Must Original Sin Cause Macroeconomic Damnation?
Luis Felipe Céspedes, Roberto Chang, and Andrés Velasco

Original sin, defined as a country's inability to borrow abroad in its own currency, is arguably the biggest obstacle that emerging markets face today as they endeavor to become more integrated into the world economy. Original sin is increasingly blamed for a host of macroeconomic ills: volatility of capital flows, vulnerable fiscal balances, and instability of investment and output. The basic story is simple enough. Having to borrow in dollars or other major currencies leaves local residents open to exchange rate risk. When the real exchange rate depreciates, for whatever reason, domestic balance sheets suffer. Locals with lower net worth find it harder to borrow abroad, and investment consequently goes down, perhaps pulling output down with it. If the shock is big enough, default and bankruptcy can take place. Understanding how vulnerable domestic corporations and banks are, foreign lenders are jittery, running for the exits at the first sign of trouble. This closes the circle, making both capital movements and exchange rates volatile, and exacerbating domestic exposure to currency risk.

The story is plausible, but it raises as many questions as it answers. First, what exactly is the link between exchange rates, balance sheets, and the capacity to borrow and invest? In the textbook IS-LM-BP model with well-functioning financial markets and perfect international capital mobility, only expectations of future returns, properly arbitraged, guide capital flows and investment; corporate balance sheets and current output levels are irrelevant. This suggests that other financial imperfections must be added to original sin to cause macroeconomic damnation.

Second, how do these assorted financial imperfections interact with exogenous shocks? Does the response depend on the exchange rate regime in place, and how? A plausible conjecture is that the imperfections magnify the effects of shocks, but that the precise magnification mechanism depends quite crucially on the accompanying exchange rate movements.

A third issue has to do with the effects of exchange rates on aggregate demand and output. Even if balance sheet effects are contractionary, standard expenditure switching effects, which obviously have an expansionary effect, are still present. Which one prevails and when?

This chapter investigates these issues. For that purpose we develop a simple general equilibrium open-economy model in which real exchange rates play a central role in the adjustment process, wages and prices are sticky in terms of domestic currency, liabilities are dollarized, and the country risk premium is endogenously determined by the net worth of domestic entrepreneurs, in the manner postulated by Bernanke and Gertler (1989). Hence, all the basic building blocks are there for unexpected real exchange rate movements to be financially dangerous under original sin. In spite of the model's apparent complexity, we obtain an analytic solution for all variables of interest, which can be depicted in terms of three familiar schedules: the IS and the LM, which correspond to equilibrium conditions in the goods and money market, and the BP, along which the international loan market is in equilibrium. This characterization helps to identify exactly how the combination of balance-sheet effects and liability dollarization may lead to departures from the standard framework. We show, for instance, that the effect of financial imperfections is to change the slope of the BP, leaving the IS and LM unchanged. This affects comparative statics and the dynamic reaction of the economy to foreign shocks, and can give rise to results that do not appear in the standard model.

We distinguish between a situation of high indebtedness and the resulting financial vulnerability, so that a real depreciation raises the country risk premium, and one of financial robustness, in which the opposite happens. Vulnerability is likely to occur when capital market imperfections are large (in a sense to be made precise below), when total initial debt is large, and when the dollar share of that debt is also large.

This chapter makes three main points. First, devaluation may be expansionary or contractionary, depending on initial conditions. It is always expansionary in financially robust economies, as it is in standard models without balance-sheet effects. But if the economy is financially vulnerable, several subcases arise. Depending on the extent of vulnerability, devaluation may still expand both output and investment, it may expand output but cause investment to contract, or it may be contractionary for both output and investment.

Second, the precise effect of shocks depends jointly on the exchange rate regime in place and the extent of financial vulnerability. Under financial robustness, flexible exchange rates cushion the effects of adverse shocks, and they are the preferred policy. Under financial vulnerability, exchange rate movements can be stabilizing or destabilizing, as we saw above. The domestic effects of shocks then depend on initial conditions and parameter values, and on the extent policy allows the exchange rate to move. Under extreme financial vulnerability, limiting exchange rate movements may help limit the reaction of domestic output to shocks.

Third, for any exchange rate regime, the effects of external shocks—such as
a fall in export volumes or an increase in the world real interest rate—are magnified by the presence of financial imperfections. The magnification effect is especially sharp under financial vulnerability, high original sin, and flexible exchange rates. Real depreciation and a fall in aggregate demand can exert negative feedback on each other: an initial depreciation reduces net worth sharply when dollar debts are large, pushing the risk premium up and reducing investment. This in turn may cause the relative price of domestic goods to fall (the real exchange rate depreciates even further), causing another round of investment cuts. Toward the end of the chapter, we explore the implications of this analysis for the design of exchange rate policy.

