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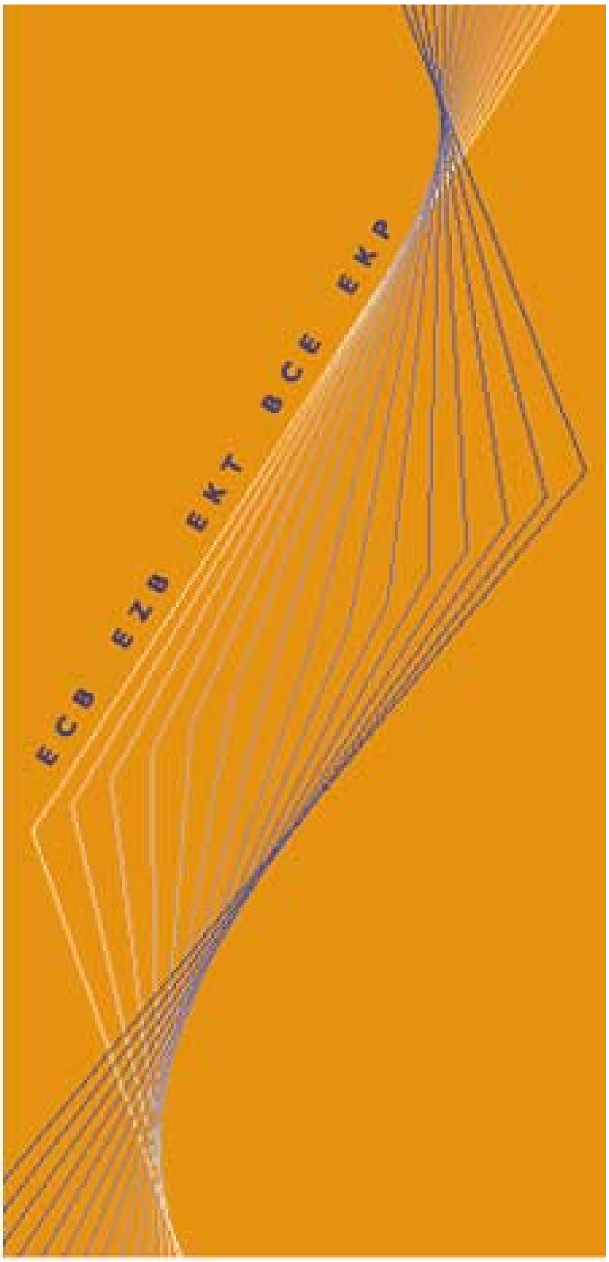

WORKING PAPER NO. 56

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Contents

Abstract

This paper studies the optimal choice of exchange rate regimes between two large currency areas. It provides a positive and normative analysis of alternative monetary policy rules in a model with sticky prices, monopolistic competition, and frictions in the processes of capital accumulation and acquisition of external finance. The stabilization and welfare analysis provides a sound result on the desirability of monetary policy and exchange rate flexibility as business cycle smoothing devices. Given the presence of financial frictions the paper gives a richer explanation of the mechanism behind the stabilization properties of floating exchange rates and explains the difference in sign of the international transmission of shocks compared to the model without capital. In a two country model without capital the pattern of output is mainly determined by the pattern of consumption: any movement in the exchange rate under floating exchange rates causes movements in the price of the international traded bond and in consumption and consequently in output. In the model with capital and financial frictions output mimics the movements in investment: an active monetary authority reacting to exchange rate movements generates perverse movements in the interest rate, destabilizing investment and output. The paper also suggests how monetary policy can improve financial stability, stressing the importance of the interest rate smoothing in tuning movements in investment and output and in reducing the welfare cost of financial frictions mostly under fixed exchange rates.

JEL Classification Numbers: E3, E42, E44, E52, F41.

Keywords: financial frictions, monetary regimes, financial stability, stabilization policy.

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1 Introduction

"For the major countries and regions (the United States, the Euro area, and Japan) where unrestricted capital mobility is the established norm, and where pursuit of a common monetary policy appears unlikely to be consistent with the key goals of macroeconomic stability, floating exchange rates will, and should, continue to prevail". Michael Mussa[1]

The central focus of this paper is the optimal choice of foreign exchange system in terms of macroeconomic stability and the international transmission mechanism of shocks between the Euro area and the U.S. economy, taking into account the conditions under which these countries operate and assuming that both economies face financial frictions in the investment decisions and in the provisions of private loans. The analysis also provides a positive and normative evaluation of alternative monetary policy rules.

The determination of the optimal choice of exchange rate regimes is a long standing problem in the literature. The aim of the paper is to see how this choice can be affected by financial frictions and to analyze stabilization and welfare properties of monetary rules in the transmission of external shocks in a model with capital and financial distress.

I will derive and analyze a model economy that mimics conditions in two large and financially integrated economies characterized by financial frictions[2] in both countries, sticky prices, imperfect competition and a rich asset structure to see to what extent policy prescriptions, such those addressed by Michael Mussa, can find consensus in a theoretical framework. The results of the paper are in accord with the Mundell's theory. Under the assumed degree of financial and trade integration between two large currency regions, and especially if credibility is not at stake, the insulation property of floating exchange rate holds. Given the presence of financial frictions the paper gives a richer explanation of the mechanism behind the stabilization properties of floating exchange rates and accounts for a difference in sign for the international transmission of shocks than that in the model without capital and financial frictions. The paper shows that in a two country model without capital the pattern of output is mainly determined by the pattern of consumption: any movement in

[1] Speech held at Jackson Hole, Wyoming in the symposium on "Global Opportunities and Challenges".

