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ABSTRACT

We study the relation among exchange rates, balance sheets, and macroeconomic outcomes in a small open economy. Because liabilities are "dollarized," a real devaluation has detrimental effects on entreprenurial net worth, which in turn constrains investment due to financial frictions. But there is an offsetting effect, int hat devaluation expands home output and the return to domestic investment, which are also components of net worth. We show that the impact of an adverse foreign shock can be strongly magnified by the balance sheet effect of the associated real devaluation. But the fall in output employment, and investment is stronger under fixed exchange rates than under flexible rates. Hence the conventional wisdom, that flexible exchange rates are better absorbers of real foreign shocks than are fixed rates, holds in spite of potentially large balance sheet effects.

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1 Introduction

Any economics undergraduate worthy of a B learns this key policy implication of the Mundell-Fleming model: if an economy is predominantly hit by foreign real shocks, flexible exchange rates dominate fixed rates.[1] The basic logic is due to Milton Friedman (1953): nominal rigidities make it both faster and less costly to adjust the nominal exchange rate in response to a shock that requires a fall of the real exchange rate. The alternative is to wait until excess demand in the goods and labor market pushes nominal wages and goods' prices down, with the consequent decline in output and employment.

This basic policy prescription is still found in textbooks and continues to be taught to undergraduates, but has come under attack recently from both academic economists and policy gurus. The real-world trigger for this shift, of course, was the Asian crisis. Countries that, like Indonesia, let their exchange rates go early on endured substantial real depreciations and seemed, at least at first, to more troubled than those that held on. An overshooting exchange rate was blamed for debt-service difficulties, bank and corporate bankruptcies and, in some cases, rising inflation.

The academic onslaught includes the work of Calvo (1999 and 2000), Krugman (1999 and 2000), Stein, Hausmann, Gavin, and Pagés-Serra (1999), and Aghion, Bachetta and Banerjee (1999). Details differ, but most arguments are built upon the following blocks:

The transfer problem: external shocks, such as a fall in export demand, may require large real devaluations to restore equilibrium to external accounts.

Dollarization of liabilities: if debts are denominated in dollars while firms depend on local currency revenues (or, more precisely, revenues increase with the relative price of goods produced at home), sharp and unexpected changes in relative prices matter for financial stability.

Balance sheets and risk premia: if a sharp devaluation wreaks havoc with bank and corporate balance sheets, country risk premia will increase.

This combination causes, in some cases, the domestic effects of external shocks to be magnified and made persistent. In others, it opens the door to multiple equilibria, so that the expectation of a large devaluation causes one to occur and damage financial health enough to justify the initially pessimistic expectations. But in most cases sudden depreciations turn out to

[1] See Flood and Marion (1982) and Aizenman and Frenkel (1985), among many others.

be contractionary, not expansionary as in the Mundell-Fleming model. The insulating role of flexible exchange rates allegedly disappears.

In this paper we investigate under which conditions, if any, this currently fashionable conclusion holds. To this end, we build a model of a small open economy in which real exchange rates play a central role in the adjustment process, wages are sticky,[2] liabilities are "dollarized," and the country risk premium is endogenously determined by the net worth of domestic entrepreneurs. Hence all the basic building blocks are there for unexpected real exchange rate movements to be financially dangerous, and for flexible exchange rates to be destabilizing. Nonetheless we show, somewhat surprisingly, that the Mundell-Fleming logic survives pretty much unscathed. Flexible exchange rates do play an insulating role in the presence of real external shocks, except in one case that is theoretically possible but empirically implausible.

We are led to these conclusions in spite of the presence of balance sheet effects. Balance sheet effects *do* matter a great deal in our model, in that they magnify the effects of foreign disturbances. Indeed, we can distinguish between a situation of high indebtedness and the resulting *financial fragility*, so that a real depreciation raises the country risk premium; and one of *financial robustness*, in which the opposite happens. The magnification effect is especially pronounced under financial fragility because endogenous increases in country risk have lasting and potentially large effects on domestic variables. But regardless of which of these two situations the economy finds itself in, fluctuations in home output and investment are larger and more persistent under fixed than under flexible exchange rates.

We consider shocks to the world real interest rate and to world demand for the country's exports. In both cases, the impact real depreciation is larger under flexible rates. This extra depreciation turns out to be "expansionary" in that it moderates the output effects of the shock. Two standard mechanisms turn out to be essential:

Real exchange rates and real interest rates: Having fixed exchange rates does not mean that real depreciations are completely avoided; instead, they are spread differently through time. In our model, adverse external shocks cause a larger *impact* real depreciation under flexible rates, but a larger *expected* real depreciation under fixed rates. *Ceteris paribus,* this causes domestic real interest rates to be higher under a peg, adversely affecting

[2]This turns out to be simpler, but sticky prices would play a similar role.

current investment and future output.

Real exchange rates and real wages: Under fixed rates, an impact real depreciation, however small, can only be achieved via *deflation*. With sticky wages, this means that the real wage goes up temporarily, and output and employment fall. This does not occur under flexible rates.

In addition, the model features novel and interesting links between exchange rates, the financial sector, and the real economy:

Real exchange rates and net worth: it is true that, after a shock, the initial devaluation of the exchange rate reduces net worth since debt is denominated in dollars. This could suggest that net worth is lower in the case of floating. But that conclusion would be wrong, because this is not the whole story. Under fixed exchange rates, there is also a real depreciation, albeit smaller than under floating, caused by deflation. In addition, net worth is affected negatively by the initial fall in output that takes place under a peg. The net result is that net worth is always lower under fixed rates.

Real exchange rates and risk premia: in the model below, risk premia depend on the ratio of current investment to firms' net worth. But of these are affected in complex ways by changes in the real exchange rate. We have seen that net worth is always higher under a float. But the domestic value of current investment is also always higher under a float. The net effect could in principle go either way. In our simple setup it turns out these effects exactly offset each other, so that risk premia are the same across exchange rate regimes. This in spite of the initial larger increase in debt service under flexible rates.

Real exchange rates and external debt: under flexible rates, unexpected real depreciations can in fact cause the *ex post* real rate of interest to jump up, thus tending to increase subsequent debt accumulation. But this does not mean that, following a shock, debt is necessarily higher under a float. Risk premia need not increase more, as we have seen. And a more depreciated real exchange rate can reduce the import content of domestic investment, which in turn tends to limit debt growth.

In short: the connections among real exchange rates, net worth and risk premia are complex, and much of the recent policy debate misses this complexity altogether. Once the different effects are tallied up, it turns out that net worth and risk premia perform no worse under flexible exchange rates, while home output is higher.

The model below is quite rich, with an infinite horizon, optimizing firms and households, and endogenous risk premia à la Bernanke and Gertler

(1989). Nonetheless we are able to obtain closed form solutions for all variables of interest, so that the previous claims can easily be proven analytically. In this sense, our solution methods are similar in spirit the those emphasized by Obstfeld and Rogoff (1995) and may be of independent interest, as they can be used in a variety of settings.

The paper is organized in the following way. The next section lays down the basic model, while section 3 studies the characteristics of the steady state and of convergence to it. Section 4 offers an analytical treatment of the reaction of the economy to a shock in the world real interest rate, assuming that all nominal prices and wages are flexible. In section 5 we adapt the analysis to the case of sticky wages, and compare regimes of flexible and fixed exchange rates. In section 6 we simulate the model for two different parameter configurations (corresponding to financially fragile and robust economies) and for a larger set of shocks. Section 7 concludes. Some technical material is deferred to an appendix.

2 The Model

We study an infinite-horizon, small and open home economy. In this economy a single good is produced by competitive firms using labor and capital, and is exported or sold to domestic agents. Labor and capital are supplied by distinct agents called workers and capitalists. These agents consume and, in the case of capitalists, invest an aggregate of the home good and a single imported good.

Capitalists finance investment in excess of their own net worth by borrowing from foreigners. The key aspect of the model is that the cost of borrowing depends inversely on net worth relative to the amount borrowed. In this way the model incorporates the "balance sheet effects," emphasized by Bernanke and Gertler (1989) and many papers since.

2.1 Domestic Production

Production of the home good is carried out by competitive firms, which take all prices as given, and have access to a common technology:

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha},\ 0 < \alpha < 1 \tag{1}$$

where Y_t denotes home output in period t, K_t denotes capital input, L_t denotes labor input, and A is a positive constant.

We assume, as in Obstfeld and Rogoff (2000), that workers are heterogeneous. As a consequence, the input L_t is an aggregate of the services of the different workers in the economy. A simple specification capturing this idea is that L_t is a CES aggregate

$$L_t = \left[\int_0^1 L_{it}{}^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}, \ \sigma > 1, \tag{2}$$

where we have indexed workers by i in the unit interval, and L_{it} denotes the services purchased from worker i. Under this specification, σ is the elasticity of demand for worker i's services.

In every period, the representative firm's problem is to maximize profits, given by

$$P_t Y_t - R_t K_t - \int_0^1 W_{it} L_{it} \, di$$

subject to 1 and 2, where P_t is the price of the home good, R_t the rental rate of capital, and W_{it} worker i's wage rate, all expressed in terms of the domestic currency (henceforth called *peso*).

The solution to this problem is standard. The minimum cost of a unit of L_t is given by

$$W_t = \left[\int_0^1 W_{it}{}^{1-\sigma} di \right]^{\frac{1}{1-\sigma}} \tag{3}$$

which can be taken to be the aggregate wage. With this definition, factor demands will be such that, in equilibrium, factor prices equal marginal productivities:

$$\frac{R_t}{P_t} = \alpha \frac{Y_t}{K_t} \tag{4}$$

$$\frac{W_t}{P_t} = (1-\alpha) \frac{Y_t}{L_t} \tag{5}$$

In addition, cost minimization yields the demand for worker i's labor:

$$L_{it} = \left(\frac{W_{it}}{W_t} \right)^{-\sigma} L_t \tag{6}$$

Finally, profits are zero in equilibrium.

2.2 Workers

As already noted, labor services are imperfect substitutes of each other; workers are identical otherwise. As a consequence, each worker enjoys some monopoly power over the services he provides. We assume that, as in Dixit and Stiglitz (1977), the market for labor is characterized by monopolistic competition. This will allow for an explicit and relatively simple introduction of nominal wage rigidities and a role for monetary policy.

Worker i 's preferences are given by

$$_0\left[\sum_{t=0}^{\infty}\left\{\log C_{it}-\left(\frac{\sigma-1}{\sigma\upsilon}\right)L_{it}^{\upsilon}\right\}\beta^t\right] \tag{7}$$

where $\upsilon > 0$ is the elasticity of labor supply, and we include the constant $\left(\frac{\sigma-1}{\sigma}\right)$ for convenience. Also, here as in the rest of the paper, the notation $_t z_{t+j}$ denotes the expectation of variable z_{t+j} conditional on information available at t. This preference specification is chosen because, as we shall see, it yields a simple solution for equilibrium employment under flexible wages.

The consumption quantity C_{it} is an aggregate of home and imported goods:

$$C_{it}=\kappa\left(C_{it}^{H}\right)^{\gamma}\left(C_{it}^{F}\right)^{1-\gamma} \tag{8}$$

where C_{it}^{H} denotes purchases of the home good, C_{it}^{F} purchases of the imported good, and $\kappa=[\gamma^{\gamma}(1-\gamma)^{1-\gamma}]^{-1}$ is an irrelevant constant.

We assume 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*. Also, we assume that imports are freely traded and that the Law of One Price holds, so that the *peso* price of imports is equal to the *nominal exchange rate* of S_t pesos per dollar.

To make things simple, we assume that workers cannot save, and that wage earnings constitute their only source of income. Worker i's problem is then to maximize 7 subject to 8, his budget constraint

$$W_{it}L_{it}=P_tC_{it}^{H}+S_tC_{it}^{F} \tag{9}$$

and the demand for his labor services, given by 6.

The worker's choice variables depend on assumptions about wage rigidity. We shall consider two cases. First, a case of *flexible wages*, in which worker i chooses consumption, his own wage W_{it}, and his labor supply L_{it} in period t. Second, a case of *sticky wages,* in which worker i chooses, in period t, consumption in period t and his wage $W_{i,t+1}$ for *next* period; in this case, he commits to supply his labor according to demand. Obviously, only in the second case will monetary and exchange rate policy affect real allocations.

Regardless of whether wages are sticky or flexible, purchasing consumption at minimum cost requires

$$\left(\frac{1-\gamma}{\gamma}\right)\frac{C_t^H}{C_t^F} = \frac{S_t}{P_t} \equiv E_t \tag{10}$$

where we have imposed symmetry in equilibrium and dropped the subscript i. Also, we have defined E_t, the *real exchange rate.*

The minimum cost of one unit of consumption is given by

$$Q_t = P_t^\gamma S_t^{1-\gamma} \tag{11}$$

If wages are flexible, each worker will set his wage to equate his marginal disutility of labor to its marginal return. Our assumptions on preferences then ensure that

$$L_t = 1$$

in equilibrium.

If wages are sticky, it is easy to show that they will be set so that

$$_tL_{t+1}^\nu = 1 \tag{12}$$

and, in that case, the employment of labor will be given by the demand condition 5.

2.3 Capitalists

Capitalists are the key players in our model, as they finance investment partly with foreign loans, and foreign borrowing is subject to frictions. These frictions can be, in principle, due to informational or enforcement problems. The details are, however, somewhat peripheral to our line of discussion, and hence this section is limited to describing the main aspects of the aggregate behavior of capitalists. That behavior is justified by more primitive assumptions about fundamentals in the appendix.

To describe the capitalists' behavior, it is best to begin at the end of some period t. At that point, the capitalists have some *net worth* P_tN_t, expressed in pesos, and have access to a world capital market where the *safe* interest rate for dollars borrowed between t and $t+1$ is given by ρ_{t+1}, which is random but becomes known at t.