The Model

There are two periods, \( t = 0, 1 \). Labor and capital are supplied by distinct agents called workers and entrepreneurs. Workers work and consume an aggregate of the domestic and foreign good. Entrepreneurs own capital and the firms. In order to finance investment in excess of their own net worth, entrepreneurs borrow from the world capital market. For concreteness, we focus on the effect of temporary shocks only at the start of period 0.

Domestic Production

Production of each variety of domestic goods is carried out by a continuum of firms acting as monopolistic competitors. These firms have access to a Cobb-Douglas technology given by

\[
Y_{jt} = AK_{jt}^{\alpha}L_{jt}^{1-\alpha}, \quad 0 < \alpha < 1,
\]

where \( Y_{jt} \) denotes output of variety \( j \) in period \( t \), \( K_{jt} \) denotes capital input, and \( L_{jt} \) denotes labor input. The input \( L_{jt} \) is a CES aggregate of the services of the different workers in the economy:

\[
L_{jt} = \left[ \int_{0}^{1} \left( L_{ijt}^{-1/\sigma} \right) \, di \right]^{-\sigma},
\]

where workers are indexed by \( i \) in the unit interval, \( L_{ijt} \) denotes the services purchased from worker \( i \) by firm \( j \), and \( \sigma > 1 \) is the elasticity of substitution among different labor types. The minimum cost of a unit of \( L_{jt} \) is given by

\[
W_t = \left[ \int_{0}^{1} W_{ijt}^{-1/\sigma} \, di \right]^{\frac{1}{1-\sigma}},
\]

which can be taken to be the aggregate nominal wage. The \( j \)th firm maximizes expected profits in every period. Profits are given by

\[
\Pi_{jt} = P_{jt}Y_{jt} - \int_{0}^{1} W_{ijt}L_{ijt} \, di - R_tK_{jt},
\]

where \( R_t \) is the return to capital, and profits are expressed in terms of the domestic currency (henceforth called peso), subject to the production function in (1) and the demand for its good,

\[
Y^d_{jt} = \left( \frac{P_{jt}}{P_t} \right)^{-\theta} Y^d_t,
\]

where \( Y^d_t \) must be understood to include demand from domestic consumers and investors and foreign consumers. Cost minimization yields the demand for worker \( i \)'s labor:

\[
L_{ijt} = \left( \frac{W_{ijt}}{W_t} \right)^{-\sigma} L_{jt},
\]

where

\[
L_{jt} = \left[ \int_{0}^{1} W_{ijt}L_{ijt} \, di \right]^{-\frac{1}{\sigma}}.
\]

Cost minimization also requires

\[
R_tK_t = \frac{\alpha}{W_tL_t}.
\]

Finally, firms set prices for their differentiated product as a constant markup over marginal cost. In the symmetric monopolistic competitive equilibrium, prices are set such that

\[
t^{-1}\left( \frac{W_tL_t}{P_tY_t} \right) = (1 - \alpha)\left( \frac{\theta - 1}{\theta} \right),
\]

where, for any variable \( X_t \), the notation \( t^{-1}X_t \) denotes its expectation conditional on information available at \( t - 1 \).

Workers

There is a continuum of workers, whose total "number" is normalized to one. The representative worker has preferences over consumption, labor supply, and real money balances in each period \( t \) given by

\[
\log C_t - \left( \frac{\sigma - 1}{\sigma} \right)\frac{1}{\nu} L_t^\nu + \frac{1}{1 - \delta} \left( M_t^{1-\epsilon} Q_t \right)
\]
where \( v > 1, \varepsilon > 0 \), and \( Q \) is defined as below. The consumption quantity \( C_t \) is an aggregate of home and imported goods:

\[
C_t = k(C^H_t)^{\gamma}(C^I_t)^{\varepsilon - \gamma},
\]

where \( C^H_t \) denotes purchases of a basket of the different varieties of goods produced domestically, \( C^I_t \) purchases of the imported good, and \( k = \left[ \gamma \varepsilon (1 - \gamma)^{1-\gamma} \right]^{-1} \) is a constant.

Assume that domestically produced goods are aggregated through the CES function

\[
C^H_t = \left[ \int_0^1 C^H_t \cdot \frac{1}{\theta} \, d\theta \right]^{\frac{1}{\theta}}, \theta > 1.
\]

Assume also that the imported good has a fixed price, normalized to one, in terms of a foreign currency, which we shall refer to as the dollar. Imports are freely traded and the law of one price holds, so that the peso price of imports is equal to the \textit{nominal exchange rate} of \( S_t \) pesos per dollar.

