibrium growth rate, ψ:

$$\omega = \frac{\alpha - (i^* - q + \sigma_q^2)}{(1-\gamma)(\alpha^2\sigma_y^2 + \sigma_q^2)} + \frac{\sigma_q^2}{\alpha^2\sigma_y^2 + \sigma_q^2} \tag{11a}$$

$$\psi = \omega\alpha(1 - g - c) + (1-\omega)(i^* - q + \sigma_q^2) \tag{11b}$$

where $c \equiv C/Y = C/(\alpha K) = C/(\alpha n_3 W)$. Equation (11a) provides an explicit solution for the relative share of capital in the traded portfolio of the representative agent's portfolio. This equation is a standard expression in stochastic models, describing the net position in terms of the risk-adjusted differential real rate of return plus a hedging component. It is determined entirely by real quantities and is therefore *independent* of the domestic government's finance policy. Equation (11b) expresses the mean growth rate as a weighted average of the domestic source of growth and the growth attributable to interest earnings from abroad, the weights being the relative portfolio shares, ω, $(1 - \omega)$, respectively. The consumption–mean income ratio, c, depends on the C/W ratio and the portfolio share of domestic capital, n_3, both of which are endogenously determined, along with the remaining portfolio shares, particularly the share of money, n_1.

Having determined ω, the remainder of the equilibrium can be determined in terms of the domestic nominal rate, i, debt policy, λ, and other exogenous real parameters, such as the exogenous sources of risk in the form of output, monetary, and foreign price shocks, σ_y^2, σ_x^2, σ_q^2; preferences θ, ρ; technology, α; and the government share in output, g. An important consequence of the specification of debt policy by (9d) is that the equilibrium growth rate depends on the domestic nominal interest rate, i. This provides the avenue through which government policy is able to influence the real part of the equilibrium. The fact that the equilibrium real growth rate depends on the monetary growth rate (inflation) through the interest rate is a dynamic manifestation of the familiar Mundell-Tobin effect. It means that the superneutrality of money associated with the traditional Sidrauski (1967) model does not apply in the present context, even though it has been shown to extend to other stochastic growth models in which the residual financing of the government budget is through lump-sum taxation or equivalently debt issuance.

5.3.6 *Nominal quantities*

Once government finance policy is specified, the equilibrium solutions for (1) the rate of inflation, p; (2) the rate of exchange depreciation, e; and (3) the domestic nominal rate of interest, i, can be attained from the following three relationships:

$$p = q + e - \omega\sigma_q^2 \quad (12a)$$

$$p = \mu - \psi(i, \lambda) + \sigma_w^2 \quad (12b)$$

$$i = \alpha + p - \sigma_x^2 - (1-\gamma)\alpha^2\omega\sigma_y^2 - \gamma\sigma_w^2. \quad (12c)$$

Equation (12a) is just the PPP equation (3a); equation (12b) describes the adjustment in inflation necessary to maintain portfolio balance along the equilibrium growth path; equation (12c) is obtained by evaluating the consumer optimality condition (8c). These equations are expressed in terms of the variances of exogenous variables. Target values for p, e, or i depend on the choice of monetary instrument. In general, this can be accomplished in a multiplicity of ways:

Financial growth rate: The monetary authorities can attain the target rate of interest, $\bar{i}$ say, by directly setting the common growth rate of its financial assets in accordance with

$$\mu = \bar{i} + \psi(\bar{i}, \lambda) - \alpha + \sigma_x^2 + (1-\gamma)\alpha^2\omega\sigma_y^2 - (1-\gamma)\sigma_w^2. \quad (13a)$$

Exchange rate depreciation: Alternatively, the monetary authorities can target the rate of exchange depreciation and allow their financial liabilities to adjust appropriately. In this case the implied rate of exchange depreciation can be expressed by the risk-adjusted nominal interest differential:

$$e = \bar{i} - i^* + \gamma\left[\sigma_w^2 - (1-\omega)\sigma_q^2\right] + \sigma_x^2. \quad (13b)$$

It is important to note that under certainty these policies are equivalent in all respects.

5.3.7 *Optimal exchange rate policy*

An important issue is to determine the extent to which the exchange rate policy followed by Mexico and Indonesia was close to being optimal. This issue can be conveniently addressed by determining the optimal rate of exchange depreciation, $\hat{e}$, where the welfare criterion we consider is the welfare of the representative agent, as specified by the intertemporal utility function (6a), evaluated along the equilibrium balanced-growth path.