Capitalist can invests in capital for next period, which they produce by assembling home goods and imports in the same fashion as 8. As a consequence, the cost of one unit of capital in $t+1$ is Q_t, as given by 11, and the capitalists' budget constraint is

$$P_t N_t + S_t D_{t+1} = Q_t K_{t+1} \tag{13}$$

where D_{t+1} denotes the amount borrowed abroad and K_{t+1} his investment in $(t+1)$ capital.

Crucially, the interest cost of borrowing abroad is not simply the world safe rate ρ_t. Instead, capitalists borrow abroad at the gross interest rate $\left(1+\rho_{t+1}\right)\left(1+\eta_{t+1}\right)$ where η_{t+1} is a *risk premium*. And, following Bernanke, Gertler, and Gilchrist (1999), we assume that the risk premium is given by

$$1+\eta_{t+1} = F\left(\frac{Q_t K_{t+1}}{P_t N_t}\right),\ F(1)=1,\ F'(.)>0 \tag{14}$$

that is, the risk premium is an increasing function of the value of investment relative to net worth. Again, Appendix 1 justifies this specification with primitive assumptions on the economy's fundamentals. For concreteness, we shall assume the following functional form for F:

$$F(g) = g^{\mu},\ \mu > 0 \tag{15}$$

at least in the neighborhood of the steady state.

Capitalists are risk neutral, and choose D_{t+1} and K_{t+1} so as to equate the return on investment to the cost of foreign borrowing. For simplicity, we assume that capital depreciates completely in production. Hence the yield on capital, in dollars, will be $R_{t+1}K_{t+1}/S_{t+1}$ which, in equilibrium, will equal $\alpha P_{t+1}Y_{t+1}/S_{t+1}$ by 4. The equality of the expected return on investment to the cost of foreign borrowing then implies

$$\frac{\alpha\ _t(P_{t+1}Y_{t+1}/S_{t+1})}{Q_t K_{t+1}/S_t} = \left(1+\rho_{t+1}\right)\left(1+\eta_{t+1}\right) \tag{16}$$

At the beginning of each period, capitalists collect the income from capital and repay foreign debt. Assume that they consume a portion $1-\delta$ of the remainder, and that (in true capitalist style) they only consume imports. As a consequence, their net worth is

$$P_t N_t = \delta \left\{ R_t K_t - (1+\rho_t)(1+\eta_t) S_t D_t \right\} \quad (17)$$
$$= \delta \left\{ \alpha P_t Y_t - (1+\rho_t)(1+\eta_t) S_t D_t \right\} \quad (18)$$

Note that –holding real income constant– a real devaluation, defined as an increase in $E_t = S_t/P_t$, will have a negative impact on net worth and, *ceteris paribus,* increase the risk premium. This will be a key and novel aspect in our analysis.[3] Also, notice that if $\gamma = 0$ –that is, if all capital were composed of foreign goods– then the risk premium would be independent of the real exchange rate. This is the real-economy counterpart of the problem of "dollarization" of liabilities stressed by Calvo (1999, 2000) and others. Because domestic capitalists' productive assets and liabilities consist of different goods, changes in relative prices affect their creditworthiness.

2.4 Equilibrium

Market clearing for home goods requires that domestic output be equal to demand. As we have seen, domestic expenditure in home goods is a fraction γ of final expenditures. In addition, the home good may be sold to foreigners. Since we want to allow for shocks to foreign demand, we simply assume that the value of home exports in dollars is exogenous and given by some random process X_t.[4]

The preceding paragraph then implies that the market for home goods will clear when

$$P_t Y_t = \gamma Q_t (K_{t+1} + C_t) + S_t X_t \quad (19)$$

and note that, because workers consume their wages in each period,

$$Q_t C_t = W_t L_t = (1-\alpha) P_t Y_t \quad (20)$$

Rational expectations equilibria are defined in the usual way, after specifying stochastic processes for ρ_t and X_t. If wages are flexible, $L_t = 1$, and 1, 4, 5, 11, 13, 14, 16, 17, 19, and 20 can be solved for Y_t, R_t, W_t, K_{t+1}, D_{t+1}, η_{t+1}, N_t, C_t, and the relative prices Q_t/P_t and S_t/P_t. If wages are

[3] See also Céspedes (2000).

[4] This is similar to Krugman (1999), and can be justified by positing that the foreign elasticity of substitution in consumption is one, but that foreigners expenditure share in domestic goods is negligible.

sticky, 12 and the preceding set of equations can be solved for L_t, Y_t, R_t, W_t, K_{t+1}, D_{t+1}, η_{t+1}, N_t, C_t, and the *nominal* prices Q_t, S_t and P_t, once some assumption about monetary policy is imposed.

The astute reader may have noted that we have not laid out the monetary side of the model –and in particular an expression for money demand– explicitly. As discussed by Bernanke, Gertler and Gilchrist (1998), Galí and Monacelli (1999) and others, this is legitimate for a class of monetary policy rules that includes the ones we are concerned with. More precisely, it would be straightforward to amend the model so that there is an equation for the real demand for pesos; then the central bank would implement the policies we discuss below by suitable adjustments in nominal interest rate and/or the supply of pesos.

A nontrivial analysis of monetary and exchange rate policy is only possible under sticky wages. However, analysis of the flexible wage case will aid the understanding the dynamics of the model, so we will examine both cases in turn. But first we turn to the existence of steady states and the convergence properties of the model.

3 Steady States and Convergence Under Perfect Foresight

3.1 Steady States

A steady state can be defined in the usual way and is the same regardless of assumptions about wage rigidity. Absence of time subscripts will denote steady state values.

Clearly, in a steady state $L = 1$, and there is no loss of generality in normalizing $P = 1$; hence the nominal exchange rate S coincides with the real exchange rate E, and the cost of investment Q is measured relative to the price of home output. The steady state is then given by:

$$Y = AK^{\alpha} \tag{21}$$

$$Q = S^{1-\gamma} \tag{22}$$

$$\frac{\alpha Y}{QK} = (1+\rho)(1+\eta) \tag{23}$$

$$1 + \eta = \left(\frac{QK}{N}\right)^{\mu} \tag{24}$$

$$N + SD = QK \tag{25}$$

$$N = \delta[\alpha Y - (1+\rho)(1+\eta)SD] \tag{26}$$

$$Y = \gamma[(1-\alpha)Y + QK] + SX \tag{27}$$

Equation 21 is the steady state version of the production function 1. Likewise, 22 corresponds to 11, 23 to 16, 24 to 14, 25 to 13, 26 to 17, and 27 to 19.

Now it is easy to show that there is a unique, nontrivial steady state. Replace 23 and 25 in 26 and rearrange to obtain

$$[1 - \delta(1+\rho)(1+\eta)]\,(QK - SD) = 0$$

But QK cannot equal SD if net worth is to be positive, as required in a nontrivial steady state. Hence $\delta(1+\rho)(1+\eta)$ must equal 1 or

$$1 + \eta = [\delta(1+\rho)]^{-1} \tag{28}$$

which pins down the risk premium in the steady state. Note that for $\eta > 0$ one needs $\delta(1+\rho) < 1$, that is, δ must be small enough.

Equations (23) and (28) now yield

$$\delta\alpha Y = QK \tag{29}$$

That is, in the steady state the value of investment is equal to the fraction of capital income that is not consumed. This and 27 yield

$$[1 - \gamma(1 - \alpha - \alpha\delta)]\,Y = SX \tag{30}$$

Since $1 - \gamma(1 - \alpha - \alpha\delta) > 0$, this is a ray from the origin in (Y, S) space, and can be thought of as an "IS curve" in the steady state..

To find a second relationship, use 21 and 22 in 29 to get

$$\alpha\delta Y = S^{1-\gamma}\left(\frac{Y}{A}\right)^{1/\alpha}$$

The L.H.S. is income invested, the RHS is the value of capital bought. This can be rewritten as

$$\alpha\delta A^{1/\alpha} = S^{1-\gamma} Y^{(1-\alpha)/\alpha}, \tag{31}$$

which is a hyperbola in (Y, S) space. The steady state values of S and Y must solve 30 and 31. Clearly, there is a unique positive solution.

The other steady state variables are determined immediately. In particular, from 24 and 28,

$$QK/SD = \left[1 - (1+\eta)^{-1/\mu}\right]^{-1} = \{1 - [\delta(1+\rho)]^{1/\mu}\}^{-1} \tag{32}$$

It will turn out that QK/SD, the ratio of the value of investment to the value of foreign debt in the steady state, is crucial. Expression 32 shows that this ratio depends only on the steady state risk premium and the parameter μ.

3.2 The linearized system

The equations that characterize equilibrium can be log-linearized around the steady state. The resulting system includes, whether wages are flexible or sticky, the following:

$$y_t = \alpha k_t + (1-\alpha) l_t \tag{33}$$

$$q_t - p_t = (1-\gamma)(s_t - p_t) \tag{34}$$

$$y_t = \lambda (k_{t+1} + q_t - p_t) + (1-\lambda)(s_t - p_t + x_t) \tag{35}$$

$$_t y_{t+1} - (q_t - p_t) - k_{t+1} = \rho'_{t+1} + \eta'_{t+1} + (s_{t+1} - p_{t+1}) - (s_t - p_t) \tag{36}$$

$$\eta'_{t+1} - \eta'_t = \mu\{(q_t - p_t + k_{t+1} - y_t) + \psi\left[(s_t - p_t - {}_{t-1}(s_t - p_t)) - (y_t - {}_{t-1}y_t)\right]\} \tag{37}$$

where $\lambda = \alpha\gamma\delta/(1-\gamma+\alpha\gamma)$, $\psi = [(QK/SD) - 1]^{-1}$, lower case letters denote percentage deviations from steady state values, and ρ'_t and η'_t denote deviations from their steady state levels.

Expression 33 is the log-linear version of the production function, while 34 is the logarithmic version of 11, the definition of the price index $q_t - p_t$. Equation 35 gives market equilibrium for the home good: the portion of output not consumed by workers is either invested or exported, with both investment and exports expressed in terms of the home good.

Equation 36 is the interest arbitrage equation. The LHS shows the marginal return in $t+1$ on an unit invested in domestic capital in period t, while the RHS shows the relevant rate of interest on foreign borrowing (inclusive of the risk premium) expressed in terms of the home good.

Finally, expression 37 shows the evolution of the risk premium.

While all other expressions, 37 will be the source of the novel twists in the analysis. To obtain an insight into this condition, use 35 to eliminate the term $(k_{t+1} + q_t - p_t)$ from 37 and recall that the real exchange rate e_t equals $s_t - p_t$ to obtain

$$\eta'_{t+1} - \eta'_t = -\mu \left(\frac{1-\lambda}{\lambda}\right) x_t + \mu (\frac{1-\lambda}{\lambda}) (y_t - e_t) + \mu\psi \left[(e_t - {}_{t-1}e_t) - (y_t - {}_{t-1}y_t) \right] \tag{38}$$

This expression decomposes the change in the risk premium into three effects, captured by the three terms in the RHS sum. The first is exogenous shocks to export demand: a fall in exports, given home output, must be compensated by an increase in investment, and consequently more foreign debt and a higher risk premium. The second term reflects a similar effect from an increase of output, measured in dollars: given exports, an increase in $(y_t - e_t)$ must be matched by more investment, debt, and a higher risk premium. The third term in the sum reflects *unexpected* changes in *net worth.* An unexpected real devaluation increases the burden of inherited debt, hence reducing net worth relative to the cost of investment. The same happens if output falls unexpectedly, since this reduces capitalists' reward from previous investment. In both cases, the fall in net worth pushes up the risk premium.

Importantly, holding previous expectations constant, a fall in dollar output, due to either a real devaluation (an increase in e_t) or a reduction in home output (a fall in y_t), may be associated with either an increase or a decrease in the risk premium η'_{t+1}. For an increase, it must be the case that $\psi > \left(\frac{1-\lambda}{\lambda}\right)$; this reflects that a fall in dollar output leads to less investment, which reduces the risk premium, but also to a fall in net worth, which increases it. The net worth effect dominates if ψ is large enough or, from the definition of ψ, if foreign debt is large enough in the steady state. Alternatively, this condition can be written as $\frac{N}{QK} < \lambda$: a fall in dollar output increases the risk premium if steady-state net worth is sufficiently small.

3.3 Convergence under perfect foresight

To examine convergence to the steady state, assume that there are no stochastic shocks hitting the system. In such a case, wage rigidity has no real consequences, and $l_t = 1$. Also, $x_t = \rho'_{t+1} = 0$, and expected and realized values coincide for any variable. With these simplifications, the system (33)-(37)

is unexpectedly tractable, since it can be reduced to only two dimensions. This has an obvious analytical advantage.

Using 33 and 34 to eliminate k and $q-p$ from 35, 36 and 37, one obtains

$$y_{t+1} - \left[(1-\gamma)\,e_t + \alpha^{-1} y_{t+1}\right] = \; e_{t+1} - e_t + \eta'_{t+1} \tag{39}$$

$$y_t = \lambda\left[(1-\gamma)\,e_t + \alpha^{-1} y_{t+1}\right] + (1-\lambda)e_t \tag{40}$$

$$\eta'_{t+1} - \eta'_t = \mu\left[(1-\gamma)\,e_t + \alpha^{-1} y_{t+1} - y_t\right] \tag{41}$$

Now, 40 can be used to eliminate the term $(1-\gamma)\,e_t + \alpha^{-1} y_{t+1}$ from 39 and 41 which, after rearrangement, become

$$(y_{t+1} - y_t) - (e_{t+1} - e_t) = \left(\frac{1-\lambda}{\lambda}\right)(y_t - e_t) + \eta'_{t+1} \tag{42}$$

$$\eta'_{t+1} - \eta'_t = \mu\left(\frac{1-\lambda}{\lambda}\right)(y_t - e_t) \tag{43}$$

Finally, define $z_t = y_t - e_t$, which is home output *in dollars*. Then 42 and 43 become

$$z_{t+1} - z_t = \left(\frac{1-\lambda}{\lambda}\right) z_t + \eta'_{t+1} \tag{44}$$

$$\eta'_{t+1} - \eta'_t = \mu\left(\frac{1-\lambda}{\lambda}\right) z_t \tag{45}$$

Expressions 44 and 45 constitute a system of two first order equations in the two unknowns, dollar output z and the risk premium η', whose solution characterizes the full dynamics of the system.