The only asset that workers can hold is money. Then, in every period \( t \), the \( i \)th worker's choices are constrained by

\[
Q_t C_t = P_t C^H_t + S_t C^I_t = W_t L_t + T_t - M_t + M_{t-1},
\]

where \( P_t \) is the peso price of one unit of the basket of domestically produced goods, given by

\[
P_t = \left[ \int_0^1 P_t^{\varepsilon - \gamma} \, d\theta \right]^{\frac{1}{\varepsilon}}.
\]

and \( Q_t \) is the minimum cost of one unit of aggregate consumption, or CPI:

\[
Q_t = P_t^{1/\gamma}. \varepsilon
\]

Fiscal policy is as simple as can be: inflation tax revenues are rebated to workers through lump-sum transfers:

\[
M_t - M_{t-1} = T_t,
\]

where \( M_t = \int_0^1 M_d \, d\theta \). This assumption ensures that, in the symmetric equilibrium, workers consume their nominal income:

\[
Q_t C_t = W_t L_t.
\]

Purchasing consumption at minimum cost requires

\[
\left( \frac{1 - \gamma}{\gamma} \right) C^H_t = \frac{S_t}{P_t} = E_t,
\]

where absence of the subscript \( i \) indicates that we have imposed symmetry in equilibrium. Notice that \( E_t \) is the price of foreign goods in terms of domestic goods, or the \textit{real exchange rate}.

Each worker optimally supplies labor to equate his marginal disutility of labor to its marginal return. Our assumptions on preferences then ensure that

\[
t^-1 L^e_t = 1
\]

in equilibrium.

Next adopt the convention that no subscript indicates an initial period variable, while a subscript 1 indicates a final period variable. Money demands in periods 0 and 1 are then given by

\[
\left( \frac{M}{Q} \right)^e + \beta \frac{1}{C} \frac{Q}{Q_1} = \frac{1}{C}
\]

and

\[
\left( \frac{M_1}{Q_1} \right)^e = \frac{1}{C}.
\]

Entrepreneurs

Entrepreneurs borrow from abroad in order to finance investment. Assume that entrepreneurs start with some inherited debt repayments, due at the end of the period 0. Some fraction of debt repayments is denominated in pesos, and the rest is denominated in dollars. After debt repayments, these entrepreneurs borrow from the world capital market in order to finance investment in excess of their own \textit{net worth}. Since we do not consider shocks in the second period, we can assume without loss of generality that all new debt contracts (running from period 0 to 1) are denominated in dollars. Because of imperfections in financial markets, entrepreneurs are required to pay a risk premium over the risk-free interest rate (as in Bernanke and Gertler 1989).

Capital for next period is produced by combining home goods and imports. For simplicity, assume that capital is produced in the same fashion as consumption in equation (11). Therefore, the cost of producing one unit of capital available in period 1 is \( Q \). The entrepreneurs' budget constraint in period 0 is therefore

\[
PN + SD_1 = Q_1,
\]

where \( N \) stands for net worth, \( D_1 \) denotes the amount borrowed abroad in period 0 (to be repaid in period 1), and \( I = K_1 \) is investment in period 1 capital.

Net worth plays a crucial role because the interest cost of borrowing abroad is not simply the world safe rate \( r \). Entrepreneurs borrow abroad paying a pre-
mium \eta above this risk-free interest rate. Assume that the risk premium is increasing in the ratio of the value of investment to net worth (or what is the same, in the ratio of debt to net worth), with the following functional form:

\[(23) \quad 1 + \eta = \left( \frac{Q}{PN} \right)^{\mu} = \left( 1 + \frac{ED_1}{N} \right)^{\mu}, \mu \geq 0.\]

For a derivation of this relationship from an underlying contract environment with imperfect information and costly monitoring, see Céspedes, Chang, and Velasco 2000.

Capital depreciates completely in production. In equilibrium, the expected dollar yield on capital must equal the cost of foreign borrowing,

\[(24) \quad \frac{R_1}{Q} = (1 + \rho)(1 + \eta)\left( \frac{S_1}{S} \right).\]

Given that entrepreneurs own local firms, rental on capital is not the only income they receive. They also get the profits resulting from the monopoly power of firms. Entrepreneurs’ net worth therefore is

\[(25) \quad PN = RK + \Pi - SD^* - D = PY - WL - SD^* - D,\]

where \(\Pi\) is firm profits in pesos, \(D^*\) dollar debt repayment, and \(D\) peso-denominated debt repayment.