The issues involved can be seen most clearly in the case of the logarithmic utility function when the optimized welfare criterion can be expressed as:

$$X\left(K_0+\frac{B_0^*}{Q_0}\right)=\frac{\theta}{\rho}\ln(\theta\rho)+\frac{1-\theta}{\rho}\ln n_1+\frac{\psi}{\rho^2}+\frac{1}{\rho}\ln\left(\frac{\omega}{n_3}\right)$$
$$+\frac{1}{\rho}\ln\left(K_0+\frac{B_0^*}{Q_0}\right)-\frac{1}{2\rho^2}\sigma_w^2. \tag{14}$$

Apart from exogenous constants, and the initial stock of traded assets, intertemporal welfare depends upon four elements. The first is the utility from holding real money balances: $((1-\theta)/\rho)\ln n_1$. The second term, ψ/ρ^2, is the utility resulting from the growth of wealth, insofar as this increases future consumption possibilities. The third, represented by the term $(1/\rho)\ln(\omega/n_3)$, results from wealth effects due to initial jumps in the exchange rate. The final term, $-(1/2\rho^2)\sigma^2_w$, represents the welfare losses due to the exogenous sources of real risk to the economy.

Government financial policy, however conducted, affects welfare only through the first three channels, doing so through its impact on the nominal interest rate i. Turnovsky and Grinols (1996) show that for the logarithmic utility function, the optimal interest rate target is determined by the quadratic equation in i

$$i^2-\rho(1+\lambda)(1-\theta)i-\rho^2(1+\lambda)^2\theta(1-\theta)=0 \tag{15}$$

whose positive root,

$$\hat{i}=\frac{\rho(1+\lambda)(1-\theta)}{2}\left[1+\sqrt{1+\frac{4\theta}{1-\theta}}\right] \tag{15'}$$

is the optimal domestic nominal interest rate. Interestingly enough, the optimal nominal interest rate is independent of the stochastic characteristics of the economy. This is a consequence of the logarithmic utility function; for the more general constant elasticity utility function, $\hat{i}$ does indeed depend upon the variances impinging on the economy. The optimal rate of exchange depreciation is then obtained by combining (15′) with (13b).

Table 5.4. *Consumption shares (c), government shares (g) (as fractions), and output growth rates (ψ) (in percent)*

				Risk aversion $(1-\gamma)$			Actual growth	
				1	3.3	10		
Year	g	c	$1\text{-}c\text{-}g$	ψ	ψ	ψ	Consumption	Output
Mexico								
1973–81	0.101	0.674	0.225	7.0	2.2	0.9	3.730	4.993
1982–88	0.091	0.648	0.261	18.3	8.5	5.7	–3.648	–4.552
1989–95	0.096	0.703	0.201	1.590	1.752	1.798	2.532	2.224
1973–95	0.097	0.670	0.233	1.736	1.733	1.732	1.056	1.201
Indonesia								
1973–81	0.103	0.654	0.243	15.1	4.7	–1.7	5.711	9.198
1982–88	0.103	0.595	0.301	–34.8	–7.4	0.40	2.950	2.629
1989–95	0.090	0.544	0.365	619.734	187.195	63.612	4.298	4.905
1973–95	0.100	0.607	0.292	1.709	1.725	1.730	4.441	5.892

have employed the real return to capital as defined by the World Bank (the rate of growth of GDP as a percentage of the average investment rate) but this does not result in any improvement in the forecast growth rates.

Interestingly enough, the model also predicts a growth rate of around 1.72 percent for Indonesia over the entire period 1973–95, and again this is independent of the degree of risk aversion. This is because the estimate of the average portfolio share is $\omega' \approx 0$, so that the growth rate is effectively determined entirely by the foreign component. Although data on the rate of return on capital cannot be constructed from *IFS* data, the numbers using the return on bonds as a proxy are more plausible for Indonesia. This is likely so because conditions were more stable in Indonesia, so that bond and capital returns moved relatively closer in tandem. The results capture the qualitative pattern of Indonesian growth, namely positive growth, followed by a reduction, and then an improvement. However, in all cases the magnitudes of the changes are seriously overstated, with declines being predicted for 1982–88. The absurd growth rate for the more recent period is a direct consequence of the unrealistically high estimated values of ω, which is completely out of line with the risk and return characteristics of domestic and foreign assets.