The analysis of convergence is now tedious but straightforward. Rewrite 44 and 45 in matrix form to arrive at

$$\begin{bmatrix} z_{t+1} \\ \eta'_{t+1} \end{bmatrix} = \Phi \begin{bmatrix} z_t \\ \eta'_t \end{bmatrix} \tag{46}$$

where

$$\Phi = \begin{bmatrix} \left(\frac{1-\lambda}{\lambda}\right)(1+\mu) + 1 & 1 \\ \mu\left(\frac{1-\lambda}{\lambda}\right) & 1 \end{bmatrix} \tag{47}$$

Note that the risk premium η'_t is predetermined at t but, since the real exchange rate can jump, dollar output z_t can jump. Hence saddle path stability requires that one eigenvalue of Φ be inside and the other one outside the unit circle. Some algebra, described in the Appendix, reveals that this is always the case, and hence the system displays saddle path stability.

Along the saddle path, the jump variable z is a unique and linear function of the predetermined variable η', say $z_t = \beta\eta'_t$, where β is a *negative* coefficient whose value can be computed using standard methods (see the appendix). The negativity of β implies that, when the risk premium η_t is above its steady state level, dollar output z_t is below its own steady state level, and viceversa. This implication seems intuitive.

4 Interest Rate Shocks With Flexible Wages

Our model can be simulated under different assumptions on shocks, wage rigidity, and policy,[5] and indeed we do so in a later section. However, it is illuminating first to examine analytically the dynamic behavior of the model. While this can only be done under somewhat strong assumptions, it yields insights on the model's behavior even after those assumptions are relaxed.

In this section we assume that wages are flexible (so that $l_t = 0$) and that all shocks are i.i.d., and focus on the effect of a sudden shock to the world interest rate. Suppose that the system starts from steady state, and that at $t = 0$ the world interest rate ρ_1 rises unexpectedly. From the period 0 versions of 33, 34, and 36, interest arbitrage reduces to

$$e_1 = -y_1\left(\frac{1-\alpha}{\alpha}\right) + \gamma e_0 - \eta'_1 - \rho'_1 \tag{48}$$

Now, from 34 and 35, we have

$$y_1 = \alpha k_1 = -\left(\frac{\alpha}{\lambda}\right)(1-\gamma\lambda)e_0 \tag{49}$$

This means that investment in period 0 and output in period one must *fall* with a real devaluation (an increase in e_0). The reason is that if e_0 increases, more home output must be exported in period 0. But home output cannot respond to an interest rate shock in period 0: the capital stock is predetermined, and our preference specification implies that $l_0 = 0$ in the flexible wage case. Hence investment must fall.

[5] Assuming, of course, that fluctuations around the steady state are "small."

The risk premium in period 0 is given by 38, that is,

$$\eta_1' = \mu \left(\psi - \frac{1-\lambda}{\lambda} \right) e_0 \equiv \varepsilon_{\eta e} e_0 \tag{50}$$

where

$$\varepsilon_{\eta e} \equiv \mu \left(\psi - \frac{1-\lambda}{\lambda} \right) \tag{51}$$

is the elasticity of the risk premium with respect to a change in the real exchange rate. This elasticity is an important parameter and, indeed, has been a focus of recent literature. To put our analysis in context, we shall distinguish between a *financially robust* economy, that is, one in which $\varepsilon_{\eta e} < 0$, and a *financially vulnerable* one, in which $\varepsilon_{\eta e} > 0$. Intuitively, balance sheet effects are "small" in the robust case and large in under financial vulnerability; the financially vulnerable case is the one that has been emphasized recently by Calvo (1999), Krugman (1999), and others.

As should be clear from the definition of $\varepsilon_{\eta e}$, whether an economy is robust or vulnerable turns out to depend on the size of ψ *vis a vis* $(1-\lambda)/\lambda$. In particular, when the steady state ratio of debt to investment, SD/QK, is large, then ψ is also large and the economy is more likely to be financially vulnerable.

Substituting 49 and 50 into the arbitrage condition 48 and rearranging we have

$$e_1 = \left(\frac{1-\alpha}{\lambda} + \alpha\gamma - \varepsilon_{\eta e} \right) e_0 - \rho_1' \tag{52}$$

This is a crucial relation between the real exchange rates in periods 0 and 1; we shall call it the *EE curve.* As we have discussed, it reflects primarily interest arbitrage.

The slope of the EE curve in (e_0, e_1) space may be positive or negative, depending mainly on the sign and magnitude of $\varepsilon_{\eta e}$. The intuition is that, holding ρ_1' constant, an increase in e_0 reduces investment and increases the return in capital. If the risk premium did not move, interest arbitrage would only hold if e_1 increased too; then the EE curve would slope up. However, if the increase in e_0 caused a *sufficiently large* increase in the risk premium, interest parity would require a *fall* in expected devaluation and, hence, a fall in e_1. In such a case, the EE curve would slope down.

A second relation between e_0 and e_1 can be derived from the fact that, from period 1 on, the economy must be on the saddle path converging to the steady state. Recall that this implies that $z_1 = y_1 - e_1 = \beta\eta_1'$. Hence $e_1 = y_1 - \beta\eta_1'$ which, after using 49 and 50 rearranging becomes

$$e_1 = -\left[\alpha\left(\frac{1-\lambda\gamma}{\lambda}\right) + \beta\varepsilon_{\eta e}\right] e_0 \tag{53}$$

which is another linear equation in e_0 and e_1 that we shall call the *FF curve.*

The slope of the FF curve can also be positive or negative, and again this depends on the elasticity $\varepsilon_{\eta e}$. To see this, recall that an increase in e_0 reduces investment and period 1 output. Given η_1', z_1 is determined by saddle path stability. Hence, if η_1' did not move, a *fall* in e_1 would be required to place the economy on the converging saddle path. However, if $\varepsilon_{\eta e}$ is positive, the risk premium increases with e_0; if this effect is sufficiently large, it may more than offset the fall in y_1, and e_1 would *increase.*

The response to the real exchange rates e_0 and e_1 to the interest rate shock ρ_1' is simply given by the intersection of the EE and the FF curves. Then it is straightforward to calculate the behavior of the rest of the variables of interest. The explicit solutions can be written as

$$e_0 = \lambda\theta\rho_1' \tag{54}$$

$$e_1 = -\theta\left[\alpha\left(1-\lambda\gamma\right) + \beta\lambda\varepsilon_{\eta e}\right]\rho_1' \tag{55}$$

where

$$\theta^{-1} = 1 - \left(1-\beta\right)\lambda\varepsilon_{\eta e} \tag{56}$$

It is worth noting, at this point, that there is a *unique* equilibrium response to the interest rate shock. In this regard, our discussion differs from that of Krugman (1999) and Aghion, Bachetta, and Banerjee (2000), both of which emphasize the possibility of multiple equilibria.

We are ready to examine the possibilities.

4.1 The financially robust economy

Recall that the economy is financially robust if a real devaluation in period 0 lowers the risk premium ($\varepsilon_{\eta e} < 0$). It is easy to see that if this condition holds, and given that $\beta < 0$, the EE curve must slope up and the FF curve must slope down in (e_0, e_1) space. An unanticipated increase of the world interest rate shifts the EE curve down but leaves the FF curve undisturbed.

Hence the rate increase causes a real depreciation on impact ($e_0 > 0$), which is reversed in the next period ($e_1 < 0$). This is depicted in panel 1A.

We already noted that home output cannot respond to the interest rate shock in period 0; equation 49 in turn implies that, since the exchange rate rises in period 0, home output must fall in period 1. On the other hand, because of the changes in the real exchange rate, the *dollar* value of output z falls at first and then recovers. In period 0, the fall in z is identical to the increase in e: $z_0 = -e_0 < 0$. In period 1, the saddle path trajectory dictates $z_1 = \beta\eta_1' = \beta\varepsilon_{\eta e}e_0 > 0$. Hence, the fall in dollar output turns out to be temporary: it is above steady state levels in period 1 already. Thereafter, η rises and z falls until returning to the steady state.

Hence, under financial robustness the response of the economy is fairly conventional. This is not too surprising, as balance sheet effects are small. The sequence of events is depicted in panel 1B. At time 0 the system jumps from the origin to point A, with an instant fall in dollar output taking place. In period 1 the system moves to point B, with dollar output above and the risk premium below their steady state levels. Gradual convergence takes place starting at that point.

4.2 The financially vulnerable economy

By definition, in a financially vulnerable economy an impact devaluation raises the risk premium ($\varepsilon_{\eta e} > 0$). However, the economy's response to the shock and, it particular, whether there is in fact a devaluation, depends on the parameters of the economy, which determine the positions of the EE and FF curves. From 54, two main possibilities emerge.

(i) Even if $\varepsilon_{\eta e} > 0$, its magnitude may be sufficiently small so that $\theta > 0$. In that case, 54 implies that there is still a real devaluation on impact ($e_0 > 0$). In particular, 54 reveals that the size of the initial depreciation increases with $\varepsilon_{\eta e}$ or, equivalently, with the coefficient ψ. That is, a larger debt ratio, holding other parameters constant, increases the sensitivity of the initial real exchange rate to movements in world interest rates.

The qualitative behavior of home output is the same as in the robust case. But the fall in output in period 1 increases with the debt ratio ψ. Also, financial vulnerability implies that the risk premium η_1' increases with the initial depreciation. As a consequence, *dollar* output must fall in period 1 for the economy to jump to the converging saddle path ($z_1 = \beta\eta_1' < 0$).[6]

Finally, the real exchange rate in period 1 may be above or below its steady state level. As seen in 55, $e_1 < 0$ if $\varepsilon_{\eta e}$ is small enough, and $e_1 > 0$ otherwise. Figure 2 depicts the latter case.[7] In 2A, the downward shift of the EE curve causes both a real depreciation in both periods. In 2B, we see that at time 0 the system jumps to point A. If $-\beta\varepsilon_{\eta e} > 1$, then in period 1 it moves to point B on the saddle path, showing a protracted recession; otherwise, it moves to point C on the saddle path. Gradual convergence, with dollar output rising and the risk premium falling, takes place thereafter.

(ii) It is possible that $\theta < 0$, as would be clearly the case for very large values of $\varepsilon_{\eta e}$. In this case, 54 implies that the interest rate increase causes an initial *appreciation* of the peso ($e_0 < 0$). This is counter-intuitive but logically possible given a large enough balance sheet effect. In addition, the risk premium η_1' must fall, and investment in period 0, output in period 1, and dollar output in periods 0 and 1 all must *increase* in response to the shock.

Clearly, while this case is logically possible, its empirical relevance is questionable. To believe that this case holds implies believing that an unfavorable interest rate shock leads to an appreciation and to an expansion in economic activity. In addition, in our numerical explorations of Section 6 we have been unable to find plausible parameter configurations for which $\theta < 0$.

4.3 Summary

Under financial robustness, a balance sheet effect exists but is mild enough so that the economy's response to an interest rate shock goes along conventional lines. But if balance sheet effects are large enough for the risk premium to increase with a devaluation, so that the economy is financially vulnerable, behavior depends on parameter values. Except in cases that seem empirically implausible, financial vulnerability exacerbates the response of exchange rates to interest rate shocks, and makes contractions in home output and dollar output more persistent.

[6] Dollar output may rise or fall between periods zero and one.

[7] The case in which $e_1 < 0$ corresponds, qualitatively, to the dynamics presented in Figures 1A and 1B.

5 Sticky Wages and Exchange Rate Policy

We are now in a good position to consider the effect of nominal rigidities under alternative monetary and exchange rate policies. As noted earlier, our assumption will be that nominal wages are predetermined for one period, and allowed to move to market-clearing levels thereafter. This is enough to ensure that monetary policy has real effects, although it obviously implies highly stylized and perhaps unrealistic dynamics for nominal aggregates.

Our discussion will focus on the age old question of the contractionary properties of alternative exchange rate regimes. As noted in the introduction, the conventional wisdom has long been that flexible exchange rates are less contractionary than fixed rates. But it has been recently argued that the presence of balance sheet effects may reverse this ranking.

The (linearized) equilibrium equations 33-37 must still hold. In addition, with sticky wages, the pre-set wage rate in period t must be such that

$$ {}_{t-1}l_t = 0 \tag{57} $$

which is the linear version of 12, and the linearized version of 5,

$$ y_t - l_t = w_t - p_t, \tag{58} $$

determines employment. Hence, if we start from the steady state in period 0, 57 and 58 imply $w_0 =_{-1} p_0$, which applied to 58 yields

$$ l_0 - y_0 = \alpha l_0 = p_0 - {}_{-1}p_0 = p_0, \tag{59} $$

after taking into account that $y_0 = \alpha k_0 + (1-\alpha)l_0 = (1-\alpha)l_0$ and that ${}_{-1}p_0 = 0$. Equation 59 is, of course, a simple expectational Phillips curve.

