Financial Exposure, Exchange Rate Regime and Fear of Floating*

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Abstract

We construct a dynamic general equilibrium model of a small open economy where domestic entrepreneurs face borrowing constraints and finance their investment projects both in domestic and international capital markets. We parametrize the degree of financial exposure as the fraction of borrowing expressed in foreign units of denomination, and study its interaction with alternative exchange rate regimes. We find that a regime of flexible exchange rates greatly amplifies, relative to fixed rates, the response to domestic shocks. However, when financial exposure is high investment can fall and financial conditions can worsen in response to favorable productivity shocks, due to detrimental balance-sheets effects. Asset price volatility and overall financial instability are found to be monotonically increasing in financial exposure. In response to a rise in world interest rates, higher financial exposure greatly worsens the performance of flexible exchange rates (relative to the case with no exposure), so that the acclaimed insulating role of the latter (relative to fixed) barely applies to output and vanishes for financial variables. In general, the higher the degree of financial exposure, the closer the resemblance between flexible and fixed exchange rates, a result that provides a theoretical background for a fear-of-floating argument.

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1 Introduction

The open economy macroeconomics literature is in search of a new paradigm. It is a typical perception among researchers that the discipline is moving rapidly towards the definition of a new Mundell-Fleming framework.[1] A striking flaw of that framework, for instance, is that it neglects the role of the financial structure of the economy. It is instead becoming increasingly fashionable in the macroeconomic debate to refer to wider economic and financial integration as the main features of the evolution of both industrialized and emerging market (EM) economies in the last years. [2]

In this paper we propose a general framework to study the interaction between exchange rate regime and financial variables in an economy characterized by credit market frictions. We devote particular attention to the role of financial exposure. We define by that the possibility for liquidity constrained firms to access loans in foreign units of denomination. This phenomenon, more commonly defined as dollarization of liabilities, is perceived as a prominent feature of the financial sector in EM economies. In Figure 1, foreign currency deposits as a share of M2 for a cross-section of countries is reported.[3] The phenomenon is widespread and significant in size (as evident from the figure), but also it shows signs of an upward trend, as documented in Honohan and Shi (2002).[4]

The aim of our analysis is to study both the real and the financial effects of firms' balance sheets being increasingly sensitive to fluctuations in the exchange rate. This aspect has been often emphasized in the recent debate on the dangers and virtues of dollarization[5]. In particular it has been stressed that a pervasive evidence of "fear floating"(especially for EM)[6] may be rationalized in economic contexts where liabilities display a high degree of dollarization and exchange rate pass-through is rapid. Our theoretical framework features

[1]Lane (2000), Obstfeld and Rogoff (2001).

[2]The macroeconomic literature has only recently started to embed the role of credit market frictions in general equilibrium models of the small open economy. Recent contributions are Gertler, Gilchrist and Natalucci (2000), Chang, Cespedes and Velasco (2001) and Devereux-Lane (2001).

[3]For each country the average yearly value in the sample 1994-2000 is reported. The whole sample comprises 58 countries, 34 of which with a percentage of foreign currency deposits in M2 greater or equal to 20 percent.

[4]Honohan and Shi (2002) report also data on foreign currency deposits as a share of total deposits. These data provide an even more robust evidence on the average size.

[5]Calvo (2000), Calvo and Reinhart (2000) among many others.

[6]Calvo and Reinhart (2000).

both these elements. One of its key predictions is that the dynamics implied by alternative exchange rate regimes (floating and fixed, or hard pegs) are highly sensitive to the degree of financial exposure. In particular, our model predicts that the higher the degree of financial exposure the closer a regime of floating tends to mimic one of fixed exchange rates. This result provides, within the context of a coherent optimizing general equilibrium model, some foundations for the "fear of floating" argument. As emphasized by Calvo (2000), in fact, if flexible exchange rates fail to provide a clear advantage over hard pegs as far as macroeconomic and financial stability in particular are concerned, the typical benefits from commitment of a fixed exchange rate system may be a sufficient condition for explaining the widespread concern for fully flexible exchange rates.

One dimension we stress in this paper is that it is important to distinguish between internal - e.g., driven by productivity - and external - e.g., driven by world rate shocks - sources of real depreciations. We begin by focusing our attention on internal sources of depreciation, and in particular on the following question. If investment opportunities in an open economy become unexpectedly favorable (due for example to a positive productivity shock) does the choice of the exchange rate regime matter ? We show that it is indeed the case. In a market characterized by frictions in the access to credit - i.e., where firms face an external finance premium that depends on collateral due to the presence of an agency problem - the response of monetary policy to shocks is crucial in triggering an interaction between the financial and the real side of the economy. The increase in profits and asset prices due to the enhanced productivity improves firms' net worth and therefore reduces the external finance premium. This effect boosts investment beyond the equilibrium response implied by the increase in the rate of return to capital. A central result we establish is that the business cycle properties of the risk premium vary across exchange rate regimes. The latter tends to fall in a regime of flexible exchange rates whereas it rises under fixed. This mechanism contributes crucially in making a regime of flexible exchange rates an amplifier of underlying structural disturbances, both on the real and the financial side of the economy.

However we show that the result above is highly sensitive to the degree of financial exposure of the economy. This is the more novel take of our paper. To explore the role of larger exposure, we assume that domestic entrepreneurs have access to a portfolio of loans denominated both in domestic and foreign units of consumption. Therefore firms' collateral and, in equilibrium, the external finance premium are sensitive to fluctuations in the real exchange rate.[7] We show that the higher is the degree of financial exposure the lower is the amplification effect that a regime of flexible exchange rates is able to deliver. In response to a positive productivity shock and in the presence of nominal price stickiness, both the nominal and the real exchange rate depreciate. On the one hand the fall in the interest rate under floating determines a fall in real rates, an increase in the net worth and a fall in the risk premium. However the larger is the portion of debt denominated in foreign units, the smaller is the increase in creditworthiness of the firm, and therefore the smaller the amplifying effect of flexible exchange rates. For a reasonable parametrization of the model, it is shown that if the economy is highly "dollarized", and due to detrimental balance sheets effects, investment can even fall and financial conditions worsen in response to a favorable productivity shock. Among other things we also show that higher financial exposure implies a sizeable effect on financial instability, in the form of larger volatility of asset prices and investment returns.

We finally explore the consequences on the domestic economy of an external source of real depreciations, i.e. a rise in world interest rates. We ask what kind of both real and financial distress the economy may experience depending on the monetary policy regime adopted. We first show that the real effects of such a shock are strikingly different under an exchange rate peg as opposed to a float. Under a currency peg, the real rate of interest, the overall cost of debt and the external finance premium rise much more than under a float. This implies that the fall in net worth and asset prices is more pronounced. The result is a more dramatic fall in investment and capital accumulation. This causes a fall in output under fixed rates, while it generates a slight expansion under a float. We argue that higher financial exposure has in this case two important effects. First, it greatly worsens the performance of flexible exchange rates relative to the case with no exposure. Second, the acclaimed insulating role of flexible exchange rates relative to fixed barely applies to output and vanishes for financial variables. This result suggests that flexible exchange rates may induce a macroeconomic outcome at least as disruptive as fixed exchange rates in the face

[7] In the recent debate on dollarization for emerging market economies the literature has labelled this as the "balance sheet effect". Cespedes et al (2001) conclude that balance sheet effects cannot per se rationalize a fear of floating and that the insulating properties of flexible exchange rates traditionally stressed by the Mundell-Fleming paradigm survive in the general equilibrium specification. The novel feature of our framework is that we argue (see ahead) that this statement is not necessarily true and that it may be an outcome of the simplifying features of their framework.

of a financial distress caused by external shocks, thereby providing a theoretical justification for a fear-of-floating argument.

The remainder of the paper is as follows. Section 2 describes the model economy. Section 3 compares the performance of the economy in response to a domestic productivity shock across alternative exchange rate regimes, and evaluates the effect of different degrees of financial exposure. Section 4 analyzes the degree of financial stress induced in the domestic small economy by a rise in world interest rates. Section 5 concludes.

2 The Model

We develop an optimizing model of the international general equilibrium with nominal price stickiness, endogenous monetary policy, financial frictions in the process of capital accumulation and loan acquisition and complete markets for state-contingent consumption claims.

The world is divided in two regions: a domestic small economy, which is characterized by a certain degree of economic openness, and the world economy, which acts as a closed economy and whose dynamics are taken as given by the residents of the small economy. The domestic economy is populated by two sets of heterogeneous households: *Workers* and *Entrepreneurs*. Each type is simultaneously a consumer and a producer. These two sets of agents account for a total measure of one, with the size of each set being exogenously determined.

2.1 The Allocation of Risk

The main feature that distinguishes the Workers is that they can insure consumption from wealth shocks. They consume, supply labor, save in the form of an internationally traded state contingent bond along with domestic and international deposits. They also act as producers of a monopolistic competitive production sector with a random pricing technology. The Workers are typically risk averse. But they can fully insure the risk stemming from the random pricing technology by investing in the state contingent asset. Notice that this state-contingent asset is designed according to the particular distribution of states associated with the random pricing risk. In other words, it is not appealing for the insurance of a different type of risk.

The Entrepreneurs, on the other hand, do not have access to wealth insurance markets. They consume, act as producers in a competitive production sector that employs capital as a production input, and face borrowing constraints on capital investment, whose return is subject to an idiosyncratic uninsurable shock. In the same domestic economy a competitive and risk neutral intermediary obtains funds from the deposits and supplies loans to the Entrepreneurs who utilize them to purchase capital. Due to the presence of asymmetric information for the realization of the idiosyncratic shock on capital return an external price for funds is charged. Notice that by assumption the Entrepreneurs do not have any incentive to invest in the state-contingent asset. In fact that asset is designed for a different type of risk. Therefore, in order for the Entrepreneurs to accept to fully bear the default risk, we assume that they are risk neutral.

Finally, the rest of the world is an optimizing large (and approximately closed) economy populated by an infinitely lived household. This household consumes, supplies labor, invests in the state contingent bond and acts as a producer in a monopolistic competitive sector that produces final differentiated goods using labor only. There is no migration across the two economies and capital is produced and traded only domestically.

2.2 The Small Open Economy: Unconstrained Workers Decisions

Each country is experiencing at each period t one of the infinite events s_t, whose history is defined by $s^t = \{s_0, ...s_t\}$ and whose probability is given by $\pi(s^t)$. The initial realization s_0 is given. We start the description of the small open economy by modelling the Workers' behavior. There is a continuum of workers indexed by i. In the following, however, we drop the index i in order to simplify the notation.