[2] I will consider frictions affecting investment decisions in the form of adjustment costs to capital formation and frictions in the provisions of loans in the form of agency costs.

the exchange rate under floating exchange rates determines movements in the price of an internationally traded bond. Given complete international markets, movements in the price of the international bond determine movements in consumption and consequently in output. In the model with capital and financial frictions the output mimics the movements in investment: an active monetary authority reacting to exchange rate movements generates perverse movements in the interest rate, destabilizing investment and output. The paper indicates how monetary policy can improve financial stability, stressing the importance of interest rate smoothing in tuning movements in investment and output. In the model with financial frictions the patterns of variables show a greater persistence and higher jumps on impact mostly under managed or fixed exchange rates: increasing the smoothing parameter on the lagged interest rate the impulse responses of the model with capital and financial frictions approach those of the model without capital. I evaluate the stabilization properties of different monetary regimes in terms of output and inflation volatility and I derive a welfare-based ranking of different exchange rate regimes. The welfare comparison yields a stricter result on the desiderability of the stabilization properties of floating exchange rates with respect to fixed or managed exchange rates and on the adverse effect in terms of cost of the business cycle of abandoning monetary policy discretion. In addition a systematic analysis of the cost of financial frictions under different regimes, shows that the welfare costs are higher under fixed exchange rate regimes and that they decrease when the smoothing parameter is increasing. The differential costs across regimes becomes almost the same in the model with and without financial frictions when an high interest rate smoothing is applied, showing that monetary authority can actually contrast the impact of financial frictions.

The analysis emphasizes the crucial role of monetary policy in determining the pattern of exchange rates and other macroeconomic and financial variables. A trade off will emerge between stabilization of output, inflation and prices of capital on the one side and exchange rate and trade balance on the other.

Since flexible exchange rate regimes became a reality many authors have studied the choice among exchange rate regimes. The general argument in favor of floating exchange rate regimes is its insulation property and is due to Friedman (1953) and Mundell (1960, 1961a,1961b,1963) [3]. Recently a considerable literature has studied the performance of different monetary policy rules in an open economy[4] and the comparison of exchange rate regimes in models with microfoundations. The classical mundellian theory continues to hold but these innovations yield new insights about the dynamics of model economies.

Most of the existing literature on comparison of exchange rate regimes and monetary policy rules in open economies concentrates attention on stabilization of the exchange rate[5] and trade balance and uses frameworks that lack markets for capital goods and frictions on investment decisions. In these models the only relevant financial asset for the economy is a state contingent bond internationally traded: any movement in the exchange rate implies movement in the price of this asset and in the wealth of consumers, with a direct effect on the overall stability of the economy. This justified the concern over a role of monetary policy in stabilizing exchange rates.

Recently the new open economy literature has examined the role on the optimal choice of exchange rate regimes of other key elements of microfounded decisions, such as pricing policies and asset market structure. The role of exchange rate pass-through has been explored by introducing into the models explicit microfoundations for the pricing decisions[6]. Another growing literature is exploring how the presence of borrowing constraints[7] and

[3]Notice that both, Friedman and Mundell assumed that prices were fixed in the short run: this implies that a model intended to mimic that result closely should include some forms of price stickiness.

Mundell (1960, 1961a,1961b,1963) pointed out that the answer to which regime is better becomes more complicated depending on whether the source of shocks is nominal or real, on the degree of capital market imperfections, on factor mobility and on the relative size of the country.

In addition, some recent literature (Benigno P. 1999, Benigno P. and G. Benigno 2000, Gali' J. and T. Monacelli 1999) pointed out that the classical dichotomy between real and monetary shocks needs to be reinterpreted by taking into account a) an active monetary policy, b) staggered sticky prices that allow dynamic effects of monetary policy.

[4]Ball (1998), Ghironi (19998), McCallum and Nelson (1999), Monacelli (1998), Svensson (2000), Weeparana (1998), Gali' and Monacelli (1999), Benigno G. and Benigno P. (2000), Benigno G., P. Benigno and Ghironi (2000).

[5]Benigno G. and P. Benigno (2000) show that under a Taylor rule the exchange rate is a non-stationary variable.

[6]M. Devereux and C. Engel (1998), M. Devereux, C. Engel and C. Tille (1999).

This literature shows that the stabilization properties of different exchange rate regimes crucially depend on pricing policy: flexible exchange rate regimes can dominate fixed exchange rate regimes with a policy of "pricing to producer" and vice-versa for a policy of "pricing to market".

[7]Many papers studied the role of financial frictions in closed economy: B. Bernanke and M. Gertler (1987, 1989, 1990, 1998), C. Carlstrom and T. Fuerst (1995), N. Kiyotaki and J. Moore (1997),B. Bernanke, M. Gertler and S. Gilchrist (1996, 1998), T. Cooley and K. Nam (1998), Cooley and Quadrini (1999a,

liabilities denominated in foreign currency can affect the stabilization properties of different exchange rate regimes[8]. This literature has mainly focused attention on small open economy and on the problem of managing currency and financial crisis.

The framework I adopt is a two country, infinite horizon model of dynamic general equilibrium. The model has several novel characteristics. I extend the set-up of the open economy described in the Galí and Monacelli (1999) by including two optimizing countries, both with a positive degree of openness, by allowing capital, adjustment costs and financial frictions in the loan markets of both countries. The design of the asset structure incorporates a domestic risk-free asset in the form of deposits in banks, a domestic and an internationally traded state contingent claim, capital and loans. The design of the financial contract links the return on deposits expressed in terms of total consumption goods with the return on capital expressed in terms of domestic output inflation: this leads to an external finance risk premium linked to the terms of trade by the degree of openness of the economy.