We keep the assumption that shocks are i.i.d. in this section, and again focus on the effect of an unanticipated increase in the world interest rate in period 0. Notice that, since after one period all variables are free to adjust, from $t = 1$ on the equilibrium of the model is identical to that computed in the previous section: the economy settles on saddle path converging to the steady state. Therefore, in analyzing the effects of wage stickiness under alternative monetary rules it is enough to focus what happens in the period of the shock.

5.1 Flexible exchange rates

We define a regime of flexible exchange rates as one in which the central bank uses its policy instrument (the money supply or an overnight interest rate, for instance) to target the price of home output p_t while letting the nominal exchange rate s_t adjust to market conditions. In principle, such a rule is consistent with any path for the price level. To make matters concrete and simple, we assume that the authorities keep the price level constant in response to shocks, so that $p_t =_{t-1} p_t = 0$ for all t.

The implications of this rule for the real exchange rate e_t are straightforward. Since $e_t = s_t - p_t$, the price targeting rule in force implies

$$e_t = s_t \text{ for all } t. \tag{60}$$

Hence movements in the nominal exchange rate are fully translated into movements in the real exchange rate.

In addition, 57, 58, and 59 imply that $l_t = w_t = p_t = w_t - p_t = 0$. That it, the nominal and real wages are always at their steady state level, and labor supply is constant and equal to its steady state level of one.

This all means that the economy behaves just as in the flexible wages case. All results of the previous section apply here, the only caveat being that movements in the real exchange rate are accomplished instantaneously through movements in the (floating) nominal exchange rate. Hence, ruling out the (implausible) appreciation cases under financial vulnerability, the temporary increase in the world real interest rate causes a real depreciation in the period of the shock, while output is initially unchanged. The real depreciation may cause an increase or decrease in the risk premium, depending on whether the economy is financially vulnerable or robust. This will matter for the subsequent course of the real exchange rate. But regardless, investment falls on impact, and output in the subsequent period is below its steady state level.

5.2 Fixed exchange rates

Focus now on a policy of *fixed* exchange rates: $s_t = 0$ for all t. This means the real exchange rate is given by

$$e_t = -p_t \tag{61}$$

That is, real depreciations (appreciations) can only be accomplished through deflation (inflation).

Consider the effects of the unexpected increase of the world real interest rate at time 0. From the production function we know that initial output will be given by

$$y_0 = (1 - \alpha)\, l_0 \tag{62}$$

Using 59 to eliminate equilibrium labor use from this equation we arrive at

$$y_0 = \left(\frac{1-\alpha}{\alpha}\right) p_0 = -\left(\frac{1-\alpha}{\alpha}\right) e_0 \tag{63}$$

so that, predictably, because wages are fixed in nominal terms, the real wage will fall and output will increase if there is unexpected inflation. Using this in 40 evaluated at ${}_0y_1 = \alpha k_1$, we can solve for the level of investment in period 0:

$$k_1 = -\left(\frac{1-\lambda\gamma}{\lambda}\right) e_0 + \left(\frac{1-\alpha}{\alpha\lambda}\right) p_0 \tag{64}$$

But since under fixed exchange rates $e_0 = -p_0$, the previous equation becomes

$$k_1 = \left(\frac{1-\lambda\gamma\alpha}{\lambda\alpha}\right) p_0 = -\left(\frac{1-\lambda\gamma\alpha}{\lambda\alpha}\right) e_0 \tag{65}$$

so that unexpected inflation must raise investment. The intuition is that, with fixed rates, inflation means appreciation, and this lowers the home good value of exports, leaving more room for investment. In addition, unexpected inflation also increases output, which pushes up investment.

Using the equilibrium equations for period 0 one can also derive the following expression for the risk premium:

$$\eta_1' = -\mu\alpha^{-1}\left(\psi - \frac{1-\lambda}{\lambda}\right) p_0 = \mu\alpha^{-1}\left(\psi - \frac{1-\lambda}{\lambda}\right) e_0 = \alpha^{-1}\varepsilon_{\eta e} e_0 \tag{66}$$

As before, the direction of the response of the risk premium to a real devaluation depends on the relative sizes of ψ and $\lambda:$ a real depreciation increases the risk premium if $\psi > \left(\frac{1-\lambda}{\lambda}\right)$, and vice-versa. In fact, the elasticity of the premium with respect to the initial real exchange rate is the same as with flexible wages, but scaled up by α^{-1}. The intuition is that, in this case, an increased real exchange rate reduces net worth, and pushes up the risk premium, both by raising the burden of the foreign debt and by reducing output and capital income. Importantly, these effects have the same sign because of the fixed exchange rates, which means that the real depreciation can only come through deflation, which reduces output.

As we did in the previous section, it is convenient to solve for period 0 and 1 variables in isolation. We know that $e_1 = \alpha k_1 - \beta \eta_1'$. Using 61, 65 and 66 in this expression we have

$$e_1 = -\left(\frac{1 - \gamma\lambda\alpha}{\lambda} + \alpha^{-1}\beta\varepsilon_{\eta e} \right) e_0 \tag{67}$$

which is the FF curve for this case. Note that, except for the role of α, it is very similar to the flexible wage FF curve.

To derive another such expression, take the arbitrage equation 39 and evaluate it at period 0, using the fact that $y_1 = \alpha k_1$:

$$\alpha k_1 - [(1-\gamma) e_0 + k_1] = e_1 - e_0 + \rho_1' + \eta_1' \tag{68}$$

Now use 65 and 66 in 68 to obtain

$$e_1 = \alpha^{-1} \left[(1-\alpha) \left(\frac{1 - \gamma\lambda\alpha}{\lambda} \right) + \alpha\gamma - \varepsilon_{\eta e} \right] e_0 - \rho_1' \tag{69}$$

This is the EE curve for this case. These two curves can be solved explicitly for

$$e_0 = \alpha\lambda\theta\rho_1' \tag{70}$$

$$e_1 = -\theta \left[\alpha (1 - \alpha\gamma\lambda) + \beta\lambda\varepsilon_{\eta e} \right] \rho_1' \tag{71}$$

where θ^{-1} was defined in 56.

Beyond this point the analysis depends on parameter configurations.

5.2.1 The financially robust economy

Recall this is the case in which a real devaluation in period 0 lowers the risk premium. Then $\varepsilon_{\eta e} < 0$, and given that $\beta < 0$ always, the EE curve slopes up, and the FF curve slopes down. Clearly, the increase in the world interest rate causes an initial real depreciation ($e_0 > 0$), which is reversed in the next period. But, unlike the case with flexible exchange rates, under fixed rates the real depreciation is achieved via an unexpected price *deflation* in period 0.

This deflation, in turn, causes a *fall* in period 0 home output, as equation 63 shows. This is again different to the flexible rates case, in which output remained constant in period 0 in response to the same shock. Also, equation 65 implies that the period 0 deflation causes investment to fall, and therefore output also falls (relative to steady state) in period 1: $y_1 = \alpha k_1 < 0$. Finally, using equation 63, dollar output in period 0 becomes $z_0 = \alpha^{-1} p_0 < 0$; that is, dollar output falls on impact, both because of the real depreciation and the fall in home output.

In period 1, the saddle path trajectory dictates $z_1 = \beta\eta_1'$. Using 66 to eliminate η_1' from this expression we have

$$z_1 = -\beta\alpha^{-1}\varepsilon_{\eta e} e_0 > 0 \tag{72}$$

Hence, the fall in dollar output turns out to be temporary: it is above its steady state level in period 1 already. Thereafter, η rises and z falls until returning to the steady state.

Figure 1 can be reinterpreted to as to apply to this case. The only difference is that there is a difference in magnitudes, and also that changes in real exchange rates reflect changes in the opposite direction in the home price level.

5.2.2 The financially vulnerable economy

Under financial vulnerability, $\varepsilon_{\eta e} > 0$, and $\theta^{-1} = 1 - (1-\beta)\lambda\varepsilon_{\eta e}$ can be positive or negative. When θ is positive, $e_0 > 0$, and the interest rate shock causes a real devaluation on impact, which is attained by an unexpected deflation and the associated output contraction. If $\theta < 0$, the reverse occurs.

The behavior of the next period exchange rate is more complex. Expression 71 implies that e_1 may be positive or negative when $\theta > 0$, depending on the slopes of EE and FF. The case in which EE is steeper, so that e_1 is positive and we have a depreciation over two periods, is qualitatively the same as Figure 2, although again there are differences in magnitudes and changes in e are translated into changes in p.

5.3 Evaluating exchange rate regimes

How do the alternative exchange rate regimes compare when the economy responds to an unexpected rise in world real interest rates? It turns out that the crucial factor is *not* whether or not the economy is financially vulnerable, but whether adjusting to the adverse interest rate shock requires a real appreciation or devaluation.

Consider, first, the case in which adjustment to the shock requires a real devaluation ($\theta > 0$). This is clearly the "normal" case. The impact behavior of the real exchange rate is, from 54 and 70,

$$e_0^{flex} - e_0^{fix} = (1-\alpha)\,\lambda\theta\rho_1' > 0 \tag{73}$$

Hence, it is apparent that the initial movement of the real exchange rate is smaller, in absolute value, with fixed than with flexible exchange rates. This is as one should have expected. And, with $\theta > 0$, 73 indicates that the initial depreciation is larger under a float.

From 55 and 71 we have

$$e_1^{flex} - e_1^{fix} = (1-\alpha)\,\alpha\lambda\gamma\theta\rho_1' > 0 \tag{74}$$

so that the subsequent real depreciation is also larger under flexible rates.

The behavior of the risk premium is also interesting, and surprising given recent policy discussions. From 50 and 66 we have

$$(\eta_1')^{flex} - (\eta_1')^{fix} = \varepsilon_{\eta e}\left(e_0^{flex} - \alpha^{-1}e_0^{fix}\right) = 0 \tag{75}$$

where the second equality comes from using 54 and 70 to eliminate the terms involving the real exchange rate. The change in the risk premium is *the same* across regimes, regardless of whether the economy is financially vulnerable, and contrary to the conjectures in much of the recent policy literature.

The intuition is straightforward: as expression 38 implies, unexpected movements in the risk premium depend not just on the behavior of the real exchange rate, but on the response of overall dollar output. This is natural, as the risk premium depends on net worth relative to the value of investment, both of which depend on dollar output. Now, in this model dollar output falls by the *same* amount independently of exchange rate policy. The real exchange rate depreciates more under flexible rates, as we saw above. However, home output falls in period 0 if rates are fixed, while with flexible rates it stays constant. The net effect on the risk premium, consequently, is nil.

While the exact offset may be an artifact of the simplicity of the model, the larger point should survive generalization: risk premia depend on investment relative to net worth, a ratio that depends on several factors which react differently to movements in the real exchange rate. Hence, the sign of the association between real depreciation and movements in country risk is likely to be ambiguous.

As mentioned, home output falls on impact with fixed rates, while it stays put with flexible rates. Remarkably, the fall in home output in period 1 is also *larger* with fixed rates. To see this, notice that, with flexible rates, y_1 can be calculated, from 49 and 54 to be:

$$y_1^{flex} = -\alpha(1-\gamma\lambda)\theta\rho_1' \tag{76}$$

while, with fixed exchange rates, 65, and 70 yield

$$y_1^{fix} = -\alpha(1-\alpha\gamma\lambda)\theta\rho_1' \tag{77}$$

The difference is

$$y_1^{flex} - y_1^{fix} = \alpha(1-\alpha)\lambda\gamma\theta\rho_1' > 0 \tag{78}$$

Output in period 1 falls in both cases, but the fall is *larger* with fixed exchange rates. Hence the Mundell-Fleming wisdom that adverse real shocks imply a deeper contraction when exchange rates are fixed holds as long as $\theta > 0$.

The period 1 response of output depends entirely on the course of investment in period 0, for in period 1 wages are flexible, labor supply is at its steady state level, and therefore $y_1 = \alpha k_1$. In turn, the difference in investment depends on the difference in real domestic interest rates. Defining $r_1' = \eta_1' + \rho_1' + (e_0 - e_1)$ and using the fact that risk premia are equal across regimes we have

$$(r_1')^{flex} - (r_1')^{fix} = (e_1^{flex} - e_0^{flex}) - \left(e_1^{fix} - e_0^{fix}\right) \tag{79}$$

which, using 73 and 74 becomes

$$(r_1')^{flex} - (r_1')^{fix} = -(1-\alpha)(1-\alpha\gamma)\lambda\theta\rho_1' < 0 \tag{80}$$

Hence, the expected real depreciation is larger under fixed rates, and this keeps the domestic real interest rate high, affecting investment. Once again, this is all very much in line with the Mundell-Fleming logic.

Finally, the evolution of net worth deserves attention. As we have noted, under flexible rates it is true that the initial devaluation of the exchange rate reduces net worth since debt is denominated in dollars. But there are other forces that push in the opposite direction. The net result is that net worth is always lower under fixed rates. This can be seen by noting that, with the definitions of Q and E, equation 14 can be written as

$$1 + \eta_1 = \left(\frac{E_0^{1-\gamma} K_1}{N_0} \right)^{\mu}, \tag{81}$$

We have proven above that the L.H.S. is the same across regimes. On the R.H.S., we have also shown that both variables in the numerator are smaller under fixed rates. It follows that the denominator has to be smaller under fixed rates.

So far we have assumed that $\theta > 0$, which implies that the interest rate shock results in a real devaluation. If this is *not* the case ($\theta < 0$), the conventional conclusions from a comparison of fixed and flexible rates are overturned. Recall that, in this case, the interest rate shock would imply a real *appreciation* if wages are flexible, and a nominal appreciation if wages are sticky but exchange rates are flexible. With fixed rates, the result is an unexpected inflation, and an unanticipated expansion of home output. Output also increases in period 1 and, by 78, the increase is larger than under flexible exchange rates.