Equilibrium

Market clearing for the home goods require that domestic output be equal to demand. In period 0, the market for home goods clears when

\[(26) \quad Y = \gamma \left( \frac{Q}{P} \right)(I + C) + E^X X.\]

Notice \(E^X X\) stands for the home-good demand by the rest of the world, where \(X > 0\).

Given that period 1 is the final period, there is no investment then. Assuming that entrepreneurs consume only foreign goods, the market-clearing condition for the second period is

\[(27) \quad P_1 Y_1 = \gamma Q_1 C_1 + E^X_1 P_1 X_1.\]

This last equation can be simplified further, since workers consume all their income each period:

\[(28) \quad Y_1 = \tau E^X_1 X_1,\]

where \(\tau = [1 - \gamma(1 - \alpha)(1 - \theta^{-1})]^{-1} > 1.\)

Linearization

The appendix establishes conditions under which there is a unique equilibrium when shocks are identically zero. The crucial condition is that financial imperfections, as captured by the parameter \(\mu\), cannot be too big. We will assume from here on that those conditions are satisfied.

The next step consists in obtaining log-linear approximations of the model around the no-shock equilibrium. We start by deriving the equilibrium relations in period 1. The first relation is the log-linear version of equation (17):

\[(29) \quad q_1 + c_1 = w_1 + l_1,\]

(Lowercase letters denote log deviations from the no-shock equilibrium.) Equation (9) shows that wage income in period 1 is a fraction of the total revenue. Therefore,

\[(30) \quad p_1 + y_1 = w_1 + l_1.\]

Combining these two equations, we obtain

\[(31) \quad c_1 = y_1 - (q_1 - p_1) = y_1 - (1 - \gamma)e_1.\]

Assuming no export shocks in period 1, the log-linear version of the market-clearing condition for period 1 is

\[(32) \quad y_1 = \chi e_1.\]

Putting these last two equations together, we obtain

\[(33) \quad c_1 = (\gamma + \chi - 1)e_1.\]

Because under no shocks labor supply is fixed at one (recall the first-order condition for labor supply), we have

\[(34) \quad Y_1 = \alpha i.\]

Combining this with (32) we have

\[(35) \quad \left( \frac{\alpha}{\chi} \right) i = e_1.\]

Pulling together these results, we arrive at

\[(36) \quad c_1 = (\gamma + \chi - 1)\left( \frac{\alpha}{\chi} \right) i.\]

We can now solve the model in the initial period. The log-linear version of the resource constraint in period 0 is

\[(37) \quad \tau y + (1 - \tau)(q + c) = \lambda(q + i) + (1 - \lambda)(\chi e + x),\]
where \( \lambda = \gamma Q \bar{I}/(\gamma Q \bar{I} + \bar{E} \bar{X}) < 1 \) and where, due to the assumption that prices are set one period in advance, \( p = 0 \).

Given that capital is a predetermined variable in period 0, deviations of output from its no-shock equilibrium will be matched by changes in labor only:

\[
y = (1 - \alpha)l.
\]

Log-linearizing equation (17), we have \( q + c = l \), since the nominal wage is preset. Combining these two equations, we arrive at

\[
q + c = \frac{y}{1 - \alpha}.
\]

Substituting this last relation and \( q = (1 - \gamma)e \) into (35) and reordering, we obtain the IS curve:

\[
y = \tau [1 - \gamma (1 - \theta^{-1})]^{-1}[\lambda i + [\chi + \lambda (1 - \gamma - \chi)]e + (1 - \lambda)x].
\]

For a given \( e \), the IS schedule slopes up in \((i, y)\) space, and its position in that space depends on the export shock \( x \). A real devaluation (an increase in \( e \)) must increase \( y \), given \( i \), and the benefits of devaluation on current output naturally increase with \( \chi \).

In order to derive the effects of monetary policy, we log-linearize money demand in each period, given by equations (20) and (21). The resulting relations are

\[
e(\bar{m}_1 - q_1) = c_1
\]

and

\[
ev_0(m - q) + (1 - \omega)(c_1 + q_1 - q) = c_0
\]

where \( \omega = 1 - \beta(Q_C)/(Q_C \bar{C}_t) \). Note that \( \omega \) is between 0 and 1 as long as the growth of nominal consumption is not too negative, which we assume from now on. The parameter \( e^{-1} \) can be interpreted as the elasticity of money demand with respect to consumption expenditures. Using (34) and (37) to substitute out the consumptions and rearranging, we have the LM schedule:

\[
m = \frac{y}{\omega(1 - \alpha)} - (e^{-1} - 1)(1 - \gamma)e
\]

\[- (\omega^{-1} - 1)e^{-1}(\gamma + \chi - 1)\left(\frac{\alpha}{\chi}\right)i.
\]