Total consumption for worker i is given by:

$$C \equiv [(1-\gamma)^{\frac{1}{\eta}} C_H^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} C_F^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{1}$$

where $C_H \equiv \left(\int_0^1 C_H(\tau)^{\frac{\vartheta-1}{\vartheta}} d\tau\right)^{\frac{\vartheta}{\vartheta-1}}$ and $C_F \equiv \left(\int_0^1 C_F(\tau)^{\frac{\vartheta-1}{\vartheta}} d\tau\right)^{\frac{\vartheta}{\vartheta-1}}$denote consumption baskets of differentiated home and foreign goods respectively, γ is the share of foreign goods in the total consumption index, η is the elasticity of substitution between domestic and foreign goods, τ is the variety of each good and ϑ is the elasticity of substitution between varieties.

The Workers solve a two-stage maximization problem. In the *first stage* they choose the demand for each variety of good $C_H(\tau)$, $C_F(\tau)$ and for the optimal amount of consumption of domestic goods C_H relative to foreign goods C_F for a given level of expenditure. The solution to this maximization problem yields typical isoelastic demand functions:

$$C_H(\tau) = (\frac{P_H(\tau)}{P_H})^{-\vartheta} C_H; \quad C_F(\tau) = (\frac{P_F(\tau)}{P_F})^{-\vartheta} C_F \tag{2}$$

$$C_H = (1-\gamma)(\frac{P_H}{P})^{-\eta}\ C\ ; \quad C_F = \gamma(\frac{P_F}{P})^{-\eta}\ C \tag{3}$$

where $P_H \equiv \left(\int_0^1 P_H(\tau)d\tau\right)^{\frac{\vartheta}{\vartheta-1}}$, $P_F \equiv \left(\int_0^1 P_F(\tau)d\tau\right)^{\frac{\vartheta}{\vartheta-1}}$, $P \equiv [(1-\gamma)P_H^{1-\eta} + \gamma P_F^{1-\eta}]^{\frac{1}{1-\eta}}$ are utility-based price indices defined accordingly. The law of one price determines the price of the foreign variety τ expressed in units of domestic currency $P_F(\tau) = eP_F^*(\tau)$ where e is the nominal exchange rate.

In the second *stage* the Workers choose the set of processes $\{C(s^t), N(s^t)\}_{t=0}^{\infty}$ and assets $\{B(s^{t+1}), D(s^t), D^*(s^t)\}_{t=0}^{\infty}$, taking as given the set of processes $\{P(s^t), W(s^t), R(s^t), R^*(s^t),$ $v(s^{t+1}|s^t)\}_{t=0}^{\infty}$ and the initial condition $B(s_0) + D(s_0) + D^*(s_0)$ to maximize:

$$\sum_{t=0}^{\infty}\sum_{s^t} \beta^t \pi(s^t) U(C(s^t), N(s^t)) \tag{4}$$

$$C(s^t) + \sum_{s_{t+1}} \nu(s^{t+1}|s^t)B(s^{t+1}) + D(s^t) + \varepsilon(s^t)D^*(s^t) \leq \tag{5}$$

$$\leq \frac{W(s^t)}{P(s^t)}N(s^t) + T(s^t) + B(s^t) + R(s^{t-1})D(s^{t-1}) + R^*(s^{t-1})\varepsilon(s^{t-1})D^*(s^{t-1})$$

where $B(s^{t+1})$ denotes the real market value (in units of the domestic consumption index) at time $t+1$ of a portfolio of state contingent securities held at the end of period t, $\nu(s^{t+1}|s^t)$ is the pricing kernel of the state contingent portfolio, $D(s^t), D^*(s^t)$ are bank deposits expressed in units of domestic and foreign consumption index respectively, $R(s^{t-1}), R^*(s^{t-1})$ are the gross real returns, paid at the end of period t, on the deposits held at the beginning of time t, and $\varepsilon(s^t)$ is the real exchange rate. The bank deposits are non-state contingent assets. For this reason bank deposits are a redundant asset for the determination of the asset pricing conditions. Nonetheless their positive demand will be justified by the presence of a demand for loans. Finally $W(s^t)$ is the nominal wage, $N(s^t)$ is total labor hours and $T(s^t)$ are real lump-sum transfers.

The condition for an optimal portfolio contingent on the realization of history s^{t+1}defines the following pricing kernel:

$$\beta\pi(s^{t+1}|s^t)\frac{U_c(C(s^{t+1}))}{U_c(C(s^t))} = \nu(s^{t+1}|s^t) \tag{6}$$

The conditional expectation of the pricing kernel over all possible histories at time $t+1$would then allow to define the expected return of the portfolio.

Let's then define $B^*(s^t)$ as the holdings of the same state-contingent bond by the foreign households. The budget constraint of the representative foreign household, expressed in units of foreign consumption index, would read:

$$C^*(s^t) + \sum_{s_{t+1}} \nu(s^{t+1}|s^t)\frac{B^*(s^{t+1})}{\varepsilon(s^t)} \leq \frac{W^*(s^t)}{P^*(s^t)}N^*(s^t) + T^*(s^t) + \frac{B^*(s^t)}{\varepsilon(s^t)} \tag{7}$$

The condition for an optimal portfolio plan for the foreign residents will then be:

$$\beta\frac{\pi(s^{t+1})}{\pi(s^t)}\frac{U_c(C^*(s^{t+1}))}{U_c(C^*(s^t))}\frac{1}{\varepsilon(s^t)} = \frac{\nu(s^{t+1}|s^t)}{\varepsilon(s^{t+1})} \tag{8}$$

By equalizing (6) and (8) one obtains the condition for the international risk insurance of the consumption pattern for workers:

$$\frac{U_c(C(s^{t+1}))}{U_c(C(s^t))} = \frac{U_c(C^*(s^{t+1}))}{U_c(C^*(s^t))}\frac{\varepsilon(s^{t+1})}{\varepsilon(s^t)}$$

which after iterating can be written

$$\frac{U_c(C^*(s^t))}{U_c(C(s^t))} = \kappa\ \varepsilon(s^t) \tag{9}$$

where κ is a constant that depends on the initial distribution of wealth.

An arbitrage condition between returns on bank deposits and state-contingent bonds implies:

$$\frac{1}{R(s^t)} = \sum_{s_{t+1}} \nu(s^{t+1}|s^t); \qquad \frac{1}{R^*(s^t)} = \sum_{s_{t+1}} \nu(s^{t+1}|s^t)\frac{\varepsilon(s^{t+1})}{\varepsilon(s^t)} \tag{10}$$

By equalizing one obtains

$$\sum_{s_{t+1}} v(s^{t+1}|s^t)[R(s^t) - R^*(s^t)(\frac{\varepsilon(s^{t+1})}{\varepsilon(s^t)})] = 0 \tag{11}$$

Finally, an efficient static allocation between consumption and leisure requires that the following standard condition is satisfied:

$$U_c(C(s^t))\frac{W(s^t)}{P(s^t)} = -U_n(N(s^t)) \tag{12}$$

2.3 The Entrepreneurs: Wealth Accumulation, Borrowing Constraints and Financial Exposure.

The second set of agents in this economy, the Entrepreneurs, consumes, supplies capital, has a positive demand for loans (denominated both in domestic and foreign consumption units) and is endowed with a certain amount of wealth at the beginning of the world. We assume that the Entrepreneurs are finitely lived (with θ being the probability of dying in each period) and risk neutral. This assumption assures that entrepreneurial consumption occurs to such an extent that self-financing never occurs and borrowing constraints are always binding.

We assume that the Entrepreneurs have a linear utility in consumption. Their individual consumption demands could then be derived either assuming that they consume in each period a constant fraction of wealth or that they consume everything when they die. We opt for the latter hypothesis, as this is also consistent with a no-Ponzi condition on wealth.

Total consumption demand in each period is then equal to the aggregate wealth of the entrepreneurs that are exiting the economy:

$$C^e(s^t) = (1-\theta)NW(s^{t-1}) \tag{13}$$

The next section describes the behavior of these agents acting as producers. Notice that there is a heterogeneity across them due to the presence of an idiosyncratic shock that determines different accumulation of assets. For this reason we employ the index j to identify individual choices.

2.4 Financial Exposure and Balance Sheets Effects

Each entrepreneur, indexed by j, is also a producer in a competitive sector that employs capital and labor as inputs. In the current period domestic entrepreneurs need to finance an investment value QK^j, where K^j is the amount of capital invested and Q is its real price (or the price of equity). To this end they employ existing collateral NW^j and resort to both domestic and international financial markets. The amount of capital investment that needs to be financed is therefore $Q(s^{t-1})K^j(s^{t-1}) - NW^j(s^{t-1})$. Let's define L^j as the total amount borrowed by each entrepreneur against the required capital investment. The entrepreneur's individual budget constraint therefore reads:

$$L^j(s^{t-1}) = Q(s^{t-1})K^j(s^{t-1}) - NW^j(s^{t-1}) \tag{14}$$

Each entrepreneur constructs a financial portfolio in which a share $\xi \in [0,1]$ of the loan is borrowed abroad and is therefore expressed in units of foreign consumption. As such it is natural to consider ξ as a measure of the degree of *financial exposure* (or "dollarization") of the domestic economy.

The individual wealth will reflect the difference between the return on capital investment and the ex-post total cost of the loan portfolio. In turn the aggregate wealth is given by the fraction θ of entrepreneurs that remain alive in the economy in each period times the individual wealth:

$$\begin{aligned} NW^j(s^t) &= \theta R^k(s^t)Q(s^{t-1})K^j(s^{t-1}) - \\ &\quad \theta[\xi L^j(s^{t-1})\varepsilon(s^t)R^*(s^t) + (1-\xi)L^j(s^{t-1})R(s^t)] \end{aligned} \tag{15}$$

where R^k is the aggregate real return on capital. The above expression shows that, as long as $\xi > 0$, aggregate wealth accumulation will depend on the dynamics of the real exchange rate. This is how the *balance-sheet effect* works in our framework. Notice that such an effect is far from straightforward. Its impact on the net worth dynamics is twofold. First, it affects the denomination of the outstanding loan. Through this channel a real depreciation - i.e., a rise in ε_t - decreases, ceteris paribus, the value of net worth *on impact*. However, a real depreciation also affects the interest cost of the loan, which in turn depends on the *expected future evolution* of the real exchange rate through equation (11).