Overall, the model *overpredicts* the growth rates of Mexico and *underpredicts* the growth rates of Indonesia. One reason why this may be so is due to the role of government expenditures. One striking difference between Mexico and Indonesia is in the fraction of output devoted to government expenditure. While it averaged around 9 percent for Mexico, it is around three times that for Indonesia. One limitation of the model is that it treats government expenditure purely as a drain on output, so that other things being equal, a country with a smaller fraction of government expenditure will have a lower growth rate. This does not capture the productive use to which government expenditure was put in improving productivity and thereby enhancing the growth rate. Maybe even more importantly, Rodrik (1996) has recently found a statistically robust positive association between a country's degree of openness and the size of its government. He provides strong evidence that this surprising correlation is due to the fact that government expenditures function to insure against or mitigate and smooth the effects of external shocks. In our context this is an important insight, since both countries opened up to the world market and the greater degree of insulation possible through government expenditures may have given Indonesia an important edge when it came to reducing macroeconomic instability.

5.4.4 *Exchange rate depreciation*

Finally we examine the implications of this stochastic model for exchange rate policy. Recalling (13b), the implied rate of exchange depreciation, corresponding to any arbitrarily set target value $\bar{i}$ of the nominal interest rate, is:

$$e = \bar{i} - i^* + \gamma\left[\sigma_w^2 - (1-\omega)\sigma_q^2\right] + \sigma_x^2. \tag{13b}$$

The optimal rate of exchange depreciation, $\hat{e}$, is then given by:

$$\hat{e} = \hat{i} - i^* + \gamma\left[\sigma_w^2 - (1-\omega)\sigma_q^2\right] + \sigma_x^2, \tag{13b'}$$

where $\hat{i}$ denotes the optimal nominal interest rate target. In the case of the logarithmic utility function, $\hat{i}$ is determined by (15′). For numerical purposes we shall assume values of $\theta = 0.8$, $\rho = 0.045$, $\lambda = 5$. This implies an optimal nominal interest rate of around 14 percent, which we have arbitrarily applied to both countries. In addition, given the arbitrariness of these parameters, we shall assume that $\hat{i}$ = 14 percent for all assumed values of the risk aversion parameter. It is interesting to note that even for the logarithmic utility function, uncertainty still affects the optimal rate of exchange depreciation. In contrast to the real returns that are functions of variances of the prices, or the capital shares that are functions of the variances of the domestic productivity and foreign price shocks, the optimal rate of exchange depreciation depends on the variance of the monetary growth rate. The calculation of that variance, necessary to compute the optimal exchange rate policy, was done in exactly the same way as the estimation of the variance of the inflation rate.

The results for the two countries are set out in Table 5.5 and show a striking contrast. The first pair of columns in the two parts of the table report the means and standard deviations of the monetary growth rates in the two economies. After 1991, the mean and standard deviation of the Mexican monetary growth rate is high relative to that of Indonesia, which reflects their differential adjustment policies after being struck by identical external shocks. The next two pairs of columns of the table report: (1) the implied rate of exchange depreciation, that is, the rate of exchange depreciation predicted by the model corresponding to (13b), and (2) the optimal rate of exchange depreciation, corresponding to the optimal, rather than the actual, nominal interest rate, as computed by (13b′). These are compared with the actual rates of exchange depreciation followed in the economies, as reported in the final column. In all cases these are averages of the annual rates of depreciation over the various subperiods, as well as over the entire sample period, and thus

Table 5.5. *Actual, implied, and optimal exchange rate depreciation (in percent)*

Year	Money growth		Optimal depreciation: Risk aversion $(1-\gamma)$			Implied depreciation: Risk aversion $(1-\gamma)$			Actual depreciation
	Mean	St. dev. (σ_x)	1	3.3	10	1	3.3	10	
Mexico									
1973–81	28.418	5.7	5.9	3.3	−7.0	6.3	3.7	−6.7	23.115
1982–88	66.196	24.9	12.4	11.9	10.1	66.1	65.6	63.9	40.276
1989–95	37.383	43.778	27.868	27.586	26.810	41.328	41.046	40.270	15.907
1973–95	42.644	31.169	16.556	16.179	14.941	36.460	36.083	34.845	27.634
Indonesia									
1973–81	34.027	8.3	6.3	5.9	4.4	1.9	1.5	1.0	5.959
1982–88	12.146	3.9	6.3	6.1	5.4	6.0	5.8	5.1	16.456
1989–95	19.668[a]	15.794[a]	11.197	6.239	−2.759	16.398	11.440	2.442	4.201
1973–95	23.497	13.271	8.602	7.781	4.910	8.198	7.377	4.506	8.619