The final block of equations to be solved is the one associated with the entrepreneurs. The log-linear version of the arbitrage relation (equation [24]) is

\[
(r_t - p_t) - q = \rho + \eta + e_t - s,
\]

while the log-linear version of (8) and (30) yield \( r_t - p_t = -(1 - \alpha)i \). Using this, the identity \( q = (1 - \gamma)e \), and (33) we have

\[
(1 - \alpha + \frac{\alpha}{\chi})i = - (\rho + \eta + \gamma e).
\]

The log-linear version of the equation for the risk premium (23) is

\[
\eta = \mu [(1 - \gamma)e + i - n],
\]

which is obtained using the fact that \( q = (1 - \gamma)e \). The log-linear version of net worth equation (25) is

\[
n = \theta^{-1}[1 - (1 - \alpha)(1 - \theta^{-1})]^{-1}[(1 + \psi)y - \phi \psi e],
\]

where \( \psi = D^f/N > 0 \), \( D^f = D + SD^f \) is the total initial debt in units of the home good, and \( \phi = SD^f/PD^f \) is the share of dollar-denominated debt in total (initial) debt. Note that when \( \psi \) is large, total initial debt is also large relative to net worth. If initial dollar-denominated debt is zero, then real devaluations have no effect on net worth.

Combining the last set of equations, we obtain the BP curve:

\[
i = [1 - \alpha + \alpha \chi^{-1} + \mu]^{-1}
\]

\[
\times \{- \rho + \theta^{-1} [1 - (1 - \alpha)(1 - \theta^{-1})]^{-1}[(1 + \psi)y - \phi \psi e] + \mu (1 + \psi)y + (\gamma - \mu (1 - \gamma + \phi \psi)]e}.
\]

Quite naturally, investment is decreasing in the world rate of interest. The other two terms are more novel. Investment increases with output only if capital markets are imperfect \( (\mu > 0) \), since higher output increases net wealth and reduces the risk premium. Hence the BP curve slopes up in \((i, y)\) space for a given real exchange rate, and the intercept depends on the shock to the world interest rate. If \( \mu = 0 \), the BP is horizontal.

Investment may be increasing or decreasing in the real exchange rate. Standard arbitrage forces described above push for an increasing relationship: a higher \( e \) makes borrowing abroad cheaper. But the balance-sheet effect pushes in the opposite direction: a higher \( e \) means a higher value of debt payments and, hence lower net worth and higher risk premia. It helps to give the possible cases a name. If in BP equation (46) the coefficient on \( e \) is positive, we have a financially vulnerable economy. If the coefficient is negative, we have a financially robust economy. Notice that financial vulnerability is more likely when the risk premium is very sensitive to the investment expenditure–net worth ratio (large \( \mu \)); the inherited ratio of total debt to net worth is high (large \( \psi \)); the share of dollar debt in total debt is high (large \( \phi \)); and the share of domestically produced goods in the investment and consumption aggregate is low (small \( \gamma \)). Notice that if initial dollar debt is zero (so that \( \psi = 0 \)), devaluation can only
reduce investment via its effect on input costs: a real devaluation increases the cost of generating one unit of capital (in units of the home good), and therefore increases the risk premium for any given level of net worth. But if capital is produced only using home goods \((\gamma = 1)\) or if capital markets are perfect \((\mu = 0)\), this effect disappears.

**Equilibrium under Alternative Exchange Rate Regimes**

If the exchange rate floats (assuming predetermined output prices), expressions \((38), (41), \) and \((46)\) are three equations in three unknowns: output \(y\), investment \(i\), and the real exchange rate \(e\), for a given money supply and exogenous shocks. Alternatively, if the exchange rate is fixed, \(e\) becomes policy-determined in the short run, and \((38)\) and \((46)\) pin down equilibrium investment and output. In turn, \((41)\) yields the level of the money supply necessary for that particular equilibrium to obtain.\(^4\)

**Shocks, Policies, and Their Effects**

In the two subsections that follow, we assume a fixed (but adjustable) exchange rate, so that we can solve the model diagrammatically in \((i, y)\) space. We use that solution to perform comparative statics and analyze the effects of unexpected external shocks and of an unexpected devaluation on equilibrium output and investment. Later we consider the effects of shocks under flexible exchange rates.