Furthermore, and most importantly, both these channels will be sensitive to the underlying exchange rate regime, although in different ways. With nominal price stickiness, real depreciations will always be on impact larger under floating than under fixed exchange rates.

Yet *expected* real depreciations will be smaller and typically less persistent under floating than under fixed rates. This suggests that only a dynamic general equilibrium analysis can allow a precise assessment of the interaction between financial conditions and exchange rate regime in our small open economy.

Before turning to a quantitative evaluation of this issue, we now proceed by defining the choice of capital investment and the demand for loans as optimizing behavior of a competitive production sector and a competitive banking sector respectively.

2.5 The Financial Intermediary

We derive the external cost of funds and the optimal demand for loans by solving a principal agent problem between the financial intermediary and the firms seeking a loan. The principal agent problem stems from the presence of asymmetric information on the realization of the idiosyncratic shocks. The financial relationship takes the form of a costly state verification debt contract à la Gale and Hellwig (1985). We incorporate the solution to the contract in the general equilibrium following a strategy similar to Cooley and Nam (1998), Bernanke, Gertler and Gilchrist (1998) and Cooley and Quadrini (1999).

To start with, let's assume that the intermediary gathers deposits denominated in both domestic and foreign units of consumption. In order to match the denomination on assets with different maturities it also supplies loans denominated in both units. In determining the conditions of the loan the intermediary maximizes the expected profits of the typical firm in the competitive sector subject to a participation constraint for both the lender and the borrower. The design of the contract seeks for the optimal repayment schedule, the optimal quantity of the loan and the optimal share between domestic and foreign denominated loan. Given the equivalence between the conditions offered on loans with different denominations the optimal fraction of debt denominated in foreign consumption units is typically indeterminate (see Appendix 1). We will therefore treat the degree of financial exposure as a free parameter and conduct a sensitivity analysis across alternative values of $\xi \in [0, 1]$.

In Appendix 1 it is shown that by solving for the optimal contract following the Gale and Hellwig (1985) scheme and deriving the demand for capital in each state of the world we can obtain an expression for the individual external finance premium as $\varkappa^j = \Psi^j(\frac{NW^j}{QK^j})$. Aggregating over all entrepreneurs it yields:

$$\varkappa(s^t) = \Psi(\frac{NW(s^t)}{Q(s^t)K(s^t)}) \tag{16}$$

where $\frac{NW}{QK}$ is the aggregate net worth capital ratio and $\Psi' < 0$. Therefore the external finance premium depends negatively on the wealth-capital ratio. Intuitively, an increase in wealth increases the value of collateral offered as guarantee on the loan, thereby reducing the external finance premium. To the extent that $\xi > 0$, movements in the real exchange rate affect the external finance premium by affecting firms' net worth. For this reason a depreciation that reduces the value of the collateral can have perverse effects on the economy by increasing the external finance premium and therefore tightening the borrowing constraints.

In equilibrium, risk-neutral entrepreneurs choose investment demand to equate the expected return to capital with its (ex-post) cost. In the aggregate the following arbitrage condition must hold:

$$R^k(s^{t+1}) = (1 + \varkappa(s^t))R^{loan}(s^t) \tag{17}$$

where

$$\begin{aligned} R^{loan}(s^t) &\equiv \xi R^*(s^t) + (1-\xi)R(s^t) \\ &= R(s^t)[(1-\xi) + \xi\frac{\varepsilon(s^t)}{\varepsilon(s^{t+1})}] \end{aligned} \tag{18}$$

is a weighted average of the gross ex-post real interest rates paid on the foreign and domestic portion of the loan portfolio respectively. Hence we see that, if $\xi > 0$, the cost of borrowing depends on (the inverse of) the expected *change* in the real exchange rate, which is throughout positive under flexible exchange rates (according to a real version of the uncovered interest parity) but can be negative for persistent periods under a currency peg.

2.6 The Supply Side in the Small Open Economy

We turn now to the description of the supply side of the small domestic economy. The production sector can be divided into three units: i) A competitive sector that produces a homogenous good by combining capital and labor under perfect competition; ii) A monopolistic competitive sector that produces differentiated goods by using the homogenous good as an input, and iii) A competitive sector which produces capital with a production function embedding adjustment costs.

2.6.1 The Homogenous Good Competitive Sector and the Capital Producers

Entrepreneurs act in the competitive unit that produces an intermediate good, which is in turn used as an input by the monopolistic sector. The assumption of finitely lived entrepreneurs implies that the firms have a probability θ of exiting the market in each period. Recall that the assumption of finitely lived agents helps to avoid an easing up of the borrowing constraints generated by sufficient accumulation of assets. There is a continuum of competitive firms indexed by j, each producing according to a constant return to scale technology $Y^j = AF(N^j K^j)$, where A is an exogenous productivity process common to all producers. Given the heterogeneity in the entrepreneurs' accumulation of assets these assumptions will allow us to aggregate across firms.

Static efficiency conditions for input demands by firm j read:

$$mc(s^t)F_k((s^t),.) = Z(s^t); \quad mc(s^t)F_n((s^t),.) = \frac{W(s^t)}{P_H(s^t)} \tag{19}$$

where F_k and F_n denote inputs' marginal products, Z is the real rental cost of capital and $mc(s^t) \equiv \frac{MC(s^t)}{P_H(s^t)}$ is the shadow unit cost of production , i.e., the real marginal cost.

Capital producers solve a dynamic maximization problem to determine the price and the optimal quantity of capital used by each homogenous good producer. The efficiency conditions of their problem imply:

$$Q(s^t) = \Phi'(\frac{X(s^t)}{K(s^{t-1})})^{-1} \tag{20}$$

$$Q(s^t) = R^k(s^t)^{-1}\{Z(s^{t+1}) + Q(s^{t+1})[1 - \delta + \Phi(\frac{X(s^t)}{K(s^{t-1})}) - \frac{X(s^t)}{K(s^{t-1})}\Phi'(\frac{X(s^t)}{K(s^{t-1})})]\} \tag{21}$$

The presence of the function $\Phi(.)$, increasing and convex, reflects the fact that X units of investment translate only into $\Phi(.)$ units of additional capital. Equation (20) determines the investment rate as a function of the price of capital, while equation (21) determines the evolution of Q over time. Notice that in (21) capital producers discount future profits according to the return to capital investment. We assume that in steady state there are no average nor marginal costs of adjustment. Therefore $\Phi(.)$ is such that $\bar{Q} = \Phi'(\frac{\overline{X}}{\overline{K}})^{-1} = 1$, and $\Phi(\frac{\overline{X}}{\overline{K}}) = \delta = \frac{\overline{X}}{\overline{K}}$.

Finally, the law of motion of aggregate capital is:

$$K(s^t) = K(s^{t-1})(1-\delta) + \Phi(\frac{X(s^t)}{K(s^{t-1})})K(s^{t-1}) + d(s^t) \tag{22}$$

where δ is the rate of physical depreciation and $d(s^t)$ is the deadweight loss due to the payment of the monitoring cost in the default state and expressed in units of the domestic good. Notice that the allocation of capital is reduced in the steady state by the amount wasted in the monitoring activity of the bank.

2.6.2 The Monopolistic Competitive Sector

The second sector in the economy (the *Retailers*) has the task of purchasing output from the competitive firms, differentiating the homogenous good and set a price for the variety produced. These firms are owned by the Workers and operate in a monopolistic competitive fashion.

Under the assumption that the monopolistic producers satisfy the whole demand for their product the demand schedule for each variety τ reads:

$$Y(\tau, s^t) = (\frac{P_H(\tau, s^t)}{P_H(s^t)})^{-\vartheta}(C_H(s^t) + C_H^*(s^t) + C^e(\tau) + X(\tau)) \tag{23}$$

where $C_H^*(s^t)$ is the foreign demand for the domestic variety τ.[8]

In choosing the price a retailer optimizes according to a standard Calvo mechanism. Let's assume that each retailer is allowed to set a new price with probability ϕ at each point in time, independently of the time elapsed since the last adjustment. The retailer will then choose $P_H^{new}(\tau, s^t)$ to maximize:

$$\sum_{k=0}^{\infty}\sum_{s^{t+k}} v(s^{t+k}|s^t)\phi^k[Y(\tau, s^{t+k})(P_H^{new}(\tau, s^t) - MC(\tau, s^{t+k}))] \tag{24}$$

subject to (23). The optimal pricing condition reads:

[8]This includes also the investment demand $X(\tau)$ for variety τ,whose isoleastic form is completely symmetric to the corresponding consumption demand. In accordance, the aggregation of investment varieties is also done by means of a Dixit-Stiglitz CES index, with the same elasticity of substitution across varities assumed for the consumption good.

$$P_H^{new}(s^t) = \frac{\vartheta}{(\vartheta - 1)} \frac{\sum_{k=0}^{\infty} \sum_{s^{t+k}} v(s^{t+k}|s^t)\phi^k MC(\tau, s^{t+k})}{\sum_{k=0}^{\infty} \sum_{s^{t+k}} v(s^{t+k}|s^t)\phi^k Y(\tau, s^{t+k})} \tag{25}$$

Given the pricing rule above, in a symmetric equilibrium where the law of large numbers holds, the domestic aggregate price index evolves according to:

$$P_H(s^t)^{1-\vartheta} = \phi(P_H(s^{t-1}))^{1-\vartheta} + (1-\phi)(P_H^{new}(s^t))^{1-\vartheta} \tag{26}$$

2.7 Monetary Policy in the Small Economy

We assume that the monetary authority of the small economy uses the short-term nominal interest rate as an instrument and sets it according to the following rule:

$$(1 + i(s^t)) = (\pi_H(s^t))^{b_\pi} \; (e(s^t))^{\frac{b_e}{1-b_e}} \tag{27}$$

where $(1+i(s^t)) = R(s^t)\frac{P(s^{t+1})}{P(s^t)}$ is the gross nominal interest rate. Notice that the parameter b_e, which measures the elasticity of the policy instrument to the nominal exchange rate, allows to approximate a continuum of exchange rate regimes. In particular $b_e = 0$ corresponds to a regime of purely floating exchange rates, whereas $b_e \in (0,1]$ can approximate a whole range of managed-fixed exchange rate regimes. A formulation as in (27) accords well with the increasing evidence that interest rate policies are replacing interventions in the foreign exchange markets as a device for smoothing exchange rates[9].