But while the conventional ranking can be reversed theoretically, this provides little ammunition to advocates of fixed rates. For this reversal requires not only that the balance sheet effect be very strong, but also that the shock cause a real appreciation and an economic expansion on impact. This is clearly implausible. In addition, our numerical work in the next section suggests that it happens only for very extreme parameter values.

What is the role of balance sheet effects in all this? Financial vulnerability means that a real devaluation increases the risk premium charged to the home economy after an unexpected increase in world interest rates. Thus understood, financial vulnerability is not, by itself, sufficient to overturn the conventional ranking of fixed versus flexible rates. If one believes that such a shock must result in a real devaluation on impact, then fixed exchange rates imply a deeper and more prolonged contraction than flexible rates whether or not there is financial vulnerability.

6 Some Numerical Explorations

In this section we parametrize our model and simulate it numerically. It is not our purpose here to perform a calibration exercise of the "real business cycle" type. Instead, we confirm the results of our analysis of the effects of an interest rate shock, as well as give some concrete quantitative perspectives of the dynamic response. We can also discuss the effects of other shocks, such as changes in the foreign demand for exports, that are more difficult to study analytically. Finally, our numerical work indicates that the cases we considered implausible on the basis of comparative dynamics can only happen with extreme parameter values.

6.1 Parametrization

We set several parameters so that some long run predictions of the model are empirically plausible. Thus, we set the steady state world interest rate to 4 percent in annual terms. The home good share in the production of capital and in the consumption index, γ, is set at 0.6, which is consistent with observed shares of imported goods in total output. The capital share in the production of the home good, α, is assumed to be 0.35, in line with standard estimates.

We choose the rest of the parameters in order to generate the cases of financial robustness and financial vulnerability discussed earlier. In order to have a robust economy, the capitalists' saving rate δ is set to 0.94 and the parameter μ in the risk premium formulation is set to 0.11. These parameters imply a steady state ratio of investment expenditures to debt (QK/SD) equal to 6 and a risk premium of 2 percent in annual terms. For a vulnerable economy, δ and μ are chosen to imply a steady state risk premium of 4 percent, in annual terms, and a ratio of investment expenditures to debt (QK/SD) that equals 1.2. In order to obtain these outcomes, the capitalist rate of saving is set to 0.92 and μ is assumed to be 0.02.

These parameters do not yield the "abnormal case" in which an increase in the world real interest causes an impact appreciation of the real exchange rate. Such a case turns out to require extreme and implausible parameter values. To generate it, we must force the a ratio of investment to debt (QK/ED) to 1.001, which implies a debt-net worth ratio (ED/PN) of 1000. In turn, such ratios require values for δ and μ far away from the benchmark. One possible combination is for δ to be 0.86 and μ to be 0.016; these values, in turn, generate a steady state risk premium of 12 percent. While it is possible to simulate the model with this set of parameters, we regard this case as too implausible for simulations to be useful. Hence we restrict the rest of our discussion to the normal cases.

6.2 Shocks to the world interest rate

Figures 3-6 show the response of the economy to a temporary, 1 percent increase in the world interest rate under flexible and fixed exchange rates. The figures are consistent with the results of the analytical sections. In particular, output falls less in the robust economy than in the vulnerable one. This follows from the role played by debt dollarization and the level of indebtedness of the economy. The increase in the world interest rate depreciates the exchange rate, which reduces the capitalists' net worth. The size of the net worth effect depends directly on the steady state debt to net worth ratio. The final effect is a bigger reduction in investment in period 0 and output in period 1 for the financially vulnerable economy.

In order to compare different exchange rate regimes, it is revealing to focus on the evolution of the *ex-post* interest rate in terms of home goods.[8] Under flexible exchange rates, the interest rate increases in both period 0 and in period 1. The increase in period 0 is explained by the unanticipated depreciation of the exchange rate, which increases the burden of the inherited debt in terms of the home good. In turn, the increase in the home goods interest rate in period 1 reflects the increase in the world interest rate. Under fixed exchange rates, the interest rate does not increase in period 0 but increases strongly in period 1. This has a more negative effect on investment, and through this on output in the next period, than under flexible rates.

Notice also, again in line with the analytical work, that movements in dollar output, and consequently in the risk premium, are the same across exchange rate regimes. And net worth is lower under fixed rates.

In our simulations for the vulnerable economy case, the real exchange rate in the second period always appreciates. This occurs because given our parametrization, the term $\varepsilon_{\eta e}$ is small. For parametrization that imply a higher elasticity of the risk premium with respect to the real exchange rate (a higher $\varepsilon_{\eta e}$), the real exchange rate in period 1 will depreciate, as it was

[8]Of course, in period 1 and thereafter *ex post* and *ex ante* real interest rates are the same.

discussed in the previous sections.

6.3 Shocks to the demand for exports

Shocks to x_t, foreign expenditure on exports, can be approached analytically as with shocks to the world interest rate. However, a change in x_0,even if temporary, affects both k_1 and η_1', and hence would shift both the EE and FF curves. So our graphical exposition is less useful here, and it is more efficient to look at impulse responses directly.

The response of the economy to a temporary, one percent *decrease* in exports under flexible and fixed exchange rates is described in Figures 7-10. This shock creates a "transfer problem" and, under normal circumstances, adjustment will require a real devaluation. This is indeed the case with our parameter values.

The figures show that financial vulnerability is associated, even after a partial output recovery in period 1, with a clearly deeper and more protracted recession than in the case of financial robustness. In this sense, vulnerability exacerbates the adverse effects of the foreign demand shock.

Again, this does not mean that fixed exchange rates are more successful in dealing with the shock. Irrespectively of whether the economy is robust or vulnerable, output does not respond on impact if rates are flexible: since the price level is kept constant, the real wage does not respond to the shock, and neither does output. However, the fall in exports leaves room for more investment, and hence there is an initial increase in investment that generates an increase in period 1 output.

Under fixed rates, on the other hand, output falls in period 0. As in the case of an interest rate shock, the required real depreciation is attained through deflation, which increases the real wage and reduces output. As a consequence, investment has less room to increase, and the initial loss in output is followed by a close-to-nil increase in output.

As in the case of interest rate shocks, the behavior of the risk premium is the same across regimes. The intuition is essentially the same: the risk premium is affected not only by the exchange rate but also by the behavior of the output. In both cases dollar output is the same and, again, in the period of the shock net worth end up higher under flexible rates.

So, although obviously some details differ, the analysis of the foreign demand shock is similar to that of the interest rate shock. In particular, and in line with the Mundell -Fleming model, the contraction of output is deeper with fixed exchange rates.

7 Final Remarks

Financial fragility is commonly cited nowadays as sufficient reason to discard flexible exchange rates and adopt pegs, currency boards and even dollarization. Greater fixity of exchange rates may well be justified on many economic and non-economic grounds. But, this paper suggests, financial fragility alone does not amount to a water-tight case against floating.

Financial fragility can mean different things to different people. Here we have focused on perhaps the most common definition in policy discussions, which links real exchange rates, debt service needs and the balance sheet of firms, and the country risk premium. According to this view, large debts denominated in foreign currency render an economy financially fragile, in that real devaluations destroy net worth and become contractionary and/or destabilizing.

What this view fails to recognize is that firms' creditworthiness depends on a number of factors, which in turn react differently to movements in the real exchange rate. In our simple model, and for a given degree of financial fragility, it is movements in dollar output (not in the real exchange rate alone) that determine the evolution of the risk premium. Different exchange rate policies affect the breakdown of dollar output between quantity and price – with flexible rates delivering a larger initial real depreciation but also a higher level of home output in the aftermath of a shock– but not the evolution of dollar output itself. Different degrees of financial fragility can change the size and persistence of real effects *across* exchange rate regimes, but not the comparison *between* regimes.

A related point is that, if a real shock calls for a real depreciation, this will happen regardless of the exchange rate policy in place. What policy can affect is the distribution of the real depreciation over time, with fixed rates minimizing the size of the initial shift in relative prices. But the other side of this coin is that, after the initial period, *expected* real depreciations are higher under fixed rates and so are, therefore, domestic real interest rates. This *also* has deleterious effects on balance sheets, as well as reducing investment and future output.

The model in this paper is very simple –so much so that it can be handled analytically. We obtained that simplicity at the expense of some assumptions that rigor-minded readers may find distasteful. Households do not have access to the capital market, and therefore cannot save; capitalists' saving rate is exogenous and constant; capital depreciates fully; wages are pre-set for only one period; debt is arbitrarily (though plausibly) assumed to be denominated in terms of the foreign good; the monetary sector is not fully specified. All these limitations in the analysis could be lifted, but at the obvious cost of much complication. We are confident that the main conclusions of the analysis would survive, but that conjecture remains to be proven.

A more powerful objection is that here we have solved the model under a particularly simple and implausible specification of shocks. A solution to the fully stochastic model would change matters in several respects. An important one is that the expected greater variability of relative prices under floating could endogenously affect the equilibrium risk premium. But that need not turn the policy balance in favor of fixed rates. Large expected variability of relative prices would also create incentives for domestic capitalists to denominate their foreign borrowing in terms of home rather than foreign goods. With less "dollarization" of liabilities the link between real exchange rate movements and financial fragility would be greatly weakened, as Hausmann and Eichengreen (1999) and a number of other analysts have observed.

8 Appendices

8.1 The risk premium

The purpose of this appendix is to sketch a justification for our specification of the risk premium (equations 14 and 16 in the main text). In the open economy this problem has been studied by Cespedes (2000). The argument outlined below follows Bernanke, Gertler, and Gilchrist (1998, henceforth BGG) closely, but our specification of the risk premium may be derived under other assumptions.

Consider the contracting problem between a single entrepreneur, indexed by j, and foreign lenders in any period t. At the time of contracting, j's net worth $(P_t N_t^j)$, the dollar interest rate (ρ_{t+1}), and prices in period t are known. For now, assume also that the period $t+1$ rental rate on capital in dollars, R_{t+1}/S_{t+1}, is known; this assumption will be dropped shortly.

Entrepreneurs and foreign creditors are risk neutral. Their joint problem is to choose a level of investment (K_{t+1}^j), a dollar loan (D_{t+1}^j), and a repayment schedule so as to maximize the expected return to the entrepreneur, such that creditors are paid at least their opportunity cost of funds, and subject to resource and information constraints. The latter are described as follows. Investment in period t, K_{t+1}^j, yields $\omega_{t+1}^j K_{t+1}^j (R_{t+1}/S_{t+1})$ dollars next period, where ω_{t+1}^j is a random shock. The distribution of ω_{t+1}^j is public information and is such that ω_{t+1}^j is i.i.d. across j and t, and its expectation is one. Crucially, as in Townsend (1979) and Williamson (1987), we assume that the realization of ω_{t+1}^j cannot be observed by lenders unless they pay a proportional monitoring cost of $\zeta \omega_{t+1}^j K_{t+1}^j (R_{t+1}/S_{t+1})$; in contrast, ω_{t+1}^j is observed freely by the entrepreneur.

Under these conditions, it has been shown by Williamson (1987) that the optimal contract is a *standard debt contract*. Such a contract stipulates a fixed repayment, say of B_{t+1}^j dollars; if the entrepreneur cannot repay that amount, lenders monitor the outcome and seize the whole yield on the investment. Clearly, monitoring occurs only if the realization of ω_{t+1}^j is low enough. Letting $\bar{\omega}$ be such that $B_{t+1}^j = \bar{\omega} K_{t+1}^j (R_{t+1}/S_{t+1})$, monitoring occurs if and only if ω_{t+1}^j is below $\bar{\omega}$, an event interpretable as bankruptcy.

The resulting problem is formally identical to that analyzed in Appendix A of BGG. For our purposes, its key feature is that, to provide the lender with an expected return of ρ_{t+1}, it must be the case that

$$K^j_{t+1}(R_{t+1}/S_{t+1})\left\{[\bar{\omega}(1-G(\bar{\omega}))+(1-\zeta)\int_0^{\bar{\omega}}\omega^j_{t+1}dG(\omega^j_{t+1})]\right\}=(1+\rho_{t+1})D^j_{t+1}$$
$$=(1+\rho_{t+1})(Q_tK^j_{t+1}-P_tN^j_t)/S_t \tag{82}$$

where $G(.)$ denotes the c.d.f. of ω^j_{t+1}. The LHS gives the expected dollar yield on investment. With probability $1-G(\bar{\omega})$ there is no bankruptcy, and lenders are repaid $B^j_{t+1}=\bar{\omega}K^j_{t+1}(R_{t+1}/S_{t+1})$. With probability $G(\bar{\omega})$, the entrepreneur goes bankrupt, and lenders are repaid whatever is left after monitoring costs; this is the term $(1-\zeta)K^j_{t+1}(R_{t+1}/S_{t+1})\int_0^{\bar{\omega}}\omega^j_{t+1}dG(\omega^j_{t+1})$. The RHS gives the opportunity cost of the loan D^j_{t+1}. The final line takes into account that the loan must equal the value of investment minus the entrepreneur's net worth.

The optimal contract maximizes the entrepreneur's utility subject to 82. As in Williamson (1987), a key aspect of the contract is that it minimizes expected monitoring costs. Moreover, expected monitoring costs decrease with net worth, which should be intuitive.

BGG show that the solution to the contract problem implies

$$Q_tK^j_{t+1}=\Upsilon(\frac{R_{t+1}S_t}{Q_t(1+\rho_{t+1})S_{t+1}})P_tN^j_t$$

where Υ is a real valued function such that $\Upsilon(1)=1$, and $\Upsilon'(x)>0$ at least for values of x close to one. Aggregating over j one thus obtains

$$\frac{Q_tK_{t+1}}{P_tN_t}=\Upsilon(\frac{R_{t+1}S_t}{Q_t(1+\rho_{t+1})S_{t+1}}) \tag{83}$$

Under perfect foresight, 14 and 16 now follow immediately from 4 and 83; in particular, the function F is given by the inverse of Υ. If R_{t+1}/S_{t+1} is uncertain as of the time of contracting, BGG show that R_{t+1}/S_{t+1} can be replaced by $_t\,(R_{t+1}/S_{t+1})$, at least in the case in which borrowers assume aggregate risk.