On this economy I perform different experiments (for technology, demand[9] and credibility[10] shocks in both countries) comparing the effects of different exchange rate regimes, implied by different monetary policy rules, on the overall stability of the economy. The simulations will be initially carried out by assuming that the two countries are symmetric in the parametrization and that the degree of openness of both countries is very low [11]. I will then perform several sensitivity experiments to check the robustness of the results. For a better understanding of the role played by financial distortions I will compare the model

1999b). Recently some papers have introduced financial frictions in an open economy, but attention has been concentrated basically on the small open economy where the rest of the world was not modeled and international markets were incomplete. P.Aghion, P. Bacchetta and A. Banerjee (1999, 2000) present a non microfounded version of a small open economy with financial frictions and private debt denominated in foreign currency; C. Burnside, M. Eichenbaum and S. Rebelo (2000) model a banking sector in small open economy in order to characterize financial fragility; L. Cespedes and A. Velasco (2000) and M. Gertler, S. Gilchrist and F. Natalucci (2000), E. Faia (2000) consider a microfounded version of a small open economy with a financial accelerator effect and incomplete international markets.

[8] Aghion, Bacchetta and Banerjee 1999, 2000 show that when firms hold a large fraction of their debt in the foreign currency, monetary policy becomes increasingly complex: this is actually the case for emerging markets as it is documented by the new BIS-World Bank-IMF dataset on external debt. Even tough this fits well in the case of small open economies with very fragile financial systems and a high degree of openness, it does not seems to be crucial for two large and closed economies such as the U.S. and Europe.

[9] The demand shock will be modeled as a shock to preferences.

[10] The credibility shock will be modeled as shock to the exchange rate that will appear in the UIP.

[11] The degree of openness will approximate the share of foreign consumption in the consumption index for US and Europe that is near 15 or 16 percent.

described with the two country model without capital, and with capital but in absence of financial frictions. The impulse response of the variables will show clearly the rank of the monetary regimes in terms of stabilization properties and will highlight the different transmission mechanism generated by the model with capital and financial frictions. The results of the stabilization analysis based on comparison of the patterns of variables and of the second moments of the calibrated model across different regimes will be confirmed by the results of the welfare evaluation. As a criterion of welfare evaluation of alternative monetary policy rules, I will adopt a measure of the costs of business cycles given by the fraction of non-steady state consumption that households would be willing to give up to be indifferent between a constant sequence of consumption and hours worked and the stochastic sequences of the same variables under the monetary regime considered.

Overall, the results from the model are informative and in accord with intuition. For large currency areas that are relatively closed, with low degree of openness on the trade balance,a low fraction of private debt denominated in foreign currency and with firms that use as common practice a "producer currency pricing rule", a Taylor rule with inflation and output stability goal associated to a floating exchange rate regimes can increase stability in terms of output, inflation, consumption and price of capital. The intuition of this result can be found in the analysis of transmission mechanism of the monetary policy in this context. The presence of adjustment costs on capital generates volatility in the price of capital that contributes to volatility in net worth. Borrower net worth is an important determinant of the business cycle of the economy and an essential source of volatility in output. In addition the presence of agency costs amplifies the cycle of the economy. These two elements require an active role of monetary policy: the constraint upon the monetary authority from fixed or managed exchange rates reduces the discretion of monetary policy in pursuing its active role and can generate movements in the nominal interest rate that can be perverse for the overall stability of the economy. The cost of deviating from the key goals of macroeconomic instability seems to be higher than the cost of fluctuations in the exchange rates.

The paper is organized as follow: section 2 shows the derivation of the theoretical model, section 3 describes the monetary policy rules that will be used in the comparisons, section 4 describes the calibration procedure, section 5 and 6 report the results of the simulation experiments, section 7 shows the volatility and welfare comparison among the policy rules, section 8 contains conclusion and suggests extensions for future work. Finally section 9 provides an appendix with the derivations of the model.

2 The Model

There are two countries of equal size. Each country is inhabited by a continuum of agents with measure one. There is no migration across countries. Labor and capital are immobile across the two regions and there is no possibility of migration.

The population can be divided into two sets of agents: infinite lived households that supply labor, workers, and finite lived households that supply capital and entrepreneurs. Workers in both economies choose consumption and leisure, own shares in a Calvo-style sector and invest in bank deposits that pay a gross interest rate at the end of the period and in state contingent bonds denominated in domestic and foreign currency[12]. Entrepreneurs choose consumption, invest in capital goods and own a share of a competitive sector. In order to pay for the capital investment the entrepreneurs seek a loan while facing borrowing constraints and a default risk that can't be insured. I will assume that the consumption demand of the entrepreneurs is a negligible fraction of total consumption: their optimizing decisions will play a role only for the demand for capital and loans necessary for production in the competitive sector.

In both countries there are three sectors of firms: the wholesale producers that produce a homogenous good in a competitive fashion using capital and labor, a monopolistic sector a' la Calvo that buys the homogenous good and differentiate it little bit and a sector of capital producers.

At each point in time, each producer in the monopolistic sector is allowed to reset his price with a constant probability, independent of the time elapsed since the last adjustment. Monopolistic producers face domestic and foreign demand for their products, but do not engage in international price discrimination. The wholesale producers get capital from the entrepreneurs and produce with a constant returns to scale technology. A competitive intermediary gets money from households' deposits and offers loans to the entrepreneurs: given

[12] Workers can then insure against the risk coming from the randomness in pricing of the firms they own.

the imperfect information the intermediary faces a monitoring problem and the solution to this generates an external finance risk premium.

2.1 The Aggregate Demand Block

2.1.1 Workers' Behavior in The Home Country and The Foreign Country

Workers are infinite lived agents who consume, work and hold non-monetary assets in the form of deposits in banks that pay a gross return at the end of the period and in the form of domestic and foreign state contingent bonds. Workers' utility is increasing, concave and separable over consumption and leisure[13]. Next, I formalize the general problem of the households in either of the two countries.