**External Shocks under Fixed Exchange Rates**

Consider first the effects of a fall in current exports, depicted in figure 2.1. The shock shifts the IS up and to the left, so that for each level of investment, there is now a smaller corresponding output level. The new intersection is at point A, with lower investment and output than in the steady state. The output fall is as in the standard model with perfect capital markets and no balance-sheet effects, but the fall in investment is not. In that model, a fall in exports today does not affect the profitability of capital tomorrow, and hence it leaves investment unchanged. That is what happens in our model in the special case \(\mu = 0\), so that the BP curve is horizontal. Notice that with stronger balance-sheet effects (larger \(\mu, \phi, \text{ and } \psi\)), the BP becomes steeper, magnifying the adverse effects on both investment and output.

Consider now the effects of a one-period increase in the world rate of interest. In figure 2.2 the shock shifts the BP down and to the right, so that investment is lower for each output level. The result is lower investment and output, as at point A. This is qualitatively as it would be in the standard model with perfect capital markets and a horizontal BP curve, but quantitatively there is a difference: for the same downward shift, the steeper the BP the larger the
reduction in investment and output. The capital market imperfections and resulting balance-sheet effects magnify the real effects of adverse interest rate shocks. 5

Next we put some numbers on these comparative statics exercises. This calibration should not be interpreted as a “real business cycle” exercise. Our purpose is only to illustrate and add some quantitative dimension to the previous analysis. We set the structural parameters of the economy to generate three different cases. One case has no financial frictions, so the presence or absence of original sin is irrelevant. The other two do feature financial frictions and differ only in the share of debt that is denominated in dollars: with full dollarization we have a situation of mortal sin, while with a small share of the debt in domestic currency we have merely venial sin. Table 2.1 displays the assumptions regarding the main parameters of the model.

Table 2.1. Parameter values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No financial frictions; original sin irrelevant</th>
<th>Financial frictions</th>
<th>Mortal sin</th>
<th>Venial sin</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha )</td>
<td>0.30</td>
<td>0.30</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>( \chi )</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>( \beta )</td>
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<td>0.99</td>
<td>0.99</td>
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<tr>
<td>( \theta )</td>
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<td>2.00</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>( \gamma )</td>
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<td>0.45</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>( \mu )</td>
<td>0.00</td>
<td>0.20</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>( \epsilon )</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>( \lambda )</td>
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<td>0.42</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>( \psi )</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>( \phi )</td>
<td>1.00</td>
<td>0.95</td>
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Table 2.2. Fixed exchange rates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No financial frictions</th>
<th>Financial frictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
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<td>-2.00</td>
</tr>
<tr>
<td>Investment</td>
<td>-0.76</td>
<td>-3.05</td>
</tr>
</tbody>
</table>

Note: Response to a 1 percent increase in world interest rate.
risk premium; in turn, this pulls down investment and aggregate demand. If the standard demand-switching effects of devaluation are not sufficiently strong, the overall impact can be contractionary.

Again, notice that none of this could happen with perfect capital markets. In that case, the BP is horizontal and shifts up after a real devaluation. The only possible outcome is an increase in both investment and output.

Next we simulate some examples, using the same underlying parameters as in the earlier simulations but stressing the role of different degrees of original sin. Table 2.3 shows the effects on output and investment of an unexpected 1 percent devaluation.

Table 2.3. Surprise devaluation

<table>
<thead>
<tr>
<th>Financial frictions (%)</th>
<th>No financial frictions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortal sin</td>
<td>0.00</td>
</tr>
<tr>
<td>Venial sin</td>
<td>-1.09</td>
</tr>
<tr>
<td>Output</td>
<td>1.02</td>
</tr>
<tr>
<td>Investment</td>
<td>-0.35</td>
</tr>
</tbody>
</table>

Note: Response to a 1 percent unexpected devaluation.

Without financial frictions, the devaluation expands both output and investment, as in a conventional Mundell-Fleming model. When the economy does display financial frictions, the outcome depends on the extent of original sin. With venial sin, the devaluation expands output by 0.3 percent but reduces investment by nearly 0.8 percent: the presence of financial vulnerability makes the BP shift down, moving the equilibrium to a point like B in figure 2.4. With mortal sin, output is unchanged while investment falls more: almost 1.1 percent. This underscores the role of original sin in determining the real effects of exchange rate policy.

External Shocks under Flexible Exchange Rates

Turn next to the case of flexible exchange rates, which we define as a regime in which the money supply is constant and the nominal (and real) exchange rate adjusts endogenously. Now the equilibrium involves, as pointed out above, the solution to three equations in three unknowns, so a simple diagrammatic presentation is not feasible. Instead, we go directly to a simulation. Since the LM schedule now comes into play, we have to assume a value for the elasticity of money demand (e⁻¹), which we set equal to 2.5.