Two additional details deserve comment. First, it is only a matter of accounting to show that the economy's net worth in any period t must equal aggregate capital income minus foreign debt repayment, as given by equation 17 in the text. Second, our assumption in the text is that entrepreneurs consume a fraction $(1-\delta)$ of their net worth and reinvest the rest. This can be derived from more primitive assumptions; for instance, one can assume that an individual entrepreneur j "dies" in period $t+1$ with probability $(1-\delta)$, and that surviving entrepreneurs are patient enough so that they choose not to consume their wealth until death.[9]

8.2 Solving for the Saddlepath

Here we justify some of the assertions in subsection 3.3. The definition of the matrix Φ implies that $\mathrm{Tr}(\Phi) = \left(\frac{1-\lambda}{\lambda}\right)(1+\mu)+2 > 1$, and $\mathrm{Det}(\Phi) = \lambda^{-1} > 1$. Since the determinant, which is equal to the product of the roots of Φ, is larger than 1, it follows that both roots cannot be below 1. If ζ_i, $i = 1, 2$, are the roots of Φ, then

$$\zeta_i = \frac{\left(\frac{1-\lambda}{\lambda}\right)(1+\mu) + 2 \pm \sqrt{\left[\left(\frac{1-\lambda}{\lambda}\right)(1+\mu)+2\right]^2 - 4\lambda^{-1}}}{2} \tag{84}$$

If one root is smaller than one, it has to be the smaller root. This requires

$$\left(\frac{1-\lambda}{\lambda}\right)(1+\mu) + 2 - \sqrt{\left[\left(\frac{1-\lambda}{\lambda}\right)(1+\mu)+2\right]^2 - 4\lambda^{-1}} < 2 \tag{85}$$

which, a little algebra reveals, is always the case, regardless of the size of μ. We conclude that the system displays saddle path stability.

Now the computation of the saddle path equation is a standard exercise, which yields

$$\beta = -\frac{2}{\left(\frac{1-\lambda}{\lambda}\right)(1+\mu) + \sqrt{\left[\left(\frac{1-\lambda}{\lambda}\right)(1+\mu)+2\right]^2 - 4\lambda^{-1}}} < 0 \tag{86}$$

[9] To keep the number of entrepreneurs constant, one can assume that each dead entrepreneur is replaced by a newborn one. A minor problem arises since new entrepreneurs must have some initial net worth to be able to borrow. This can be remedied by assuming that new entrepreneurs are born with an exogenous and arbitrarily small endowment, or that they have a small endowment of labor (as in Carlstrom and Fuerst 1998). The effects of either assumption would be negligible, and so we ignore this issue in the text.

References

[1] Aizenman, Joshua, and Jacob A. Frenkel, "Optimal Wage Indexation, Foreign Exchange Intervention, and Monetary Policy," *American Economic Review*, 73, 3, June 1985: 402-423.

[2] Bernanke, B. and M. Gertler, "Agency costs, Net worth, and Business Fluctuations," *American Economic Review* 79, 1989, 14-31.

[3] Bernanke, B. , M. Gertler and S. Gilchrist, " The Financial Accelerator in a Quantitative Business Cycle Framework," NBER Working Paper 6455, March 1998.

[4] Calvo, G. "Fixed vs. Flexible Exchange Rates: Preliminaries of a Turn-of-Millennium Rematch," May 1999. In http://www.bsos.umd.edu/econ/.

[5] Calvo, G. "Capital Market And The Exchange Rate With Special Reference to the Dollarization Debate in Latin America," April 2000. In http://www.bsos.umd.edu/econ/.

[6] Céspedes, L. "Credit Constraints and Instability in a Small Open Economy," mimeo NYU, April 2000.

[7] Dixit, A. and J. Stiglitz. "Monopolistic Competition and Optimum Product Diversity," *American Economic Review 67*, 1977, 297-308.

[8] Eichengreen, B. and R. Hausmann, "Financial Fragility and Exchange Rates." Paper presented at the Annual Conference of the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, August 1999.

[9] Flood, Robert P., and Nancy P. Marion, "The Transmission of Disturbances under Alternative Exchange-Rate Regimes with Optimal Indexing," *Quarterly Journal of Economics*, 97, 1, February 1982: 43-66.

[10] Galí, J., and T. Monacelli, "Optimal Monetary Policy and Exchange Rate Volatility in a Small Open Economy," November 1999.

[11] Krugman, P. "Balance Sheets, the Transfer Problem and Financial Crises," in: International Finance and Financial Crises, P. Isard, A. Razin and A. Rose (eds.), Kluwer Academic Publishers, 1999.

[12] Krugman, P., "Analytical Afterthoughts on the Asian Crisis." in http://web.mit.edu/krugman/www/MINCRIS.htr.

[13] Obstfeld, M. and K. Rogoff, "Exchange Rate Dynamics redux," *Journal of Political Economy* 103, 1995, 624-660

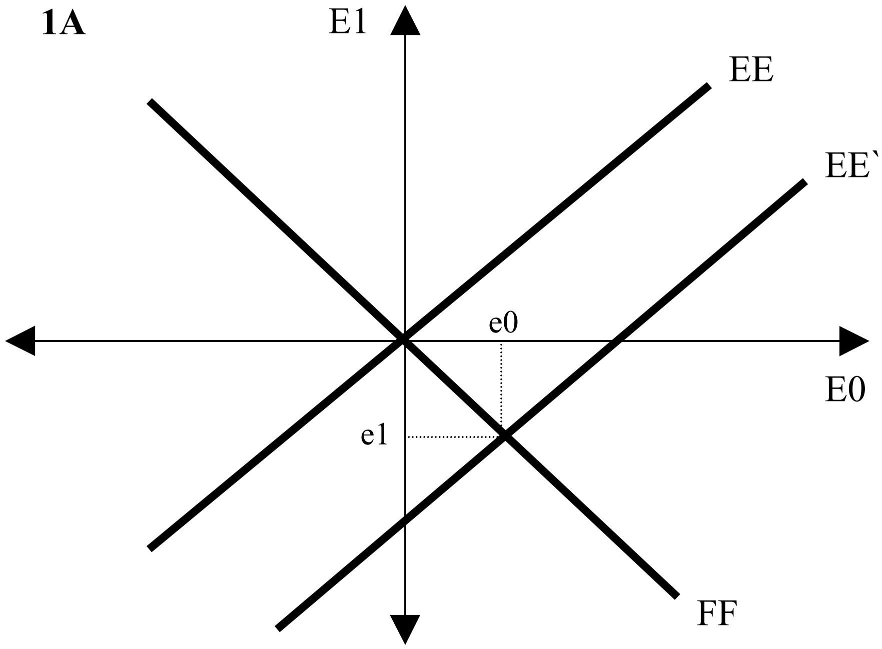
[14] Obstfeld, M. and K. Rogoff, "New Directions for Stochastic Open Economy Models," *Journal of International Economics* 50, 2000, 117-154.

[15] Stein, E. H.; Hausmann, R.; Gavin, Michael; Pagés-Serra, C., "Financial Turmoil and Choice of Exchange Rate Regime," working Paper, Research Department, IADB, January 1999. Also in http://www.iadb.org/oce.

[16] Williamson, S. "Costly Monitoring, Loan Contracts, and Equilibrium Credit Rationing," *Quarterly Journal of Economics* 1987, 102, 135-45.

Figure 1: Financially Robust
Flexible Exchange Rates

1A



1B

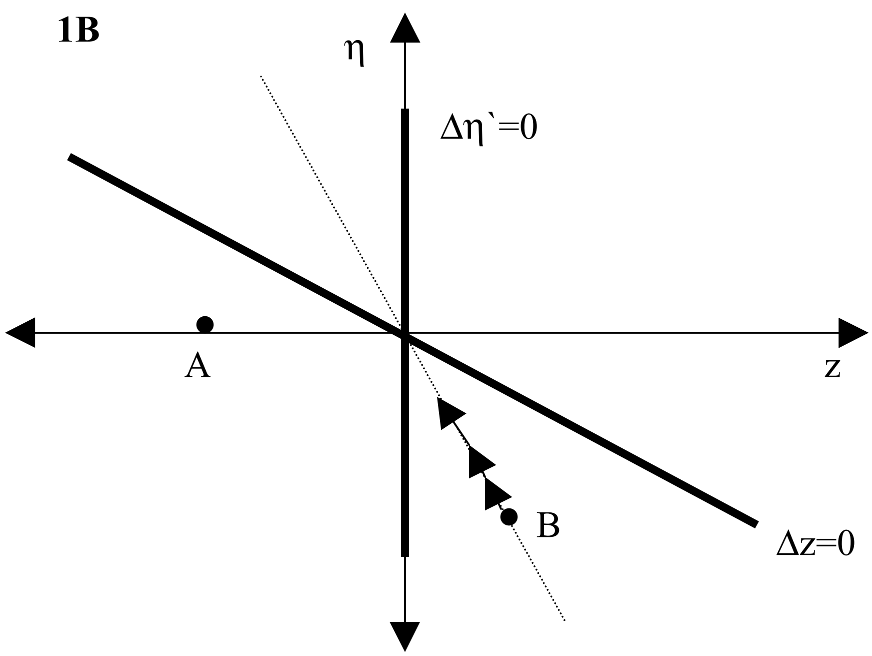


Figure 2: Financially Vulnerable
Flexible Exchange Rates

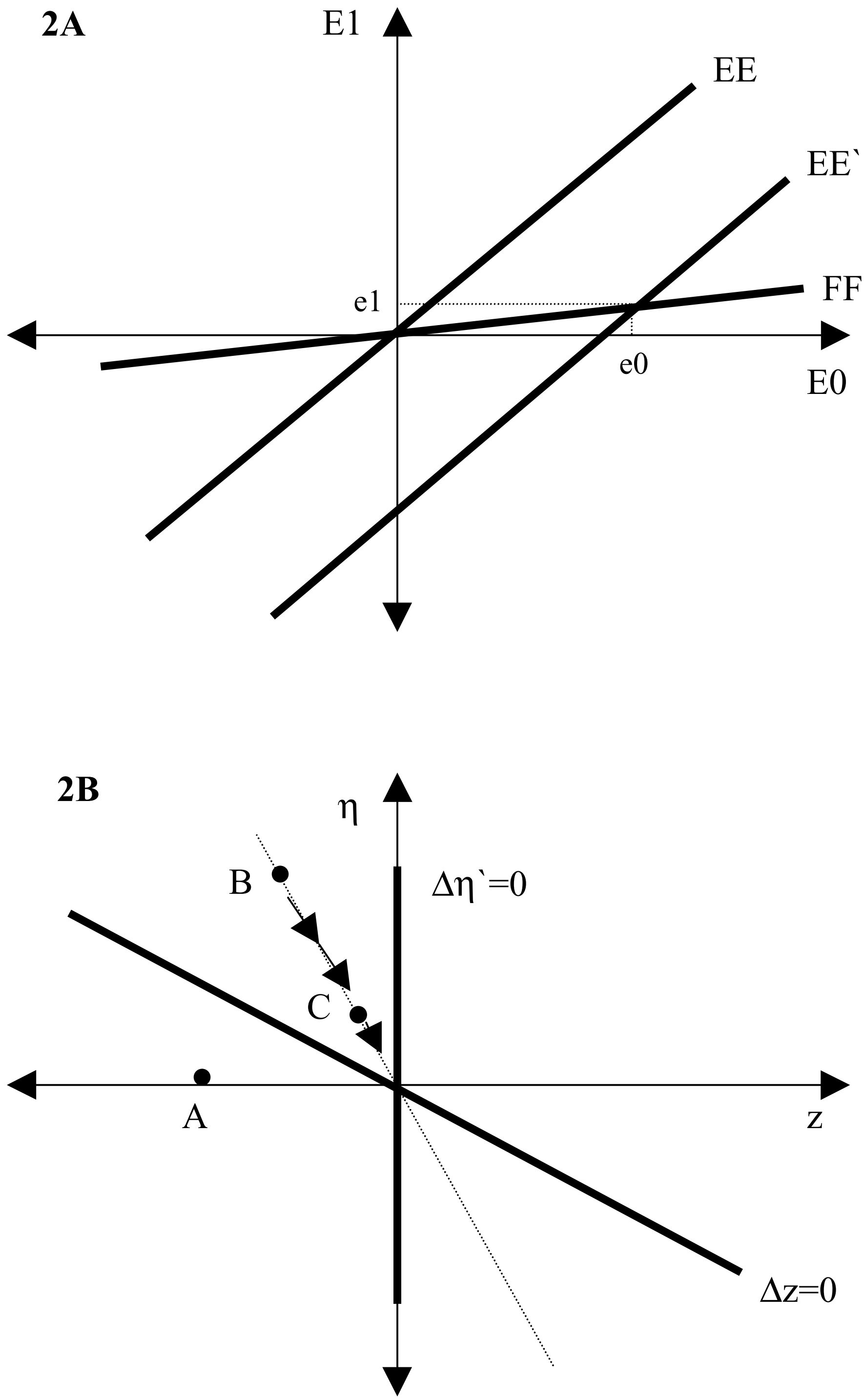


Figure 3: Financially Robust Economy
Flexible Exchange Rates
Impulse Responses to a World Interest Rate Shock