Households' utility in each country[14] is given by:

$$E_t \sum_{k=0}^{\infty} \beta^k [(U(C_{s,t+k}(C^H, C^F)) - V_s(N_{t+k})] \tag{1}$$

where N_t denotes the number of hours worked by the representative agent[15], C^H is the consumption demand of households in the home country for goods produced in the home country and C^F is the consumption demand of agents of the home country for goods produced in the home country, U is increasing, concave and differentiable and V is increasing, convex and differentiable, and C_t is a Dixit-Stiglitz-Spence aggregator[16].

[13]Notice that I am omitting money because the monetary policy will be specified in terms of the interest rate. The quantity of money will then be endogenously determined but will not play any role in determining the real side of the economy.

[14]Since now on, the foreign variables will be denoted by a star.

[15]I am assuming that households and firms are different agents, so I can express the households' utility in terms of leisure. In this economy agents are taking the decisions about their labor supply and firms are taking decisions about labor demand. The market clearing conditions will give the amount of labor in the economy.

[16]The quantity of the composite consumption good is given by:

$$C_t \equiv [(1-\gamma)^{1/\eta} C_{H,t}^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}$$

where $C_{H,t}$and $C_{F,t}$denotes respectively consumption of home goods and foreign goods, η represents the elasticity of substitution between home and foreign consumption at time t, and γ is the share of foreign consumption in the index and also represents the degree of openness. The CPI associated with minimum expenditure over the consumption basket is:

Households solve a three stage decision problem: they choose the optimal allocation of each variety in the first stage, the optimal allocation between home and foreign consumption and in the third stage they make consumption, labor and investment decision by maximizing the utility subject to a sequence of budget constraints for each state of the world. Appendix 9.1.1 contains the derivation of the maximization problem, the loglinearized expressions of the aggregate demand relations and the derivations of some identities for a two country economy.

By using the optimal consumption demands derived in the first two stages of the maximization problem I am able to write the budget constraint in each state in a compact form:

$$\int_0^1 [P_{H,t}(i)C_{H,t}(i) + P_{F,t}(i)C_{F,t}(i)]di + E_t\{d_{t,t+1}B_{t+1}\} + E_t\{e_t d^*_{t,t+1}B^*_{t+1}\} + D_{t+1} \leq \qquad (2)$$

$$\leq W_t N_t + T_t + B_t + B^*_t + R_t D_t$$

where B_t is the quantity of the domestic bond[17], B^*_{t+1} is the quantity of the international bond and $E\{d_{t,t+1}\}$ is the expected price of one unit of the domestic bond, $E\{e_t d^*_{t,t+1}\}$ is the expected price of one unit of the international bond and e_t is the nominal exchange rate, D_{t+1} is the quantity of bank deposits and R^n_t is the nominal gross return on deposits ($R^n_t = R_t \frac{P_t}{P_{t+1}}$ where R_t is the real gross return expressed in terms of CPI consumption goods), W_t is the nominal wage and T_t are the nominal lump-sum transfers (or taxes) . All the variables are expressed in terms of the domestic currency.

$$P_t \equiv [(1-\gamma)P_{H,t}^{1-\eta} + \gamma P_{F,t}^{1-\eta}]^{\frac{1}{1-\eta}}$$

The indices for home and foreign consumption are given by Dixit-Stiglitz aggregators over a continuum of goods with the property of constant elasticity of substitution over time:

$$C_{s,t} = \left(\int_0^1 C_{s,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where ε denotes the intertemporal elasticity of substitution.

[17] The return paid by the contingent bond is actually dependent on the state of nature, but for notational simplicity I avoid this cumbersome notation.

Combining the results on optimal allocation of expenditures from the first two stage of the maximization, I get the total demand for good i:

$$Y^d_{t+k}(i) = (\frac{P_{H,t}(i)}{P_{H,t+k}})^{-\varepsilon}(C_{H,t+k} + C^*_{H,t+k}) \tag{3}$$

where $C^*_{H,t+k}$ is the foreign demand for goods produced in the home country. A similar expression holds for the foreign country.

As a result of the third stage maximization problem I get the following optimality conditions:

$$\beta\frac{U_c(C_{t+1})}{U_c(C_t)}(\frac{P_t}{P_{t+1}}) = d_{t,t+1}; \beta\frac{U_c(C_{t+1})}{U_c(C_t)}(\frac{P_t}{P_{t+1}})(\frac{e_{t+1}}{e_t}) = d^*_{t,t+1} \tag{4}$$

$$U_c(C_t)W_t/P_t = -V_N(N_t) \tag{5}$$

$$R^n_t = E_t\{d_{t,t+1}\}^{-1}; R^{n*}_t = E_t\{d^*_{t,t+1}\}^{-1} \tag{6}$$

$$E_t\{C^{-\sigma}_{t+1}\frac{P_t}{P_{t+1}}[R^n_t - R^{n*}_t(\frac{e_{t+1}}{e_t})]\} = 0. \tag{7}$$

Equations (4) are the FOC with respect to the domestic and international contigent bond in each state of the world. Equation (5) gives the labor supply. Equation (6) are arbitrage conditions between the state contingent bonds and the deposits[18]. Finally equations (7) is a version of the UIP and is obtained by equating the conditional expectations of the first two and using (6).

I assume that in both the home and the foreign country there is a complete set of state contingent bonds in the Arrow-Debreu sense This implies that for the consumers in the other country we get a similar Euler equation:

$$U'(C^*_t) = R^n_{t+1}\beta U'(C^*_{t+1})(\frac{P^*_t}{P^*_{t+1}})(\frac{e_t}{e_{t+1}}). \tag{8}$$

[18] They are obtained from equating the FOC with respect to the deposits with the conditional expectation of the FOC with respect to the contingent bonds.

2.2 The Aggregate Supply Block: Firms' Behavior At Home and In The Foreign Country

I will solve the firm's maximization problem for the home country. A similar derivation holds for the firms in the foreign country.