[a] 1989–92 only.

exchange depreciation over the full period, suggesting that from a long-run standpoint Indonesia was following close to an optimal monetary policy. With a more stable monetary policy, the variance of the monetary growth rate contributes more modestly to the implied and optimal rates of depreciation (around 1.75 percentage points over the entire horizon). While the model performs quite well in the 1970s it seriously underpredicts the rates of depreciation of the 1982–88 period. Closer examination of the data and circumstances indicates, however, that the model is sensitive enough to pick up the extreme degree of financial repression during that period, due to a nationalized banking system, restricted capital flows, and a government-imposed interest rate of 6 percent. The implied and optimal rates of depreciation are severely affected by the Indonesian interest rate, which was clearly divorced from economic fundamentals. This distortion is picked up by the model to generate the implausibly low depreciation during this period.

However, the pattern of implied and predicted depreciation improves relative to the historical experience as financial liberalization is implemented. After financial liberalization, the implied rate of depreciation reflects Indonesia's relatively stable monetary growth rate over the 1980s, and suggests that its monetary and exchange rate policy was not far from the implied depreciation rate. Again the optimal rate reflects the pattern of the implied rate, but the level is too low.

By the early 1990s we find the same pattern in Indonesia as in Mexico. Massive deregulation and the ensuing investment boom introduced financial instability that led to increased risk and money growth. As in the case of Mexico, Indonesia did not devalue the rupiah to the extent that the implied risk-adjusted interest rate suggests. Compared with that of Mexico, Indonesia's relatively more stable macroeconomic environment generated an annual implied rate of depreciation (10.6 percent) that is close to the actual (9 percent).[7] As in the Mexican case, the model predicts that this depreciation should have been managed in a much more gradual manner than the Indonesian authorities instituted.

5.5 Conclusion

This chapter employs a stochastic general equilibrium growth model to see what insights it offers into the effect of uncertainty on the real, risk-adjusted return to capital, capital flows, exchange rate policy, and

[7] Here we compare annual rates of depreciation between 1984–91, because of the severe degree of financial repression in the early 1980s. If we compare 1980–91, the implied and actual rates are 5.2% and 10.1%, respectively.

economic growth in two LDCs, Mexico and Indonesia. Both countries in particular, and LDCs in general, are vulnerable to exogenous world price shocks, such as oil shocks, and are subject to relatively greater domestic instability of both an economic and political nature. Thus one might reasonably expect that stochastic general equilibrium models may be highly relevant to the analysis of macroeconomic policy in LDCs.

Our results suggest that the stochastic monetary growth model does offer useful insights into the experiences of Mexico and Indonesia since the early 1970s. For example, we find that once real interest rates are amended to incorporate price shocks explicitly, the additional variance component becomes a crucial component of the rate of return during periods of high and variable prices. Although this is not significant for the United States, with its relatively stable prices, it is generally important for Mexico as well as for Indonesia during the 1970s. After accounting for the variance of inflation, our analysis suggests that the average real rate of return on bonds in Mexico since 1973 was around +7.5 percent rather than –5.4 percent, when this element is ignored. In addition, the Mexican inflation variance shows a clear pattern that reflects the tremendous variation in the degree of risk in the economy, and picks up nicely both the hyperinflation and the debt crisis (1982–90). Although the variance of inflation is smaller in Indonesia than in Mexico, it is larger as a percentage of the mean in Indonesia than in Mexico, and also larger in terms of absolute size in Indonesia than in the United States. Interestingly enough, the inclusion of risk allows us to highlight that not only inflationary but also *disinflationary* episodes can be characterized by high degrees of uncertainty.

With respect to portfolio shares, we find that the model is consistent with the changing composition of domestic and foreign assets held in Mexico. The implied variation in the portfolio shares over time clearly indicates (1) the positive effects of the Brady plan in terms of the return of private capital inflows, (2) the large volume of foreign borrowing by both the Mexican private and public sector, (3) the return of foreign financing, and (4) the deterioration of the current account. The Indonesian portfolio share instead reflects the country's easy and stable access to the world financial market. Throughout the sample period, Indonesia has a higher share of domestic capital in its portfolio than does Mexico. Again we find that the model captures the effects of financial and macroeconomic instability.

While our overall estimates of the growth rate are not particularly successful, it is not too bad over certain subperiods. However, it completely misses the 1982–88 contractionary period in Mexico. Our calibrations suggest that investors were not properly compensated for