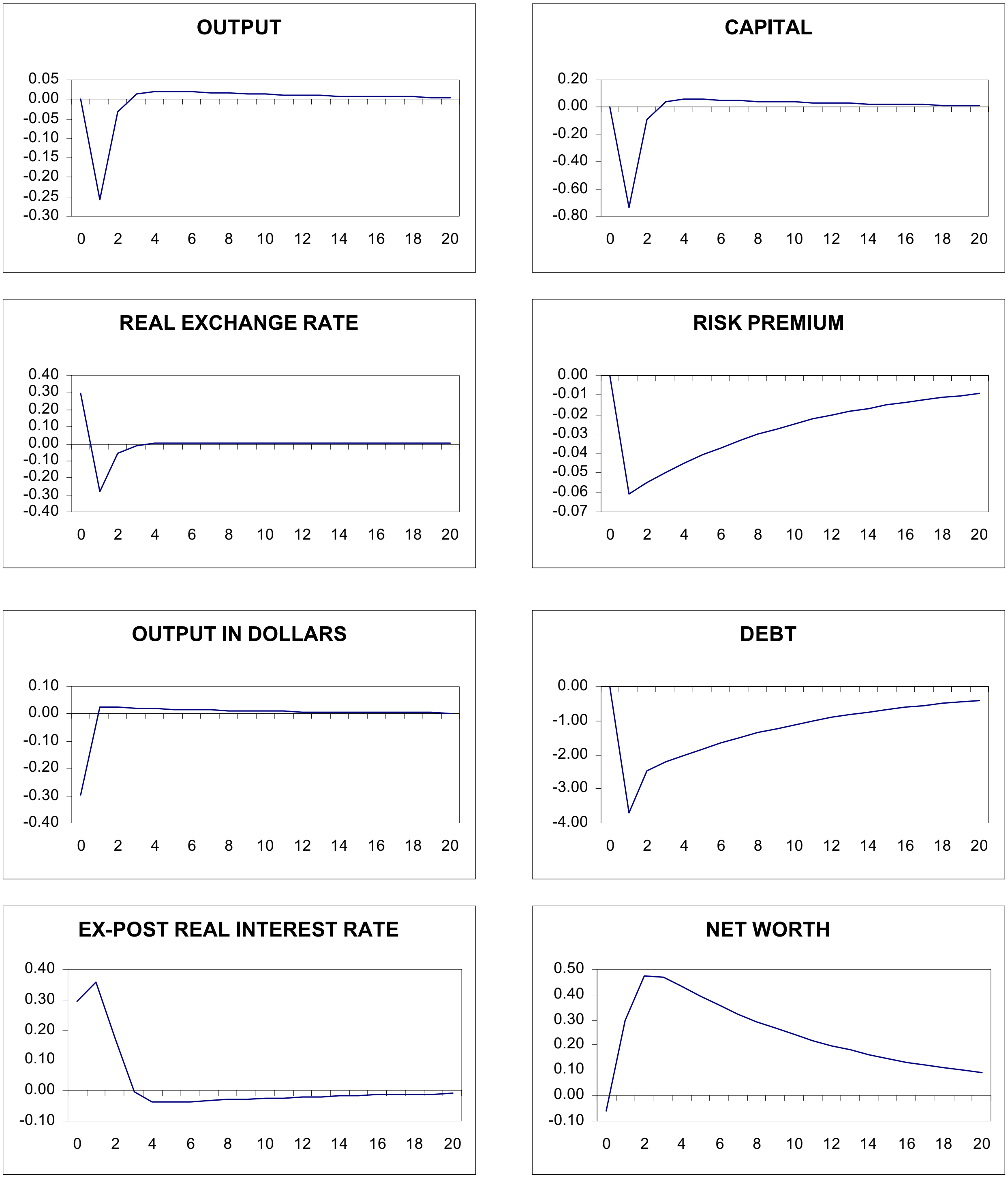


Figure 4: Financially Vulnerable Economy
Flexible Exchange Rates
Impulse Responses to a World Interest Rate Shock

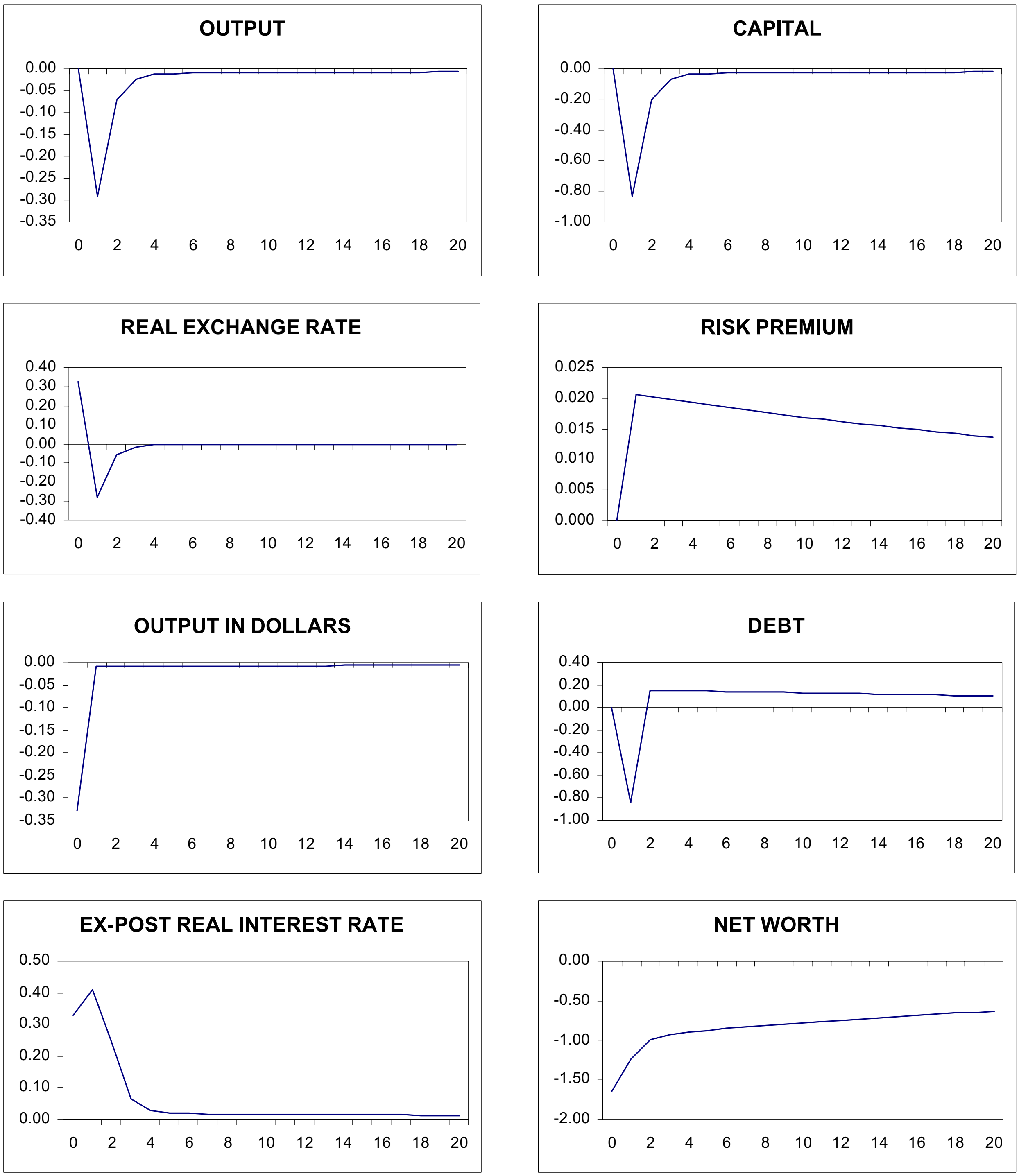


Figure 5: Financially Robust Economy
Fixed Exchange Rates
Impulse Responses to a World Interest Rate Shock

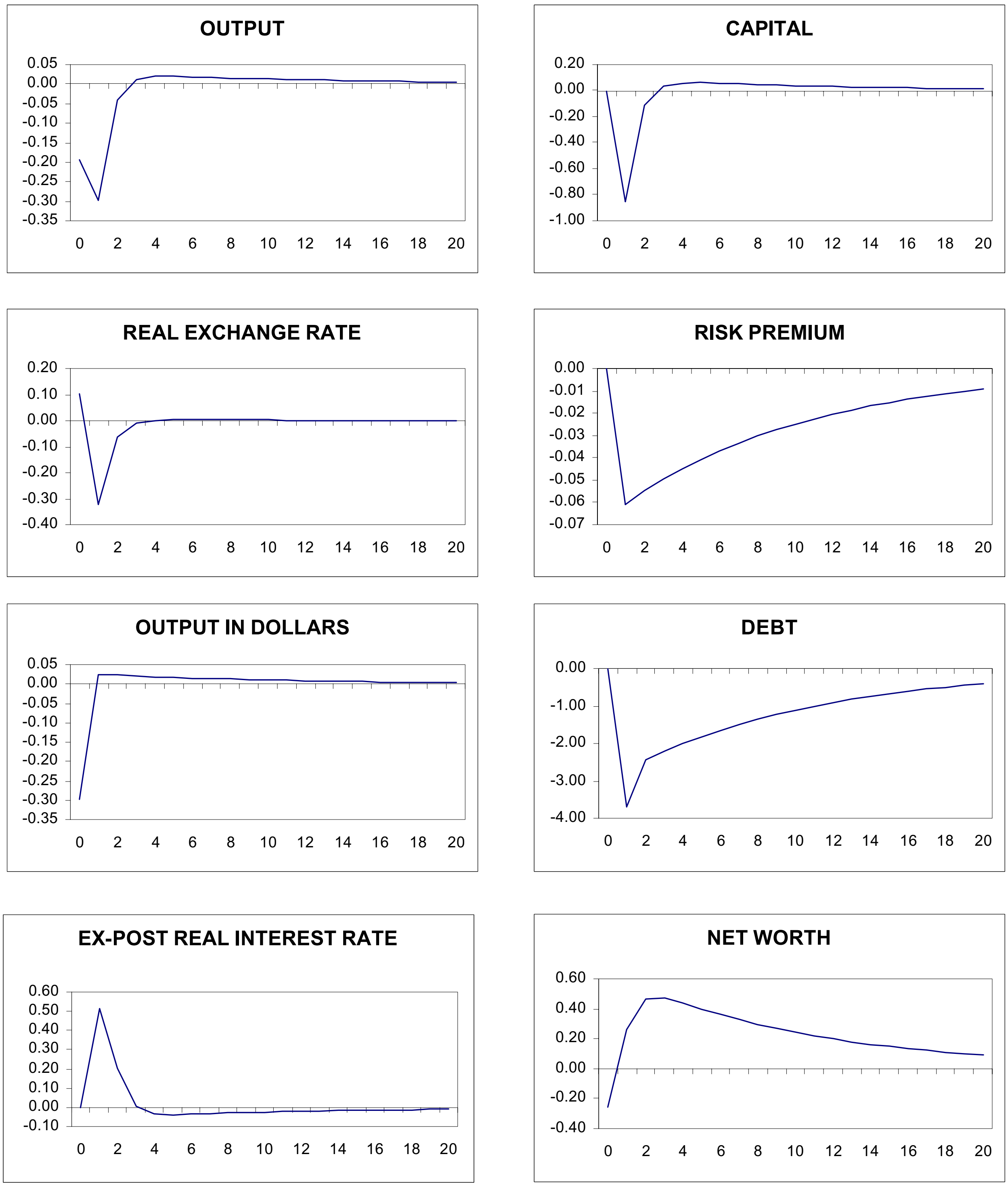


Figure 6: Financially Vulnerable Economy
Fixed Exchange Rates
Impulse Responses to a World Interest Rate Shock