2.2.1 The Competitive Sector and The Capital Producers

There is a competitive sector owned by finite lived agents, the entrepreneurs, [19] (firms have an exogenous probability of failure ζ). The sector produces a homogenous good, hiring capital and labor. There is a continuum of firms indexed by k. Each firm is subject to idiosyncratic shocks and to aggregate shocks on the return on capital. At the beginning of each period the entrepreneur observes the aggregate shock. Before buying capital the entrepreneur goes to the loan markets and borrows money from the intermediary by making a contract which is written before the idiosyncratic shock is recognized. With the money borrowed from the intermediary, the entrepreneur goes to the factor market to hire capital. The optimal demand for capital (and labor) is determined by minimization of total production cost subject to a constant return to scale production function[20]. After investing in capital goods the entrepreneur observes the idiosyncratic shock.

For the whole competitive sector there is an aggregate demand for capital and labor. The aggregate demand for capital will give the return on capital (R^k) for each realization of

[19] This assumption is necessary to rule out the possibility that the borrowing constraint will not be binding. If the firm has an infinite life or an expected survival time sufficiently long, it can accumulate a large amount of assets and ease the borrowing constraints.

[20] The problem is a standard one and looks like this. Each competitive firm k chooses $K_t(k)$ and $L_t(k)$ to:

$$Min \frac{W_t}{P_t} L_t(k) + Z_t(k) K_t$$

s.t.

$$Y_t(k) = A_t L_t(k)^{\alpha} K_t(k)^{1-\alpha}$$

Both, the production function and the labor supply are increasing, concave, constant return to scale and differentiable. Setting the Lagrangian and taking derivatives with respect to $K_t(k)$ and $L_t(k)$ we get:

$$\frac{1}{MC_t}\frac{W_t}{P_t} = (1-\alpha)\frac{Y_t(k)}{L_t(k)}; \frac{1}{MC_t} MPK_t = \alpha \frac{Y_t(k)}{K_t(k)}$$

where MC_t is the real marginal cost evaluated at the home currency.

the idiosyncratic shock. In equilibrium the expected real return on capital is:

$$E(R^k_{t+1}) = E(\frac{mc_t\alpha\frac{Y_t(k)}{K_t(k)} + Q_{t+1}(1-\delta)}{Q_t}) \tag{9}$$

mc_t is the real marginal cost given by $\frac{1}{mc_t}\frac{MPK_t}{P_{H,t}} = \alpha\frac{Y_t(k)}{K_t(k)}$, $Y_t(k) = A_tN_t(k)^{\alpha}K_t(k)^{1-\alpha}$, A_t is the technology shock, $N_t(k)$ is the labor input, $K_t(k)$ is capital, Q_t is the real price of capital and δ is the depreciation rate. Given that capital is not traded internationally, every variable is expressed in terms of domestic consumption good.

After determining the demand for capital, entrepreneurs use the money borrowed from the intermediary to buy capital. The sector of capital producers faces adjustment costs and sets a price for capital as a function of R^k[21]. From the maximization problem of the capital producers[22] we get the real price of capital:

$$Q_t = [\phi'(\frac{I_t}{K_t})]^{-1} \tag{10}$$

where I_t is investment. The law of motion of capital is:

$$K_{t+1} = \phi(\frac{I_t + I_t(z)}{K_t})K_t + (1-\delta)K_t \tag{11}$$

where $\phi(\frac{I_t+I_t(z)}{K_t})$ is a production function that embeds adjustment costs, where $I_t(z)$ is the aggregate investment from all the other firms.

[21] The presence of a third sector producing capital that faces adjustment costs permits derivation of a price for capital in the form of Tobin's q. An alternative way of modeling this would be to assume that the competitive sector faces a dynamic decision on capital investment. Firms get a return given by the marginal product of capital by using capital goods as production input in each period and they get a return in the form of capital gains by selling capital from one period to the other. This second alternative is quite cumbersome.

[22] The introduction of adjustment costs will follow Kiyotaki and Moore (1998). There is a competitive sector for firms producing capital. These firms operate with a technology embedding external adjustment costs. The adjustment costs are modeled trough the following production function for capital: $\phi(\frac{I_t+I_t(z)}{K_t})K_t$where $\phi(.)$is increasing and concave and $\phi(0) = 0$ and $I_t$is the aggregate level of investment and $I_t + I_t(z)$is the gross output of new capital goods. The problem of the representative firm is to choose $I_t(z)$ to:

$$MaxQ_t\phi(\frac{I_t + I_t(z)}{K_t})K_t - I_t(z)$$

subject to

$$K_{t+1} = \phi(\frac{I_t + I_t(z)}{K_t})K_t + (1-\delta)K_t$$

having normalized the price of $I_t(z)$equal to one.

2.2.2 The Behavior of the Monopolistic Sector

The second production sector in the economy has the task of differentiating the homogenous good: it is a monopolistic competitive sector. In choosing the optimal price they optimize in the Calvo fashion. The optimizing behavior of this sector will provide the pricing function for the final good and through this it will provide a relationship that works as a Phillips curve.