2.8 The Rest of the World

We model the rest of the world as an optimizing large economy, whose equilibrium dynamics is taken as given by the domestic households. We assume that the share of domestic goods consumed by the foreign residents is negligible. Therefore the consumption basket of the residents in the rest of the world is given by

$$C^* \equiv [(1-\gamma^*)^{\frac{1}{\eta}} C_F^{*\frac{\eta-1}{\eta}} + \gamma^{*\frac{1}{\eta}} C_H^{*\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{28}$$

with $\gamma^* \to 0$.[10] In this economy there is a continuum of homogenous infinitely lived agents that consume, supply labor and invest in the state contingent bond. Efficiency conditions

[9] See Calvo and Reinhart 2000.

[10] This implies that $C^* = C_F^*$ and $P^* = P_F^*$.

are standard and, besides equation 8, can be recovered as closed-economy versions (i.e., for $\gamma = 0$) of equations (19), (25) and (26), thereby reducing the model to a typical sticky-price optimizing framework[11].

The equilibrium in the foreign economy requires then a specification of a policy rule for the monetary authority. Unlike the small economy we postulate that the only concern of the foreign monetary authority is the stabilization of inflation:

$$(1 + i^*(s^t)) = \pi^*(s^t)^{b_\pi} \; z^*(s^t) \tag{29}$$

where z^* captures exogenous innovations in the world interest rate. Notice that (29) can be considered as a flexible version of an inflation targeting rule.

2.9 Equilibrium

Market clearing for each variety τ in the domestic economy, under a symmetric equilibrium, implies:

$$Y(\tau) = C_H(\tau) + C^*(\tau) + C^e(\tau) + X(\tau) + d(s^t) \tag{30}$$

where $C^*(\tau)$ is the foreign demand for variety τ and $d(s^t)$ is the deadweight loss due to the payment of the monitoring cost in the default state and expressed in units of the domestic good (see Appendix 1 for a characterization).

Equilibrium in the bonds market implies:

$$B(s^{t-1}) + B^*(s^{t-1}) = 0 \tag{31}$$

The real demand for loans must match the supply of deposits:

$$D(s^{t-1}) + \varepsilon(s^t)D^*(s^{t-1}) = L(s^{t-1}) \tag{32}$$

3 Financial Conditions and the Exchange Rate Regime: A Quantitative Evaluation.

In this section we conduct a quantitative analysis of the impact of alternative exchange rate regimes on the financial conditions of the domestic economy. Let us first describe the details

[11] See Rotemberg and Woodford (1999), Clarida, Gali and Gertler (2000), Gali and Monacelli (2001).

of our calibration strategy.

3.1 Calibration

Preferences. We choose an isoelastic form of the utility function $U(C,N) = \frac{1}{1-\sigma}C_t^{1-\sigma} - \frac{1}{1+\varphi}N_t^{1+\varphi}$ with $\sigma = 1$ and $\varphi = 3$. We set the discount factor $\beta = 0.99$, so that the annual interest rate is equal to 4%. The elasticity of substitution between domestic and foreign goods η is equal to 1.5. The share of foreign goods in the domestic consumption basket γ is 0.4.

Technology. The share of capital in the production function α is 0.3, the quarterly depreciation rate δ is 0.025, the steady state mark-up value μ is 1.2. The probability of not resetting prices in each period ϕ is set equal to 0.75, a value consistent with an average period of one year between price adjustments. The elasticity of the price of capital with respect to investment output ratio φ is 0.5. (Log) productivity is assumed to follow an autoregressive process: $log(A(s_t)) = \rho^a \log(A(s_{t-1})) + \zeta^a(s^t)$,where ζ^a is an i.i.d. shock and ρ^a is set to 0.9.

Monetary policy rules: The coefficient on inflation in the interest rate rule is set to $b_\pi = 1.5$, while the size of b_e varies with the type of exchange rate regime, with $b_e = 0$ defining a regime purely floating exchange rates and $b_e \in (0,1]$ a continuum of managed-fixed exchange rate regimes. We assume an autoregressive structure also for the policy shock in (29): $log(z^*(s^t)) = \rho^* \log(z^*(s^{t-1})) + \zeta^*(s^t)$,where ζ^* is i.i.d. and ρ^* is set to 0.7.

Financial frictions: The parameters that define the financial frictions in the general equilibrium are derived by solving the financial contract for some given primitive parameters. The primitive parameters of the contract are the following (see also Appendix 1): i) the volatility of the idiosyncratic shock that defines the riskiness of the investment projects, $\sigma_{\omega_j} = 0.28$; ii) the size of the monitoring cost that defines the size of the deadweight loss, $c_m = 0.12$, and iii) the probability that a firm will be alive next period, $\theta = 0.975$. Given these parameter values, and assuming a log-normal distribution for the idiosyncratic shock, the solution of the contract allows to pin down the following parameters that define the tightness of the financial frictions in the steady state and over the business cycle: i) the steady state ratio of net worth to capital, which defines the steady-state amount of collateral, $\frac{NW}{K} = 0.5$; ii) the average (i.e., steady-state) external finance premium ψ_{ss} which is set to 280 basis points; iii) the business failure rate, $F(\overline{\omega}^j) = 13.6$, and iv) the elasticity of the external finance premium to the capital/net worth ratio that defines the sensitivity of the business cycle to the financing conditions, $\psi(\cdot) = 0.053$.

The calibration of the contract has been based on the following criterion. At first we set the probability that a firm will be alive next period, and then we choose a value of the monitoring cost in the default states using as a reference value the same cost of bankruptcy as in La Porta et al. (1998). Finally we choose the volatility of the idiosyncratic shock to obtain a steady state value of the external finance premium of 280 basis points, as in Bernanke, Gertler and Gilchrist (1998). The fraction of debt denominated in foreign currency ξ will assume alternative values in order to analyze the relation between the stabilization properties of different exchange rate regimes and the degree of financial exposure of the small open economy.

3.2 Dynamics in Response to Domestic Productivity Shocks

We begin our quantitative exploration by analyzing the macroeconomic effects of an internal source of real depreciation, i.e., an innovation in productivity. A first result on the interaction between exchange rate regime and financial conditions will emerge:

- *In a credit constrained economy a regime of flexible exchange rates amplifies, relative to a regime of fixed, the response of both real and financial variables to shocks.*

The key reason is that, in equilibrium, the overall cost of borrowing R^{loan}, which comprises a real exchange rate sensitive component, tends to fall under flexible whereas it rises under fixed exchange rates. Recall that in a closed economy the link between the external finance premium (the "external finance premium") and the financial conditions of the firm is central to the working of the accelerator. Any shock that boosts firms' profits and asset prices enhances the net worth and reduces the external finance premium, therefore boosting investment and capital accumulation. This mechanism typically works in the direction of amplifying the business cycle effects of underlying structural shocks (Bernanke, Gertler and Gilchrist 1998). Here we show that, in an open economy context, the choice of the exchange rate regime matters substantially for both the qualitative and quantitative impact of the financial accelerator.

In *Figure 2* we consider impulse responses of domestic variables to a positive domestic productivity shock across alternative exchange rate regimes when the *degree of financial* *exposure is null* ($\xi = 0$). The solid line displays the response under flexible rates ($b_e = 0$), whereas the dashed line under fixed exchange rates ($b_e \sim 1$). It immediately stands clear that the dynamics under the two regimes are quite different. The deflationary effect of the shock dictates a loosening of monetary policy that can be undertaken only in a regime of flexible exchange rates. Only in that case, in fact, a fall in the nominal interest rate, consistent with the parameter values of the policy rule, implies also a fall in the real rate of interest. Under fixed exchange rates monetary policy has instead an external constraint. The nominal interest rate is pegged to the world interest rate and therefore the fall in inflation determines a rise in the real rate of interest. The implication is therefore that the cost of borrowing falls under flexible rates whereas it rises under fixed. Under the former regime asset prices and profits also rise more, and therefore the expansionary dynamics of the net worth is much more pronounced. This results in a fall of the risk premium, and in a larger expansion of investment and capital relative to a regime of fixed.

We then try to obtain some quantitative assessment of these results. In *Table 1*, left panel, second moments for selected domestic variables are reported when the dynamics is driven by innovations in productivity only. For the case of no financial exposure we compare the volatility under both exchange rate regimes, flexible and fixed. The role of a flexible exchange rate regime as an amplifier immediately stands out. Net worth, asset prices and return to capital are much more volatile in a regime of flexible relative to fixed exchange rates. This in turn results in more volatile investment and output under flexible exchange rates relative to fixed.

Notice that the acceleration effect of flexible of exchange rates is particularly pronounced on investment and financial variables, and less so on output. However, it is interesting to recall that a key implication of the prototype Mundell-Fleming model is that flexible exchange rates act as fundamental shock absorbers in an environment with sluggish nominal prices, for they allow real relative prices to respond more quickly. Therefore it seems relevant per se that our results on output seem to overturn that ranking, with flexible exchange rates implying, although slightly, larger output volatility relative to fixed rates.

3.3 "Dollarized" Balance Sheets

How does a higher degree of financial exposure affect the relative performance of alternative exchange rate regimes ? How does it affect the response of financial variables to shocks ? As it stands clear from equation (15) and (18) when a fraction ξ of the Entrepreneurs' loan portfolio is denominated in foreign units the balance sheets of the domestic firms are sensitive to the dynamics of the real exchange rate.

We establish here a less standard result on the quantitative impact of financial exposure on the financial conditions of a small open economy:

- *In an economy with a high degree of financial exposure (i.e., highly "dollarized"), independently of the exchange rate regime, investment can fall and financial conditions can worsen in response to a favorable productivity shock.*

In *Figure 3* the response of domestic variables to a productivity shock are compared across exchange rate regimes in the case of *high* financial exposure ("dollarization"). Two interesting elements stand out. First, even though investment profitability is higher, the worsening of balance sheets induced by the real depreciation is so large that it triggers a fall in net worth, thereby causing a persistent rise in the risk premium, a fall in asset prices and investment. Second, these dynamics are virtually the same across exchange rate regimes. In a highly dollarized economy not only the amplification effect of flexible exchange rates, relative to fixed, vanishes, but the two regimes imply a very similar behavior of both investment and financial variables. Recall that in response to a rise in productivity a *real* depreciation is the equilibrium outcome also under fixed exchange rates. Yet the inability of the nominal exchange rate to compensate for the excess smoothness in relative prices (due to the nominal stickiness) substantially dampens the balance sheets effect under fixed exchange rates.[12]

From *Table 1* it is then possible to assess the quantitative impact on macroeconomic and financial stability of a higher degree of financial exposure. The evidence of our simulation

[12]This contrasts with the result of Chang, Cespedes and Velasco (2001). On the one hand they, like us, highlight that a real depreciation can induce competing effects on firms' net worth under both regimes: a rise in output due to the improvement in the trade balance, but also a detrimental composition effect if firms' balance sheets are dollarized. However their analysis is conducted within the context of a simplified model that prevents a full-blown dynamic quantitative evaluation of the two effects.

results is twofold. First, higher financial exposure implies larger investment and financial volatility, and this holds independently of the underlying exchange rate regime. We will elaborate on this point below. Second, higher financial exposure contributes in narrowing the difference between flexible and fixed exchange rates, as it was already evident from a visual inspection of the impulse responses.