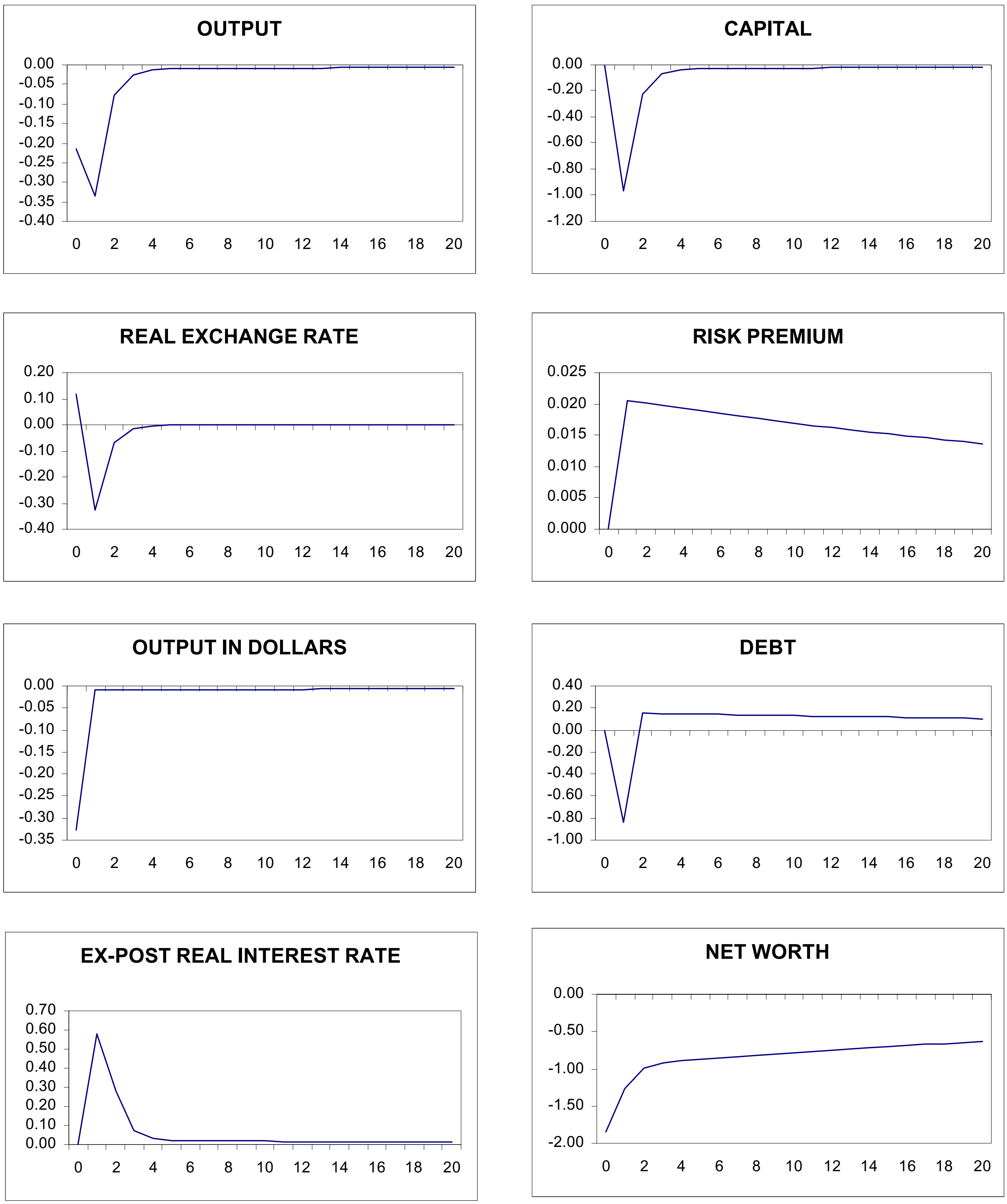


Figure 7: Financially Robust Economy
Flexible Exchange Rates
Impulse Responses to an Export Shock

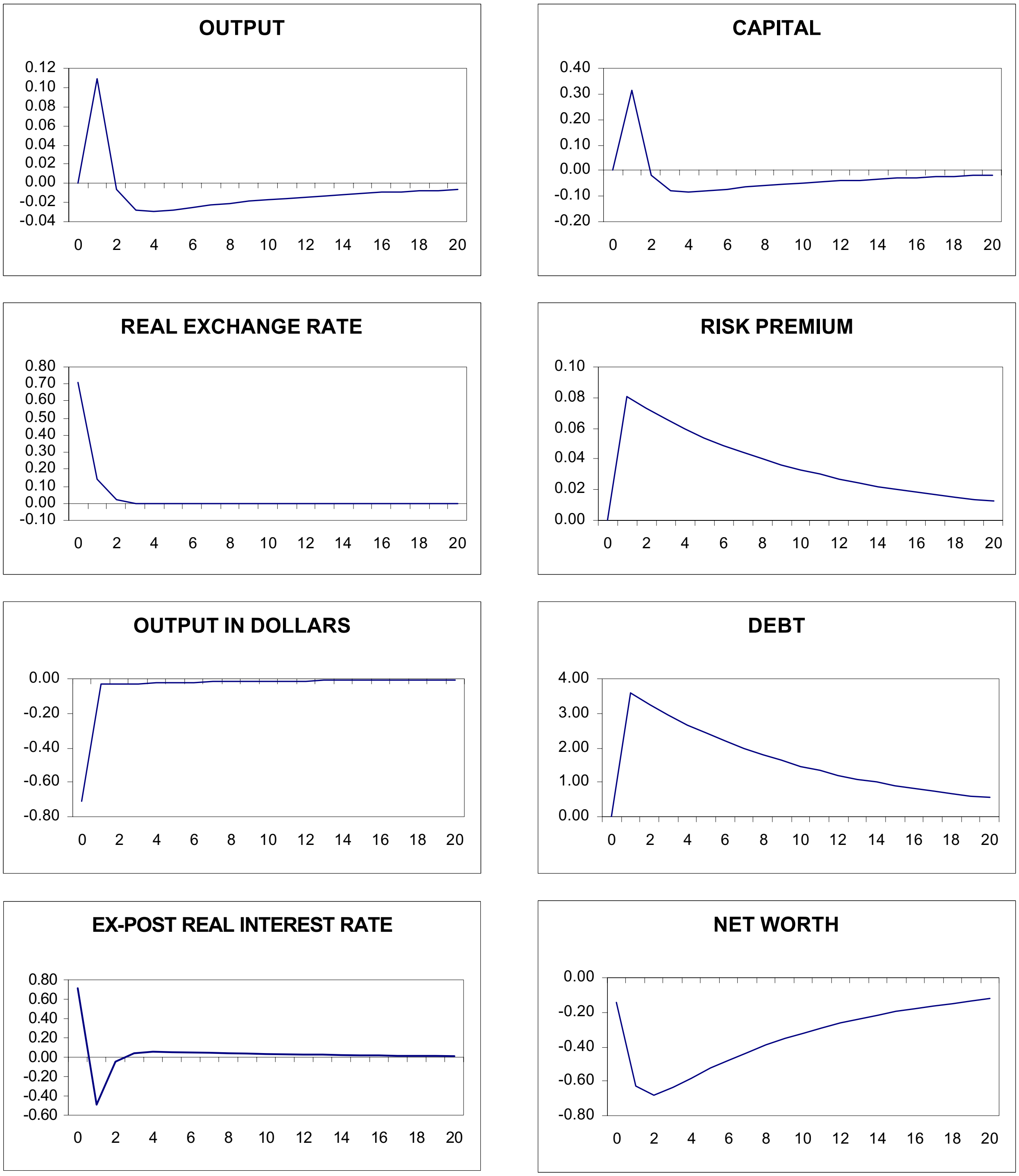


Figure 8: Financially Vulnerable Economy
Flexible Exchange Rates
Impulse Responses to an Export Shock

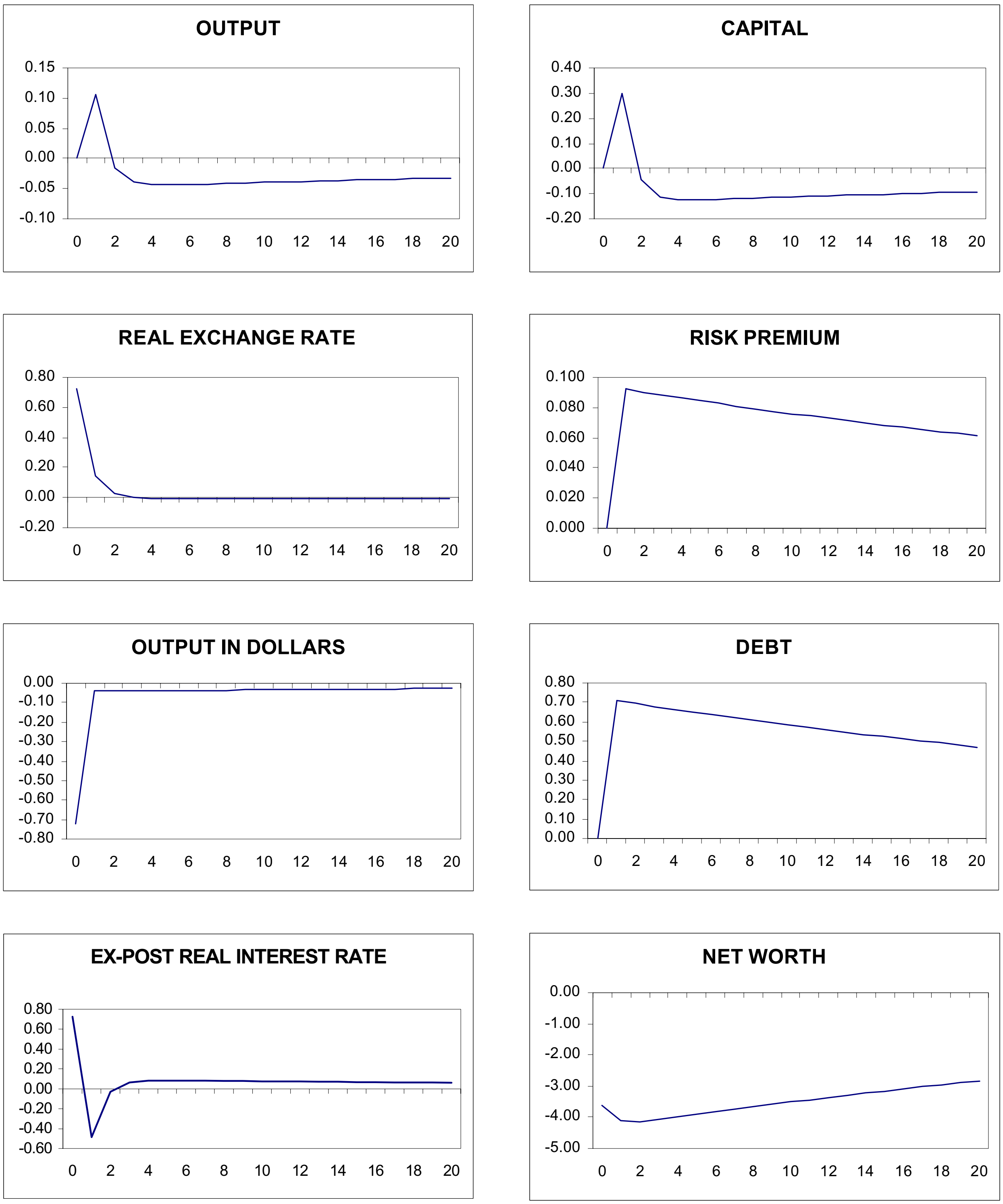


Figure 9: Financially Robust Economy
Fixed Exchange Rates
Impulse Responses to an Export Shock

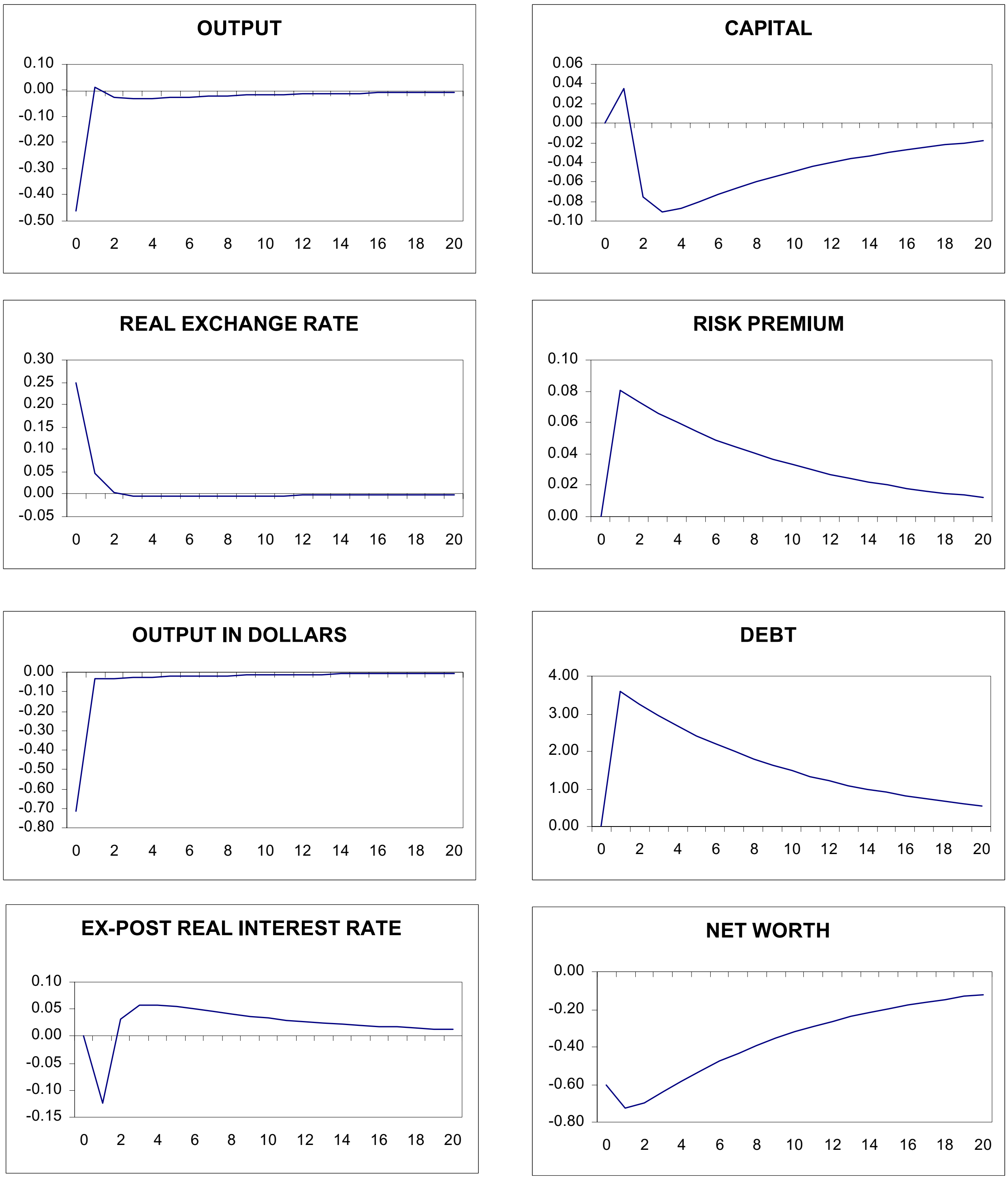


Figure 10: Financially Vulnerable Economy
Fixed Exchange Rates
Impulse Responses to an Export Shock