Agents are monopolists and prices are staggered. In each period the agent faces a fixed probability of adjusting prices $(1-\vartheta)$. In this event the agent chooses the price $p_{s,t}(i)$ with $s = H, F$ (H stands for home country and F stands for foreign country) for the produced differentiated good i so as to maximize the expected utility resulting from sale revenues minus nominal marginal costs in each of the future states in which the price commitment still applies. The maximization (Appendix 9.2) is performed taking as given $P, P_{H,} P_F$ and C and subject to the aggregate demand curve(3). The solution to the maximization problem is:

$$P_{s,t}^{new} = \mu \frac{E_t \sum_{k=0}^{\infty} (\vartheta)^k \Lambda_{t,t+k} Y_{t+k}(i) MC_{t+k}}{E_t \sum_{k=0}^{\infty} (\vartheta)^k \Lambda_{t,t+k} Y_{t+k}(i)} \tag{12}$$

where μ is a mark-up, ϑ is the probability that the price is fixed in each period, $Y_{t+k}(i) = (\frac{P_{H,t}(i)}{P_{H,t+k}})^{-\varepsilon}(C_{H,t+k} + C^*_{H,t+k})$ and $\Lambda_{t,t+k} = \beta^k(\frac{C_t}{C_{t+k}})(\frac{P_t}{P_{t+k}})$. The new price is determined as a constant mark-up over the discounted future stream of marginal costs. Embedded in the maximization problem of the monopolistic sector is the assumption that the producers set the price of their goods in domestic currency. The price of that good in the foreign market is then determined in accord with the prevailing exchange rate[23].

[23] This assumption is certainly true for the US producers, but it may not be true for producers of a small country: given the size of the US market, foreign producers may find it convenient to set the price in dollars in order to avoid the risk of exchange rate fluctuations. Notice that the model economy is build up as a two region world with two big countries, such as the US. and Europe, that have a low degree of openness (the share of domestically produced goods that are sold outside is around 15 or 16 percent for both countries). This allows us to consider as reasonable the assumption that also European producers set prices in Euro. For this reason the microfoundations of the model do not incorporate producers who discriminate between markets and I will, in general, assume "producer currency pricing" for each region.

2.3 The Financial Intermediary

The financial intermediary collects money from deposits and supplies loans to the entrepreneurs facing an incentive problem due to asymmetric information. The asymmetric information in this economy arises from the fact that firms observe the idiosyncratic shock but households and banks can do so only at some cost. The role of financial intermediary is to minimize the monitoring cost by pooling projects[24]. The incentive problem is solved via the design of a contract that takes the form of costly state verification that is shown to be an optimal debt contract in Gale and Hellwig (1985)[25]. I will introduce financial frictions in the general equilibrium following a standard strategy like that in Bernanke, Gertler and Gilchrist (1998) or Cooley and Quadrini (1999). Given that the fraction of private loans in foreign currency for the Euro area and the U.S. economy is negligible, I will assume that the entire loan demand is expressed in domestic currency.

Appendix 9.3 shows the maximization problem faced by the intermediary. The solution to the problem yields the following loglinearized expression for the external finance premium:

$$\frac{E_t(R^k_{t+1})}{R_t(P_t/P_{H,t})} = -F[\frac{\Pi_t}{Q_t K_t}] \tag{13}$$

where $\Pi_{t+1}$are net worth of the entrepreneurs, and $\frac{E_t(R^k_{t+1})}{R_t(P_t/P_{H,t})}$ is the external finance premium and F is the elasticity of the risk premium to the collateral. Both variables are expressed in terms of domestic consumption goods. Equation (13) entails a negative relation between the finance premium and the collateral of the firms, expressed by the ration between net worth and capital.

The aggregate level of net worth (Π) is derived by assuming that the change in the wealth of the entrepreneur is given by the return on capital investment minus the cost of loans and that only a fraction ξ of entrepreneurs remain alive period by period:

[24]There is no asymmetric information between households and the intermediary: the bank pays a fixed rate of return on deposits.

[25]A standard debt contract requires a fixed payments in the states for which the firm is solvent and requires the intermediary to recoup as much as possible of the debt when the firm cannot meet the payment.

$$\Pi_{t+1} = \xi[R_t^k Q_{t-1} K_t - (1+\varkappa)(1+R_{t-1}\frac{P_t}{P_{H,t}})(Q_{t-1}K_t - \Pi_t)] \tag{14}$$

where $(1+\varkappa)$ is the ex post cost of loans.

Notice that the return on deposit is evaluated in terms total consumption goods while the return on capital is evaluated in terms of domestic consumption goods: this generates a loglinearized expression for the external finance premium $(E_t(\hat{r}_{t+1}^k) - \hat{r}_t = \gamma\hat{s}_t - v[\hat{\Pi}_{t+1} - (\hat{q}_t + \hat{k}_{t+1})])$ that depends positively on the terms of trade and whose dependence is defined by the degree of openness. An increase in the terms of trade due to an increase in the domestic prices implies an increase in the return of capital goods and an increase in the external finance risk premium.

2.4 Fiscal Authority

For simplicity I am assuming that the fiscal authority in each country does not make public expenditures. The fiscal authority just makes lump sum transfers among individuals. The budget constraint at date t in the home country (the same holds for the foreign country) is:

$$\int_0^1 T_s(i)di = 0. \tag{15}$$

2.5 The Equilibrium Conditions

In equilibrium the market clearing condition implies:

$$Y_t(i) = C_{H,t}(i) + C_{H,t}^*(i) + I_{H,t}(i). \tag{16}$$

Given certain assumption on the aggregator functions[26] for each country the following

[26] The aggregation problem has been solved by assuming that the aggregate investment in both countries can be represented trough a CES aggregator:

$$I_{s,t} = \left(\int_0^1 I_{s,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}},$$

and that aggregate outputs can be approximated by the sum of individuals output at least in a neighborhood of the steady state. There is no trade on investment goods, meaning that each country uses its own production of capital goods as input.

equilibrium conditions must hold:

$$Y_t = C_{H,t} + C^*_{H,t} + I_{H,t};\ Y^*_t = C_{F,t} + C^*_{F,t} + I_{F,t}. \tag{17}$$

Market clearing condition for bonds denominated in the currencies of the two countries requires these asset to be in zero net supply:

$$B_{H,t} + B^*_{F,t} = 0;\ B_{F,t} + B^*_{H,t} = 0. \tag{18}$$

Finally the real demand for loan has to be equal to the real supply of loans:

$$\frac{D_t}{P_t} = L_t = (Q_t K_t - \Pi_t); \frac{D^*_t}{P^*_t} = L^*_t = (Q^*_t K^*_t - \Pi^*_t). \tag{19}$$

2.6 The Loglinearized version of the model

I now present the complete macroeconomic framework. Lower case variables denote percentage deviations from the steady state (Appendix 9.4). I will present the equations for the home country, but those for the foreign country look the same.