Notice that so far we have treated the dynamics in the domestic economy as being driven by productivity shocks only. However the recent literature on dollarization and balance sheets, being mostly targeted on developing economies, has focused on the role of credit frictions in affecting the response to world interest rate shocks under alternative regimes. In the following we therefore analyze the predictions of our model for the response of real and financial variables to an external source of real depreciation.

3.4 Detrimental Real Depreciations: A Rise in World Interest Rates.

What kind of real and/or financial distress does a small open economy face when confronted with an unexpected rise in world (real) interest rates ? In the presence of credit market frictions, does the choice of the exchange rate regime matter for the real effects of the transmission of such a shock ? In this section we show that the two alternative policy regimes can deliver strikingly different effects on real activity .

In *Figure 4* impulse responses of domestic variables to an increase in the world real interest rate are displayed. Like above a solid line denotes the response when the currency is free to float, while a dashed line denotes the response when the small economy is pegging the exchange rate to the world currency. We again focus on the case of no financial exposure first. Under flexible exchange rates the domestic monetary authority lets the currency depreciate in response to the shock, whereas in the case of a peg it tries to defend the exchange rate parity by increasing nominal interest rates. In both cases the result is a real exchange rate depreciation (not displayed here), although as usual more pronounced and less persistent when the nominal exchange rate is free to respond.

However the attempt to defend the currency peg causes a large fall in output, while a regime of floating determines a slight expansion. The role of financial variables contributes in determining this difference. Under a currency peg both the real rate of interest and the overall cost of debt rise more than under a float. Similarly the risk premium rises much more under fixed than under floating exchange rates. As a result the fall in net worth and asset prices is more sizeable under a peg. Overall this determines a more dramatic fall in investment and capital accumulation. Therefore the financial channel, with its negative effects on investment, contributes, under a currency peg, to overturn the expansionary effect of a real depreciation, which works through the improvement of the trade balance.

The results above suggest that the conventional wisdom on the insulating role of floating exchange rates in response to external shocks still holds at this stage. Under floating, unlike fixed exchange rates, output rises, investment falls less and financial variables collapse much less dramatically than under fixed exchange rates. However it is interesting to analyze to what extent this insulating property is sensitive to the degree of financial exposure. We therefore have the following result:

- *When the degree of financial exposure is high the insulating role of flexible exchange rates in response to an external source of depreciation tends to vanish.*

In *Figure 5* impulse responses of the same domestic variables to a rise in the world interest rate are displayed when the degree of financial exposure is high ($\xi = 0.9$). As it stands clear a regime of floating exchange rates barely insulates output from the external shock, whereas all remaining variables display dynamics that closely resemble the one under fixed exchange rates, showing in general a sizeable worsening of the financial conditions of the economy. Therefore the specificity of flexible exchange rates in providing an insulating role in response to external sources of real depreciations tends to disappear when financial exposure is high. In our framework a system of flexible exchange rates cannot certainly be advocated as a shock absorber to insure financial stability in the face of adverse foreign shocks.

In *Table 1* second moments for selected variables are reported when the dynamics of the small economy is driven entirely by world interest rate shocks. The quantitative analysis confirms our intuition. When financial exposure is null macroeconomic instability is much larger under a currency peg than under a float. This is particularly true for all the financial variables (investment, price of capital, return to capital). However, when financial exposure is high the performance under flexible exchange rates mimics very closely the one under a peg.

3.5 Financial Exposure and Financial Stability

Do more dollarized economies tend to display larger financial instability ? Does this depend on the underlying exchange rate regime? *Figure 6* and *7* show how the volatility of selected financial variables (asset prices, risk premium, return to capital, cost of borrowing) varies with the degree of financial exposure. Two results are worth noticing:

- *Under both productivity and world real rate shocks, higher financial exposure substantially increases financial instability.*

- *If financial exposure is sufficiently high the amplification effect of flexible exchange rates, relative to fixed, tends to vanish.*

From Figure 6 it is already clear that an interesting feature of our framework is that the implied volatility of asset prices is substantially magnified by the degree of financial exposure. Notice that this holds independently of the underlying exchange rate regime. Notice also that the reduced-form relationship is non-monotonic. Asset price volatility can fall for low values of financial exposure, but is greatly magnified when the economy converges towards full dollarization. Furthermore the impact of financial exposure on financial instability varies with the exchange rate regime. For null or low values of financial exposure the amplification effect of flexible exchange rates prevails. However, as the economy becomes increasingly dollarized, the same amplification effect is dampened, and financial instability becomes larger under fixed exchange rates.

Figure 7 displays the effect of varying the degree of financial exposure on the volatility of financial variables conditional on world interest rate shocks only. Similarly to the case with productivity shocks the effect is sizeable and this holds particularly for flexible exchange rates. When exposure is null financial instability is much larger under a peg. However, as the economy converges towards full dollarization ($\xi \rightarrow 1$) financial instability is boosted, and the performance of flexible exchange rates tends to replicate the one under fixed.

4 Conclusions

In searching for a new Mundell-Fleming paradigm international economists have so far neglected a fundamental flaw of that highly acclaimed model: the absence of any role for the financial dimension of the economy. In this paper we have taken a step in that direction. We have shown that the conventional wisdom on the relative desirability of flexible relative to fixed exchange rates is greatly sensitive to the degree of financial exposure of the economy, defined as the fraction of outstanding liabilities expressed in foreign units of denomination. For example, a regime of flexible rates amplifies, relative to fixed, the response of both real and financial variables to domestic shocks. However, when financial exposure is high investment can even fall and financial conditions can worsen in response to favorable productivity shocks, due to detrimental balance-sheets effects.

We have emphasized that the general equilibrium effect of higher financial exposure is to induce flexible exchange rates to mimic the macroeconomic dynamics under a regime of fixed rates. For example, in response to a rise in world interest rates, high financial exposure greatly worsens the performance of flexible exchange rates (relative to the case with no exposure), so that the acclaimed insulating role of the latter (relative to fixed) tends to vanish. This result can in our view contribute to the recent debate on the link between dollarization of liabilities and "fear of floating". If flexible exchange rates may end up generating, in response to external shocks, a degree of financial distress at least comparable to the one generated by fixed exchange rates, the gains from commitment that the latter regime is in principle able to provide may constitute a sufficient argument for explaining the apparent widespread skepticism against full free floating. Overall our paper stresses the idea that financial frictions and financial exposure in particular should play a major role in the long-lasting debate on the desirability of flexible relative to fixed exchange rates.

Appendix 1: The Maximization Problem of The Financial Intermediary.

The design of the optimal contract in this open economy framework follows the one-period optimal debt contract considered in Gale and Hellwig (1985). The assumptions of the contract can be summarized as follow:

- The risk neutral bank holds a large portfolio obtained through riskless deposits and can pool the risk. The entrepreneurs are risk neutral too.
- The contract is contingent only to an idiosyncratic shock ω_j that hits entrepreneurial wealth. The shock has a distribution $F(\omega_j)$ with a decreasing hazard rate and can be observed by the bank only after its realization. The idiosyncratic shock itself is not contingent on the aggregate state.
- The intermediary in the home country lends money only to the entrepreneur in the home country but it can lend both in domestic and foreign currency without additional costs.

To be feasible and incentive compatible the contract is designed according to the following optimality conditions:

- In the non-default states the entrepreneur repays a fixed amount in order to eliminate the incentive to misreport the realized wealth. Also we assume that the amount is neither contingent on the aggregate shocks nor on the exchange rate risk.
- In the default states the bank pays a monitoring cost to observe the state and gets everything is left.
- To avoid possibility of renegotiation, the probability of exiting the market for the entrepreneur is set lower than the failure probability.
- The entrepreneur holds the bargaining power.

Given the described assumptions the contract is designed to maximize the expected utility of the entrepreneur subject to the participation constraints for both agents involved in the contract. The choice variables are the demand for loans, the repayment schedule and the optimal fraction of debt in foreign currency. Given a one to one relation between the demand for loan and the demand for capital[13] and a one to one relation between the repayment schedule and the value of the idiosyncratic shock that defines the bankruptcy point[14], the contract at time t can be defined in the following way:

$$Max_{\overline{\omega}^j, K^j(s^t), \xi} \int_{\overline{\omega}^j}^{\infty} (\omega^j - \overline{\omega}^j) R^k(s^{t+1}) Q(s^t) K^j(s^t) dF(\omega) \tag{33}$$

$$[1 - F(\overline{\omega}^j)](R_L^j(s^t)L^j(s^t) + R_L^{*j}(s^t)L^{*j}(s^t)\varepsilon_{t+1}) + (1 - c_m)\int_0^{\overline{\omega}^j} \omega^j dF(\omega) R^k(s^{t+1}) Q(s^t) K^j(s^t) \tag{34}$$

$$= (R(s^t)D(s^t) + R^*(s^t)D^*(s^t)\varepsilon(s^t))(\frac{P(s^t)}{P_H(s^t)})$$

$$\overline{\omega}^j R^k(s^{t+1}) Q(s^t) K^j(s^t) = (R_L^j(s^t)L^j(s^t) + R_L^{*j}(s^t)L^{*j}(s^t)) \tag{35}$$

$$\varepsilon_t L^{*j}(s^t) + L^j(s^t) = \xi(Q(s^t)K^j(s^t) - NW(s^t)) + (1 - \xi)(Q(s^t)K^j(s^t) - NW(s^t)) \tag{36}$$

where ω^j is the idiosyncratic shock faced by the entrepreneur and distributed with function $F(\omega)$, $\overline{\omega}^j$ is the value of the shock that divides the random space into a default and a solvency region, R_L^j and $R_L^j$are the repayment schedules required for loans denominated in domestic and foreign consumption units, L and L^* are the fractions of the loan denominated in domestic and foreign consumption index respectively, c_m is the monitoring cost paid by the lender. This allows to define $d(s^t) \equiv c_m \int_0^{\overline{\omega}^j} \omega^j dF(\omega) R^k(s^{t+1}) Q(s^t) K^j(s^t)$ as the deadweight loss of capital in the steady state.