Table 2.4 presents the effects of a 1 percent increase in the world interest rate under the constant money rule. A first striking result is that this rule implies little endogenous movement in the exchange rate in the robust economy (extreme case with no financial frictions at all), but much larger movements in the vulnerable economy—especially so if sin is mortal. Effects on output and investment differ accordingly.

In the economy without frictions, flexibility in the exchange rate has a stabilizing role. Comparing this outcome with that of the same shock under fixed rates (recall table 2.2), we see that the small depreciation under floating reduces the fall in output from 0.5 percent to almost zero, and dampens the investment contraction slightly.

Things are more complicated if the economy does have frictions and sin is mortal, leading to extreme vulnerability. The endogenous depreciation is large (19 percent), causing a mild recession (output falls by 0.4 percent) and a collapse of investment (it falls by 24 percent). If sin is merely venial, the depreciation is milder, output is practically constant, and the drop in investment is held down to 7.9 percent. Compared with the response to the same shock under a fixed exchange rate, we see that now the output fall is smaller, regardless of the degree of sin. But the cost of the depreciation is a much larger fall in investment,

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Table 2.4. Constant-money rule

<table>
<thead>
<tr>
<th>Financial frictions (%)</th>
<th>No financial frictions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortal sin</td>
<td>19.00</td>
</tr>
<tr>
<td>Venial sin</td>
<td>6.31</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>-0.48</td>
</tr>
<tr>
<td>Output</td>
<td>-0.01</td>
</tr>
<tr>
<td>Investment</td>
<td>-0.60</td>
</tr>
</tbody>
</table>

Note: Response to a 1 percent increase in the world interest rate.
with the difference in the case of mortal sin being very substantial. This suggests that investment is particularly sensitive to the share of dollar debt in total indebtedness.

With original sin, the real depreciation and the fall in investment exert negative feedback on each other, a factor that helps explain the magnitude of the equilibrium movements in both variables. An initial depreciation reduces net worth sharply when dollar debts are large, pushing the risk premium up and reducing investment. If, on the other hand, the real depreciation does not increase exports much (because the price elasticity of exports is low, as assumed in the vulnerable economy), then total demand falls for domestically produced goods. This in turn causes the relative price of domestic goods to fall (the real exchange rate depreciates even further), causing another round of investment cuts and so on, until the system finally settles on a much lower investment rate and a sharply depreciated exchange rate.

Implications for the Exchange Rate Regime
The extent to which this cycle plays itself out, of course, depends on the reaction of monetary policy. In the example above, money is constant in response to the shock. But if policymakers fear these contractionary effects of depreciation, then they might try to limit it by manipulating monetary policy, thus giving rise to fear of floating. The model presented here has stark positive implications for the choice of exchange rate regimes. If output and investment stabilization are paramount objectives, one should observe countries with mortal sin (Argentina? Uruguay?) trying to limit exchange rate movements, so that their observed reaction to shocks would resemble that of table 2.2. Countries with only venial sin (Chile, Brazil) would welcome the endogenous movements in the real exchange rate, in which case their observed reaction to shocks would resemble that of table 2.4, last column on the right. Venial sin allows these latter countries to enjoy stabilizing effects of exchange rates (at least as far as current output is concerned) that are not available to irredeemable sinners.

This all leaves open the question of normative rules to guide optimal monetary and exchange rate policy. Optimality involves a lot more than output and investment stabilization. And there may be intertemporal trade-offs that the informal discussion above ignores. In Céspedes, Chang, and Velasco (2000) we have identified conditions for floating to be welfare-maximizing in a model much like the one in this paper. There we show that floating can be optimal even with mortal sin as long as domestic and foreign goods are sufficiently substitutable in consumption and investment. Computing optimal policies for other, more complex model economies remains to be done.

Conclusions
Must original sin bring macroeconomic damnation? No, but it just might. Perhaps the most striking implication of the model presented in this chapter is that—with financial imperfections—macroeconomic outcomes depend crucially on the extent of original sin.

But while all sinful economies are equal in this respect, some are more equal than others. We have seen that other factors—the size of total debt regardless of currency denomination, the sensitivity of the risk premium to debt levels, the degree of openness of the economy, the price elasticity of demand for exports—all matter in determining how the economy will react to shocks, including unexpected movements in the real exchange rate. There may be cases in which sinful economies can use the exchange rate to offset shocks, as in the textbooks.