- Aggregate Demand.

$$\widehat{y}_{H,t} = (\zeta_h - \zeta_{h^*})(\eta(1-\gamma)\hat{s}_t) + \zeta_h \widehat{c}_t + \zeta_{h^*} \widehat{c}^*_t + \zeta_{I_h} \widehat{i}_{H,t} \tag{20}$$

$$\hat{c}_t = E_t\{\hat{c}_{t+1}\} - \frac{1}{\sigma}(\hat{r}^n_t - E_t\{\pi_{H,t+1}\}) + \frac{\gamma}{\sigma} E_t\{\Delta \hat{s}_{t+1}\} - \frac{1}{\sigma}(\nu_{t+1} - \nu_t) \tag{21}$$

$$E_t(\hat{r}^k_{t+1}) - \hat{r}_t - \gamma \hat{s}_t = -F\,[\hat{\Pi}_{t+1} - (\hat{q}_t + \hat{k}_{t+1})] \tag{22}$$

$$\hat{r}^k_{t+1} = (1-g)(\hat{y}_{H,t+1} - \hat{k}_{t+1} + \hat{mc}_{t+1}) + g(\hat{q}_{t+1} - \hat{q}_t) \tag{23}$$

$$\hat{q}_t = \varphi(\hat{i}_t - \hat{k}_t) \tag{24}$$

$$\hat{s}_t = (\hat{r}^*_t - E_t\{\pi^*_{F,t+1}\}) - (\hat{r}_t - E_t\{\pi_{H,t+1}\}) + E_t\{\hat{s}_{t+1}\} + f_t \tag{25}$$

In addition I assumed that the consumption basket can be represented by a CES aggregator and that aggregate output can be represented as the sum of the individuals outputs:

$$Y_{s,t} = \left(\int_0^1 Y_{s,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where $s = H, F$.

- Aggregate Supply Block.

$$\hat{y}_{H,t} = \hat{a}_t + \alpha \hat{k}_t + (1-\alpha)\hat{n}_t \tag{26}$$

$$\hat{y}_{H,t} + \hat{mc}_t - \sigma \hat{c}_t = (1+\tau)\hat{n}_t + (1-\gamma)\hat{s}_t \tag{27}$$

$$\pi_{H,t} = \beta E_t(\pi_{H,t+1}) + \lambda(\hat{mc}_t) \tag{28}$$

- Law of Motion for State Variables.

$$\hat{k}_{t+1} = \delta \hat{i}_t + (1-\delta)\hat{k}_t \tag{29}$$

$$\hat{\Pi}_{t+1} = \frac{\xi RK}{\Pi}(\hat{r}^k_t - \hat{r}_t) + \hat{r}_t - \gamma \hat{s}_t + \hat{\Pi}_t + \phi^n \tag{30}$$

- Evolution of Processes for the Stochastic Variables (shock to technology, preferences and exchange rates):

$$\hat{a}_t = \rho_a \hat{a}_{t-1} + \varepsilon^a_t; \hat{\nu}_t = \rho_\nu \hat{\nu}_{t-1} + \varepsilon^\nu_t; \hat{f}_t = \rho_\nu \hat{f}_{t-1} + \varepsilon^f_t \tag{31}$$

- where $\zeta_h = (1-\gamma)[1 - \frac{\delta\alpha}{\mu(R^k-1+\delta)}]$, $\zeta_{h^*} = \frac{\gamma}{1-\gamma}\zeta_h, \zeta_I = \frac{\delta\alpha}{\mu(R^k-1+\delta)}$, $g = (1-\delta)/[(1-\delta) + \alpha Y/K]$, $\nu = \psi(R^k/R)/\psi'(R^k/R)$, $\varphi = [(\phi(I/K)^{-1})'(I/K)/(\phi(I/K)^{-1})'']$, $\lambda = \frac{(1-\vartheta)(1-\beta\vartheta)}{\vartheta}$, $\delta = \phi(\frac{I_t}{K_t}) = \frac{I_t}{K_t}$, $\phi^n = \frac{(R^k/R-1)K}{\Pi}(r^k_t + q_{t-1} + k_t), E(a) = 0, Var(a) = 1.$

Equation (20) is obtained by substituting in the loglinearized version of the resource constraint the demand for domestic and foreign consumption good. Equation (21) is the loglinear Euler equation after substituting the expression for the CPI domestic inflation. Equation (22) is the loglinear external finance risk premium. Equation (23) is the loglinear expected return on capital. Equation (24) is the loglinear Tobin's q. Equation (25) is the loglinear UIP expressed in real terms. Equation (26) is the loglinear production function of the competitive sector. Equation (27) is obtained by loglinearizing the equilibrium condition for the labor market. Equation (28) is the Phillips curve. For the foreign country we have the same set of equations.

3 The Monetary Policy Rules

There is an active monetary policy: the monetary authority sets the short term nominal interest rate by reacting to endogenous variables. Each monetary and exchange rate regime will be identified with a different specification of the monetary policy rule.