Equation (33) is the expected return to the entrepreneur, equation (34) is the participation constraint of the lender, equation (35) is the participation constraint for the borrower, while equation (**??**) and (**??**) define the amount of loans in both domestic and foreign currency. All quantities are expressed in term of domestic consumption goods.

[13]This is true for values of the return to investment that we assume as given period by period from the general equilibrium.

[14]The repayment schedule is a monotone and increasing function of the bankruptcy point since an increase in the failure probability requires an higher repayment in the default states. Also, given a decreasing hazard rate for $F(\omega)$, the bankruptcy point is unique.

Notice that since the last constraint holds with equality the optimal fraction ξ can be solved as residual after obtaining optimal values for the other two variables. Let $\varkappa^j \equiv \frac{R^{j,k}}{\xi R^* + (1-\xi)R}$ be the ratio of the return to capital to the cost of loan and $k^j \equiv \frac{QK^j}{NW^j}$ be the ratio of the value of capital to the net worth for each entrepreneur. Given this and substituting the definitions for the loans and the second participation constraint in the first, we can rewrite the maximization problem for each borrower j in the following way:

$$Max_{k,\overline{\omega}^j} \int_{\bar{\omega}^j}^{\infty} (\omega^j - \overline{\omega}^j) dF(\omega^j)(\varkappa^j(s^t)k^j(s^t)) \tag{37}$$

subject to

$$[1 - F(\overline{\omega}^j)] + (1 - c_m) \int_0^{\bar{\omega}^j} \omega^j dF(\omega^j)\}(\varkappa^j(s^t)k^j(s^t)) = [k^j(s^t) - 1] \tag{38}$$

Using Leibniz rule to differentiate the integral function with respect to $\overline{\omega}^j$ it yields the following first order conditions with respect to $k^j(s^t)$, $\overline{\omega}^j$ and the Lagrange multiplier ϕ_1:

$$(\int_{\bar{\omega}^j}^{\infty} (\omega^j - \overline{\omega}^j) dF(\omega)) + \phi_1 * [(1 - F(\overline{\omega}^j)) + (1 - c_m) \int_0^{\bar{\omega}^j} \omega^j dF(\omega^j)] * (\varkappa^j(s^t)) - \phi_1 = 0 \tag{39}$$

$$[1 - F(\overline{\omega}^j)] - \phi_1[(1 - F(\overline{\omega}^j)) - c_m F'(\overline{\omega}^j)] = 0 \tag{40}$$

$$[1 - F(\overline{\omega}^j)] + (1 - c_m) \int_0^{\bar{\omega}^j} \omega^j dF(\omega^j)(\varkappa^j(s^t)k^j(s^t)) = [k^j(s^t) - 1] \tag{41}$$

Defining $\int_{\bar{\omega}^j}^{\infty} (\omega^j - \overline{\omega}^j) dF(\omega) = \Gamma(\omega^j)$ and $\int_0^{\bar{\omega}^j} \omega^j dF(\omega) = G(\omega^j)$ we can rewrite the first order conditions as:

$$([(1 - \Gamma(\bar{\omega}^j)] + \phi_1(\Gamma(\bar{\omega}^j) - c_m G(\bar{\omega}^j))] * (\varkappa^j(s^t)) - \phi_1 = 0 \tag{42}$$

$$\Gamma'(\bar{\omega}^j) - \phi_1[\Gamma'(\bar{\omega}^j) - c_m G'(\bar{\omega}^j)] = 0 \tag{43}$$

$$[\Gamma(\bar{\omega}^j) - c_m G(\bar{\omega}^j)](\varkappa^j(s^t)k^j(s^t)) - [k^j(s^t) - 1] = 0 \tag{44}$$

There is a one to one relation between the capital/net worth ratio $k^j(s^t)$ and the ratio between the risk free interest rate and the cost of loan $\varkappa^j(s^t)$, with this relation being negative. Assuming an interior and unique solution for $\overline{\omega}^j$ (see Gale and Hellwig 1985 for a proof) and using equation (43), we can derive ϕ_1 as an increasing function of $\overline{\omega}^j$. By substituting $\phi_1(\overline{\omega}^j)$ in (42) one can derive a one to one relation between the external finance premium and $\overline{\omega}^j$: so that $\varkappa^j(s^t) = f(\overline{\omega}^j), f'(\overline{\omega}^j) < 0$ for $0 < \overline{\omega}^j < \overline{\omega}^{*j}$. Intuitively when the cut-off value increases the probability of default decreases and the external finance premium required by the bank to repay the monitoring cost decreases too. Since $f(\cdot)$ is monotonically increasing over the range of possible bankruptcy points $0 < \overline{\omega}^j < \overline{\omega}^{*j}$ the inverse relation $\overline{\omega}^j = f^{-1}(\varkappa^j(s^t))$ is well defined. By substituting $\overline{\omega}^j = f^{-1}(\varkappa^j(s^t))$ in (44) we can derive a one to one relation $k^j(s^t) = \Psi^{-1}(\varkappa^j(s^t))$. Inverting the last relation it yields the risk premium for each firm j:

$$\varkappa^j(s^t) = \{\frac{R^{j,k}(s^{t+1})}{R^{loan}(s^t)}\} = \Psi(\frac{NW^j(s^t)}{Q_t K^j(s^t)}) \tag{45}$$

with $\Psi' < 0$ (this can be proved by simply substituting $\overline{\omega}^j = f^{-1}(\varkappa^j(s^t))$ into (44) and taking derivative of $k^j(s^t)$ with respect to $\varkappa^j(s^t)$ or by applying implicit function theorems). Aggregating over all the entrepreneurs we can finally derive the optimal demand for capital:

$$Q(s^t)K(s^t) = \frac{NW(s^t)}{\Psi^{-1}(\varkappa(s^t))} \tag{46}$$

It is important to notice that the share of foreign currency loans (deposits) is indeterminate in this framework. We have the following proposition.

Proposition 1 *Any share $\xi \in [0,1]$ of foreign currency denominated deposits is consistent with the equilibrium.*

Proof. Given the optimal value for $K(s^t)$ one can obtain the optimal fraction ξ by using the constraint (36).

$$\varepsilon_t L^{*j}(s^t) + L^j(s^t) = \xi(Q(s^{t-1})K^j(s^t) - NW(s^t)) + (1-\xi)(Q(s^{t-1})K^j(s^t) - NW(s^t)) =$$

$$= \xi(\frac{NW(s^t)}{\Psi^{-1}(\varkappa(s^t))} - NW(s^t)) + (1-\xi)(\frac{NW(s^t)}{\Psi^{-1}(\varkappa(s^t))} - NW(s^t))$$

Given that the same cost $\varkappa_t$ is applied to both domestic and international loans, any convex combination between the two can satisfy the equation above. Therefore the quantity of both domestic and international loans is indeterminate.

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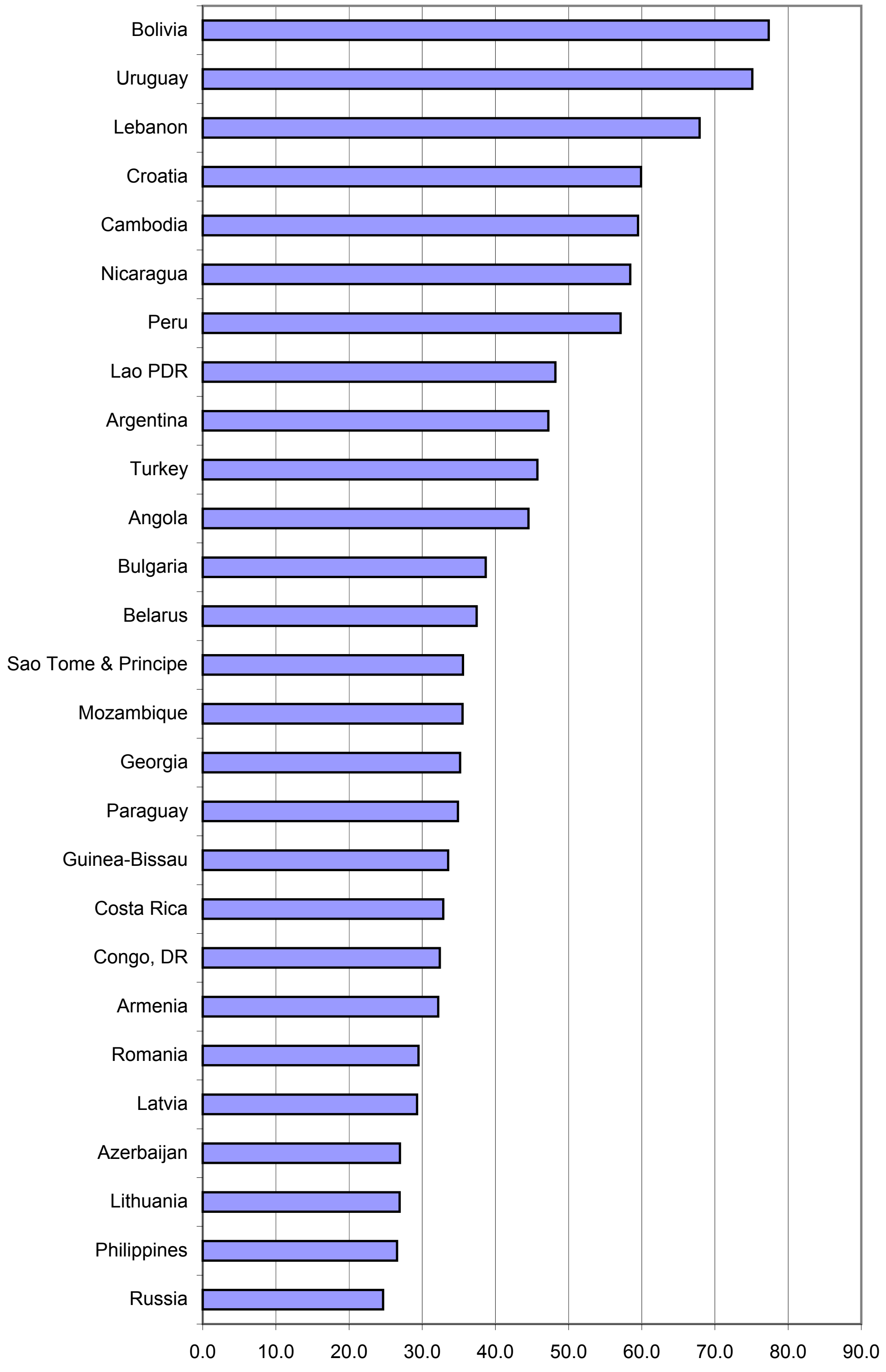
Figure 1. Foreign Currency Deposits as a Share of M2