The model presented here simplifies perhaps a bit too much. Other links between financial imperfections and the real exchange rate may also prove crucial. Here local capitalists borrow to invest, so financial imperfections affect the demand for investment and indirectly the real exchange rate. This leaves room for monetary policy to affect aggregate demand and potentially play a stabilizing role. Alternatively, local producers could borrow abroad to pay for productive inputs. In that case, shocks that affected the risk premium (for instance, by lowering net worth) would cut domestic supply of goods directly, making it harder for aggregate demand policies to play a useful role. This is an important issue to explore in future work. 7

Appendix
No-Shock Equilibrium
Suppose that all shocks are identically zero, and let overbars denote no-shock equilibrium values. Then, from (19)

$$ L = \bar{L} = 1. $$

(Subscripts indicate future period values.) Hence, domestic production is

$$ \bar{Y} = AK^n, \bar{Y}_1 = AK^n_1, $$

and (28) is

$$ \bar{Y}_1 = \tau \bar{E}_1 X_1. $$

Next, note that if there are no shocks,


(49) \[
Q_C = (1 - \alpha) \left( \frac{\theta - 1}{\theta} \right) P Y,
\]

so the goods market equilibrium condition for the domestic good becomes

(50) \[
[1 - \gamma(1 - \alpha)(1 - \theta^{-1})] \bar{Y} = \gamma \bar{E}^{1-\gamma} \bar{K}_1 + \bar{E}^{\gamma} \bar{X}.
\]

Since \( \bar{Y} \) is given by \( AK^\alpha \), equation (50) is a relation between the no-shock values of \( \bar{E} \) and \( \bar{K}_1 \). It is a schedule that slopes down in \( (\bar{K}_1, \bar{E}) \) space.

For a second schedule, write the interest parity condition (24) as

(51) \[
\frac{\bar{R}_1 \bar{K}_1 / \bar{P}_1}{Q \bar{K}_1 / \bar{P}_0} = (1 + \rho) \left( \frac{Q \bar{K}_1}{PN} \right)^{\mu} \frac{\bar{E}_1}{\bar{E}}.
\]

Note now that \( \bar{R}_1 \bar{K}_1 = \alpha(1 - \theta^{-1}) \bar{P}_1 \bar{Y}_1 \), and use (47), (48), and (25) to get

\[
\alpha(1 - \theta^{-1})(\tau \bar{X})^{1/\mu} \left( AK_1^\alpha \right)^{1-1/\mu} = \frac{(1 + \rho) E^{1-\gamma(1+\mu)-1} K_1^{1+\mu}}{\left( [1 - (1 - \alpha)(1 - \theta^{-1})] \bar{Y} - \bar{E} D + \bar{D} \bar{P} \right)^{\mu}}.
\]

This is the no-shock BP. Note that because \( \bar{Y}, \bar{D}, \) and \( \bar{D}/\bar{P} \) are given, the preceding equation is also a relation between \( \bar{E} \) and \( \bar{K}_1 \).

This is a complicated expression. However, note that if \( \mu \) is zero, this curve must start from the origin and slope up in \( (\bar{K}_1, \bar{E}) \) space. Hence, if it intersects the no-shock IS, the intersection must be unique. By continuity, there is a unique no-shock equilibrium if \( \mu \) is not too large.

Notes

We are grateful to Barry Eichengreen, Ricardo Hausmann, Carmen Reinhart, and seminar participants for comments, and to the National Science Foundation and the Harvard Center for International Development for generous financial support.

1. The term original sin was coined by Eichengreen and Hausmann (1999). Calvo (1999) and Hausmann et al. (2000) were among the first to warn about the dangers of dollarization of liabilities. See also Krugman (1999) and Calvo and Reinhart (2002).

2. An additional issue, which we do not study in detail here, is the uniqueness of equilibrium. The story in which exchange rate movements cause an economic contraction, which in turn causes capital outflows and exchange rate movements, has a strong flavor of self-fulfilling expectations. When are crises prompted by the shift to a "bad" equilibrium possible? For an analysis, see Velasco 2001; Cespedes, Chang, and Velasco 2000; Aghion, Bacchetta, and Banneroj 2000; and Krugman 1999.

3. Note that a bar over a variable denotes its no-shock equilibrium level.

4. Recall that these are percentage deviations from the no-shock steady state, holding prices and wages constant. Without nominal stickiness, output is exogenous (pinned down by the inherited capital stock and by equilibrium labor supply \( l = 0 \)), the IS and BP pin down the equilibrium real exchange rate for a given output level, and the LM only determines the price level.

5. The same is true of export shocks.

6. Notice that the presence of financial imperfections has ambiguous effects on the size of the expansion. On the one hand, having \( \mu > 0 \) and \( \delta \) large reduces the size of the vertical shift in the BP; on the other hand, a large \( \mu \) increases the slope of the BP, which magnifies the equilibrium impact of any depreciation.

7. We are thankful to Mick Devereux for making this point.

References


7. We are thankful to Mick Devereux for making this point.