Source: World Bank, 2002

TABLE 1

Statistics for the Calibrated Economy

Standard deviation in %

	Productivity Shocks				World Interest Rate Shocks			
Financial Exposure	**No Exposure**		**High Exposure**		**No Exposure**		**High Exposure**	
Regime	*FLEXIBLE*	*FIXED*	*FLEXIBLE*	*FIXED*	*FLEXIBLE*	*FIXED*	*FLEXIBLE*	*FIXED*
Output	2.37	2.11	2.17	1.89	0.10	0.91	0.19	0.91
Investment	1.13	0.82	2.03	2.04	0.26	1.31	1.11	1.38
Asset Price	1.93	1.24	3.33	3.39	0.66	2.82	2.46	3.16
Net Worth	4.14	1.23	11.47	12.05	1.60	8.41	7.53	9.44
Return to Capital	0.88	0.17	0.83	1.15	0.49	2.06	1.46	2.20
Risk Premium	0.11	0.01	0.42	0.44	0.05	0.29	0.27	0.33
Cost of Borrowing	0.110	0.117	0.01	0.01	0.209	0.423	0.42	0.43

FIGURE 2. Productivity Shock: No Financial Exposure

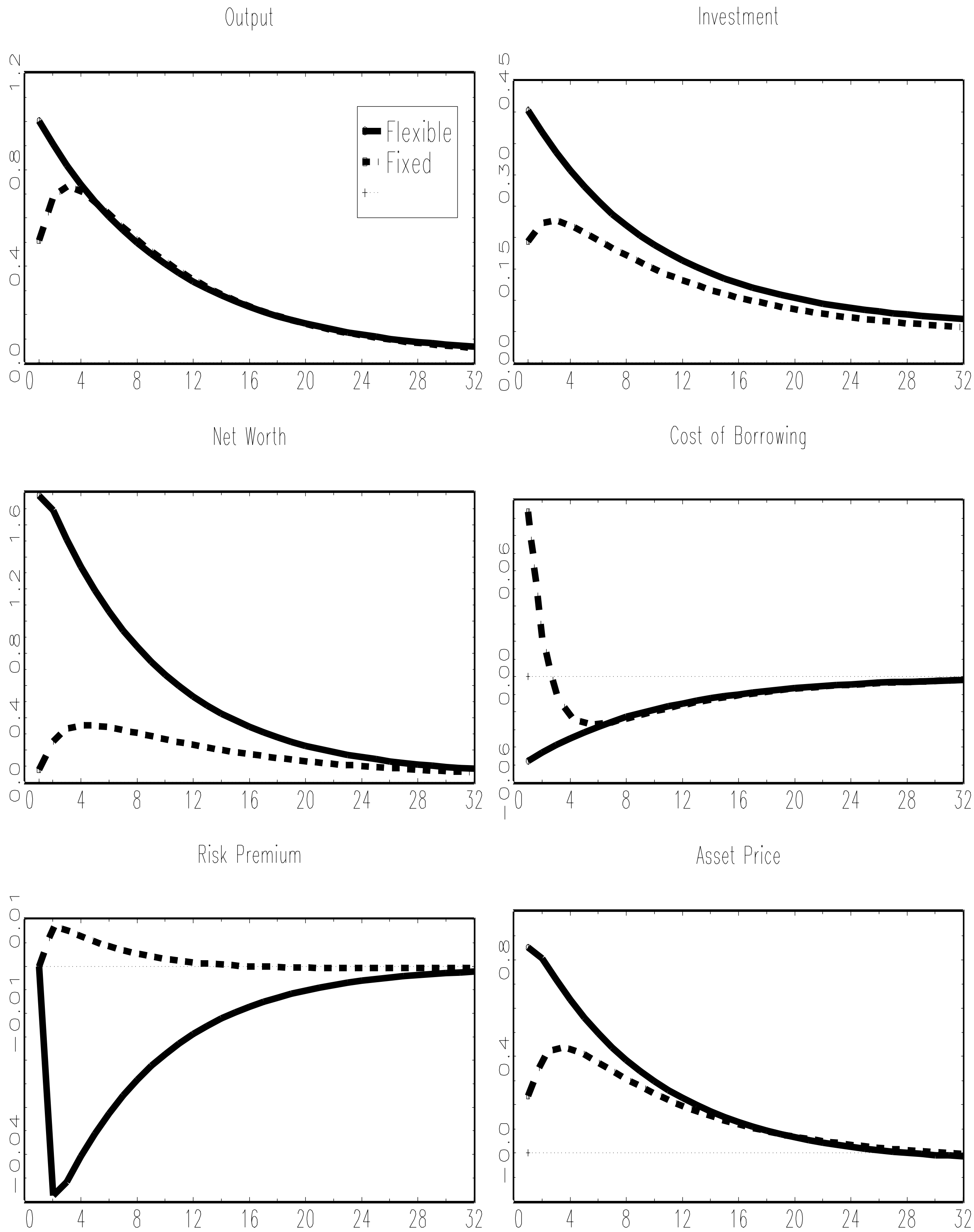


FIGURE 3. Productivity Shock: High Financial Exposure

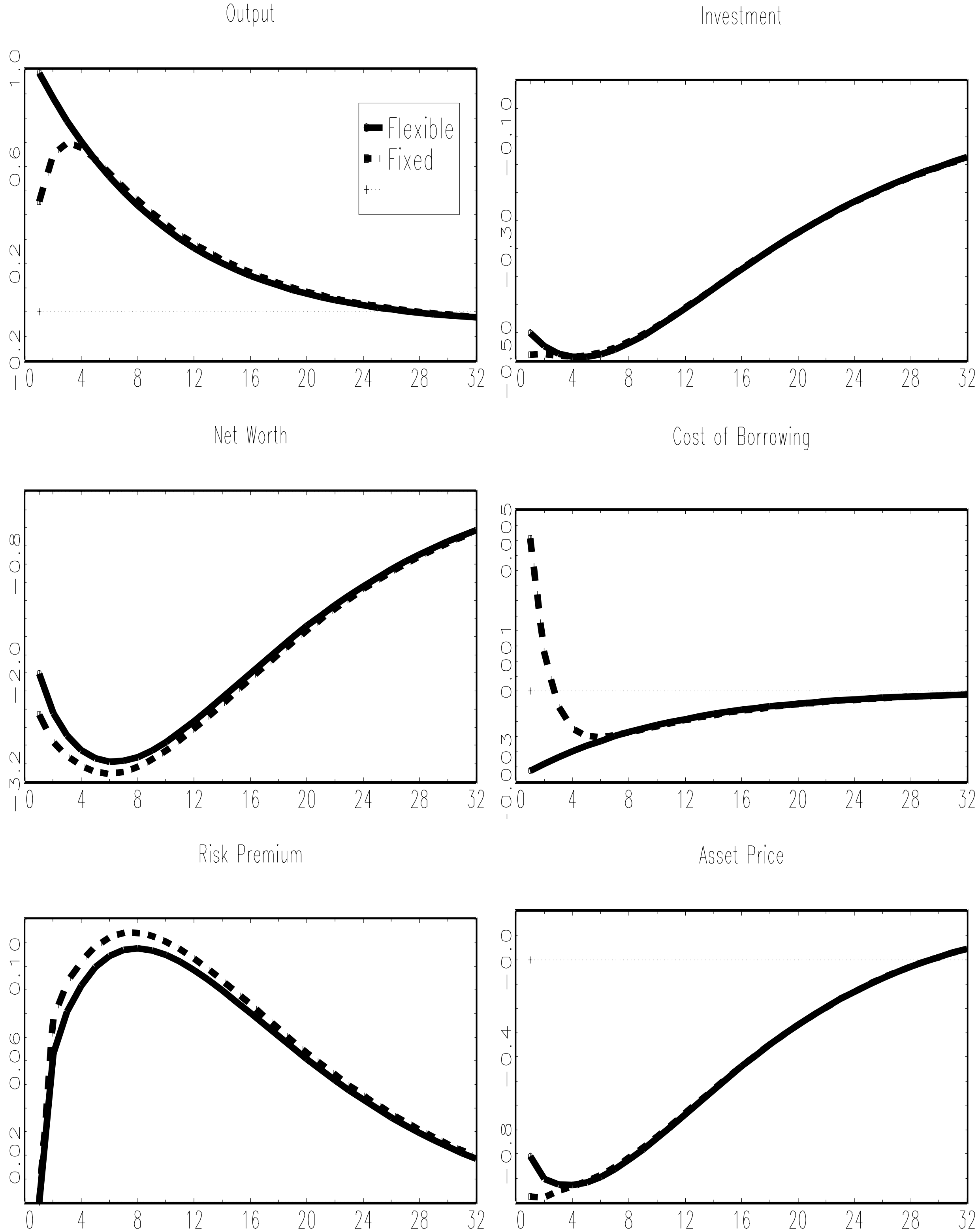


FIGURE 4. World Real Interest Rate Shock: No Financial Exposure

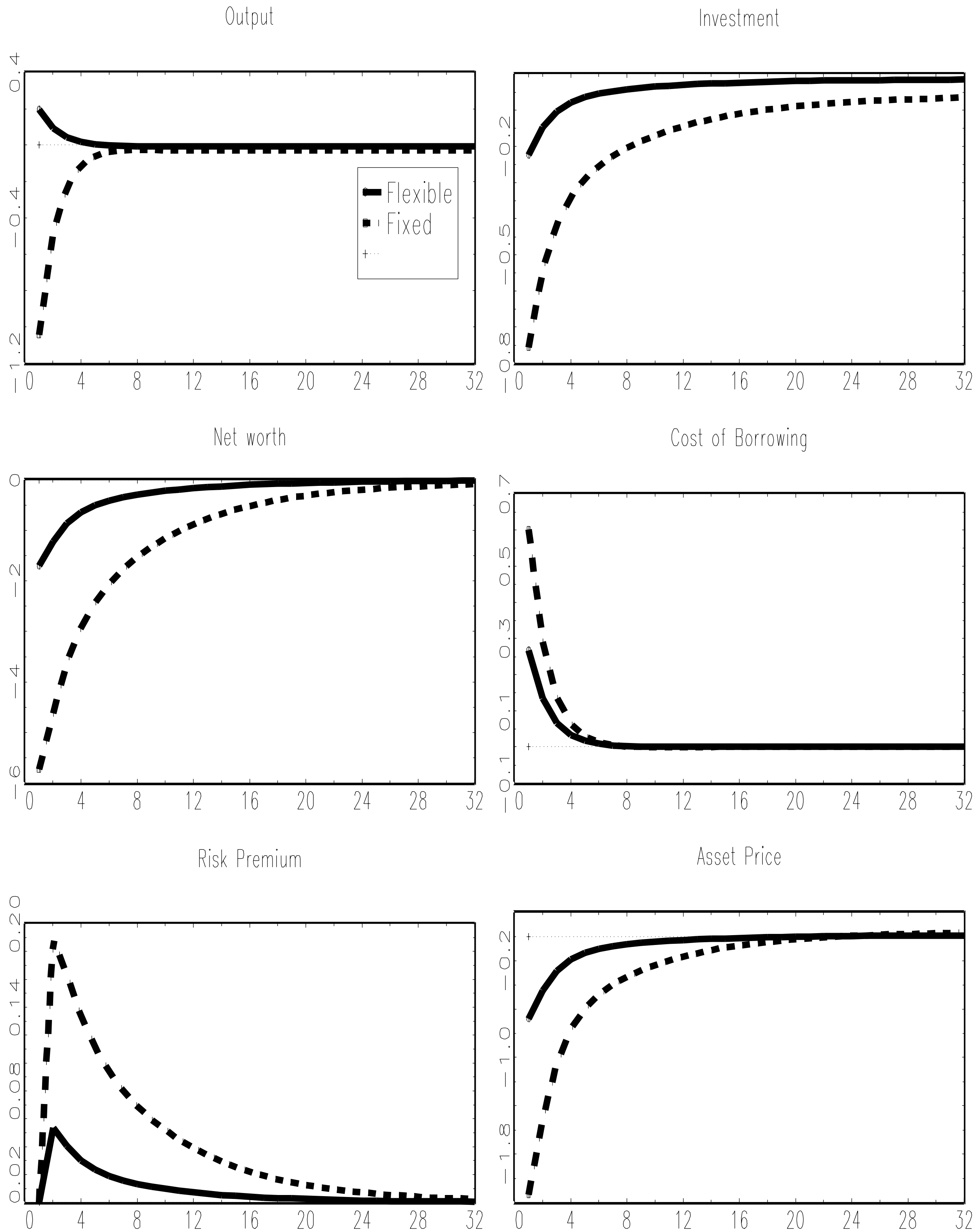


FIGURE 5. World Real Interest Rate Shock: High Financial Exposure

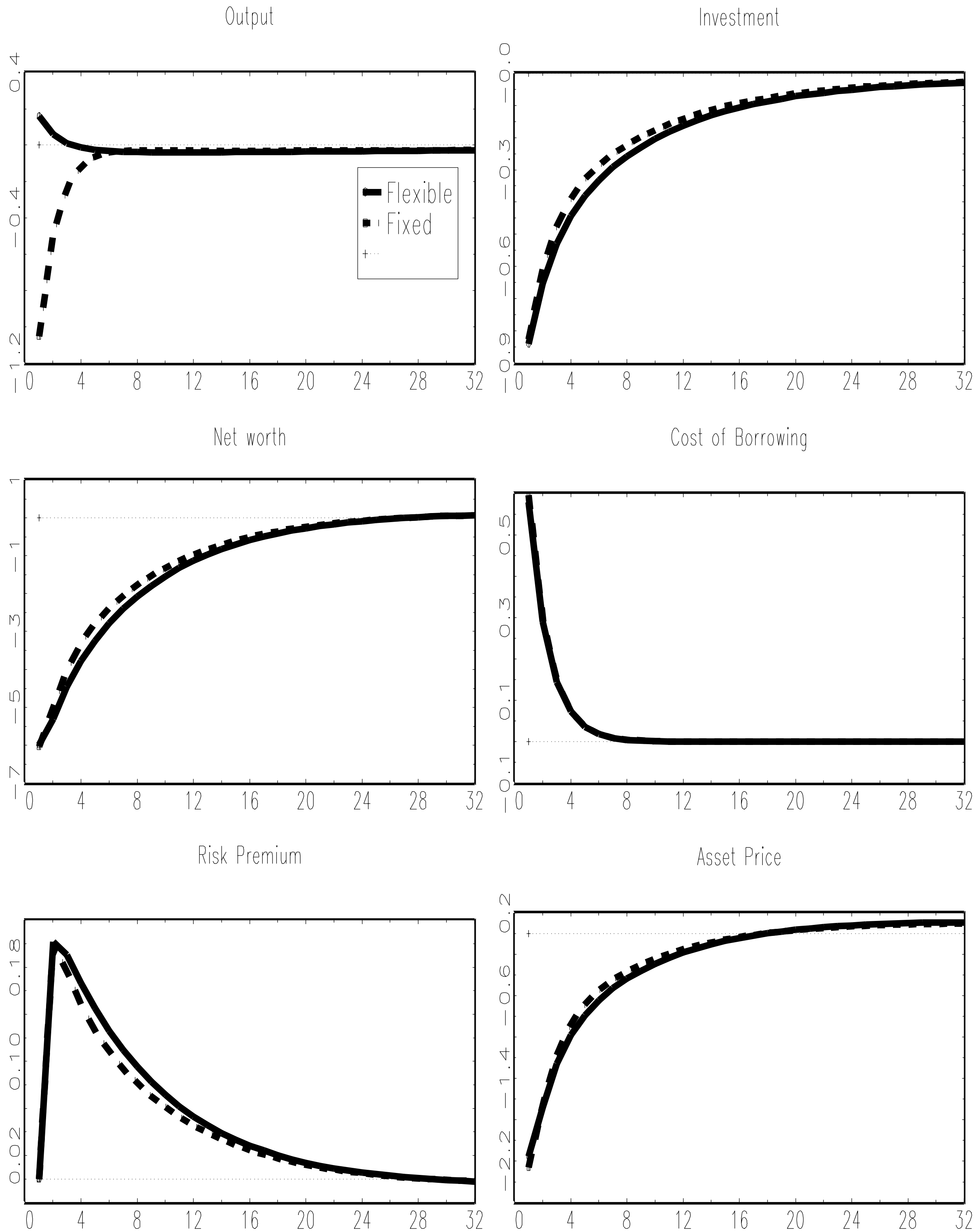


FIGURE 6. Effect of Varying Financial Exposure: Productivity Shocks

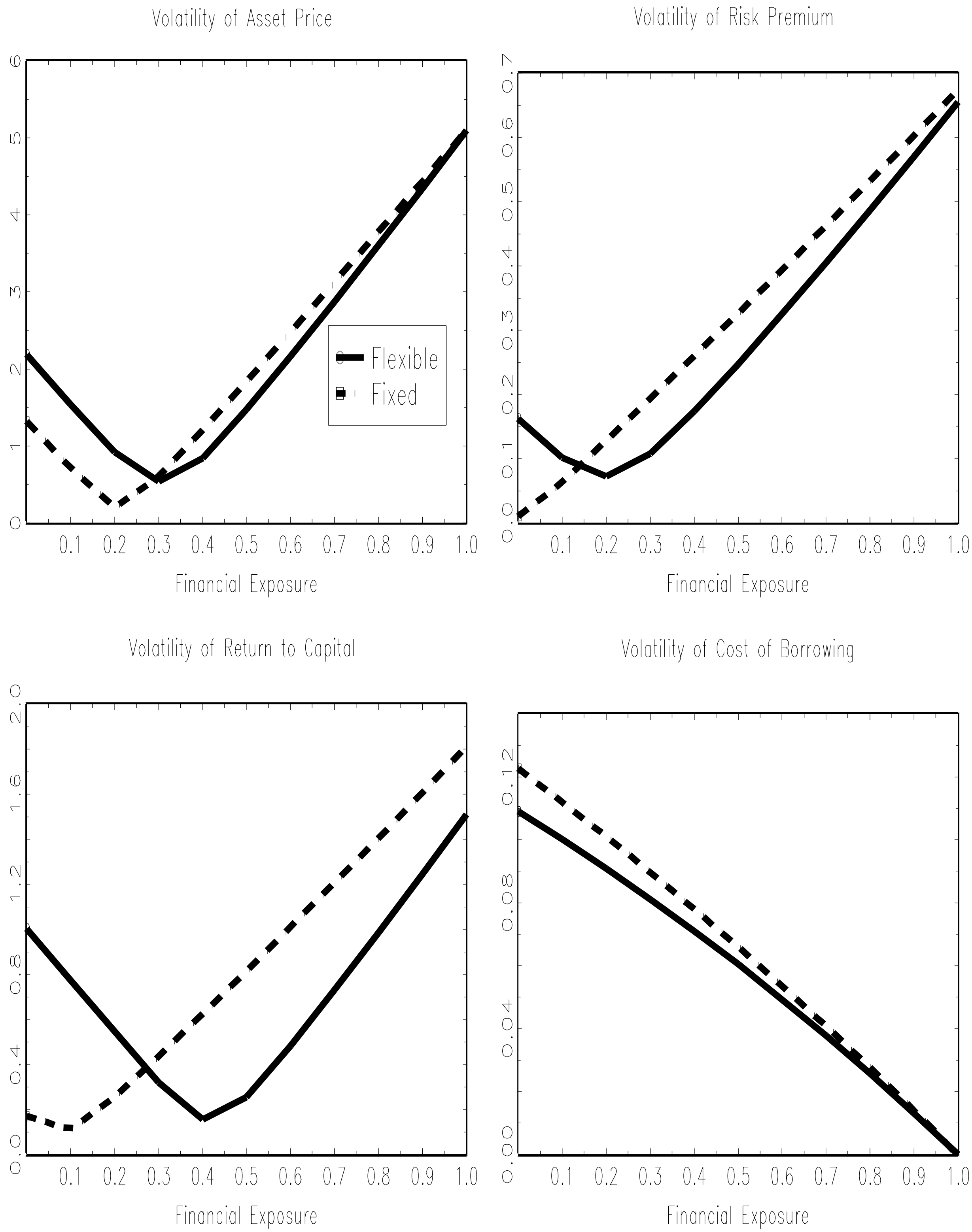


FIGURE 7. Effect of Varying Financial Exposure: World Rate Shocks