The comparison between different specifications of the monetary rule and the exchange rate regime at the same time seeks for the scenario that yields the greatest degree of stability. I will consider the general class of the Taylor rules of the following form:

$$\hat{r}^{n} = \varpi_{\pi}(\pi_{H,t-l} - \bar{\pi}) + \varpi_{y}(\hat{y}_{t-l} - \bar{y}) + +\varpi_{e}(\hat{e}_{t} - \bar{e}) + \hat{m}_{t} \tag{32}$$

where $\varpi_{\pi}$is the weight the monetary authority puts on the deviation of inflation from the target $(\bar{\pi})$, $\varpi_{y}$is the weight that the monetary authority puts on the deviation of output from the target level $(\bar{y})$, $\varpi_{e}$is the weight that the monetary authority puts on the deviation of the exchange rate from the target $(\hat{e}_{t} - \bar{e})$ and $\hat{m}_{t}$ is a monetary policy shock that evolves according to $\hat{m}_{t} = \rho_{m}\hat{m}_{t-1} + \varepsilon_{t}^{m}$.

Following Clarida-Gali'-Gertler (1998) and Rotemberg-Woodford (1998) I assume that monetary policy goal is to smooth changes in interest rate:

$$\hat{r}_{t}^{n} = (1-\chi)\hat{r}_{t}^{n} + \chi\hat{r}_{t-1}^{n} \tag{33}$$

I will identify a regime of pure floating exchange rate with a Taylor rule of the form (32) in which $\varpi^{e} = 0$. I will consider two different kind of managed exchange rate systems: one identified by a Taylor rule of the form (32) in which $\varpi^{e} > 0$ and one identified by a Taylor rule in which the monetary authority sets a positive reaction coefficient on the change of the exchange rate over time $(e_{t} - e_{t-1})$. Finally I will identify a regime of pure peg with the following monetary rule[27]:

$$\hat{r}_{t}^{n} = \hat{r}_{t}^{n*}. \tag{34}$$

[27]This rule follows just from the assumption that the monetary authority sets equal to zero the deviation of the exchange rate from its steady state value.

I will also compare the situation in which the specification is perfectly symmetric for both and the situation in which the "leader" country uses a different parametrization and a specification different from that of the "follower".

4 Calibration

The model is parametrized as followed. The two country are assumed to be symmetric in preference and technology specifications in the first simulations. Time is taken to be measured in quarters.

Preferences: I set the discount factor $\beta = 0.99$, so that the annual interest rate is equal to 4 percent. As in most of the literature on RBC, I set the elasticity of substitution between domestic and foreign goods η equal to 1.5. The parameters on consumption and labor in the utility function are set equal to one to generate a log utility and a unity supply of labor[28]. I set the degree of openness at $\gamma = 0.15$ (and I allow for variations ranging between 0.10 and 0.20) that is consistent with the US-Europe case. The intertemporal elasticity of substitution of labor is $\phi = 1$, and the intertemporal elasticity of substitution is $\sigma = 1$[29].

Technology: the share of capital in the production functions $\alpha = 0.3$, the quarterly depreciation rate $\delta = 0.025$, the steady state mark-up value $\mu = 1.2$.The probability of adjusting prices in each period ϑ is set equal to 0.75, a value consistent with an average period of one year between price adjustment. The elasticity of the price of capital with respect to investment output ratio $\varphi = 0.5$.

Financial frictions parameters: The elasticity of the premium with respect to the leverage ratio is $F = 0.05$,the probability that a firm will be alive next period is $\xi = 0.975$. The steady state ratio of net worth over capital is 0.5. The values calibrated as described are the result of assuming a risk premium in steady state of 200 hundred basis point, a business failure rate $(F(\bar{\omega}))$ of three percent, a ratio of capital to net worth of 2 and a ratio of debt to capital of eighty percent. All the values are consistent with data in industrialized countries, like U.S. and Europe.

[28]These values are compatible with those of a steady state balanced growth.

[29]The intertemporal elasticity of substitution also gives the elasticity of the aggregate exports demand with unit real exchange rate.

Monetary policy parameters: I fix the weight on inflation in the Taylor rule at $\varpi_\pi = 1.5$ and the smoothing parameter at $\chi = 0$ or $\chi = 0.9$. The other parameters will vary according to the experiment performed.

Exogenous shocks: The persistence of the shocks varies between 0.8 and 0.9.

The equilibrium of the model is characterized as the solution of the system of expectation difference equations of the loglinearized form[30].

5 Fixed Versus Floating Exchange Rates

This section describes the dynamics of the home economy driven by stochastic innovations in the technology process and in the monetary policy process in both the home and foreign country and compares the impact of these shocks under floating and pure peg exchange rate regimes. I will assume for simplicity that the monetary authority of the foreign country is following a Taylor rule of the form described in (32). For the home country I will compare different regimes: pure floating, managed and pure peg[31].

Productivity Shock in the Home Country. Figure 1 shows the impulse response functions of the home economy in the model with capital and financial frictions to a 1% technology shock (with a 0.9 autoregressive coefficient) in the home country under both, floating (solid curves) and fixed (dashed curves) exchange rate regimes with a zero smoothing parameter factor in the Taylor rule. The persistence of patterns of the variables under fixed exchange rates looks greater than that under floating exchange rates. For all the variables, under fixed exchange rate regimes, the jump on impact is bigger and the convergence to the steady state

[30] The loglinearized system can be described by a general homogenous matrix equation:

$$E_t \sum_{i=-m}^{n} A_i X_{t+i} = 0, t \geq 0$$

where m is the number of leads, n is the number of lags, A_i are the structural coefficient matrices, and $A_n(n = 1)$ is not full-rank. I apply the solution method developed by Anderson and Moore (1985) which enables us to deal with possibly singular systems, unlike the Blanchard-Khan (1980).

[31] For Europe I will set the coefficient on the income deviations from the steady state in the Taylor rule always equal to 0. The EU Treaty unambiguously assigns to the ECB the mandate of maintaining price stability. On the contrary the statutory mandate of the Fed is less clearly defined and US monetary policy is usually interpreted to be sensitive to both output and inflation. For the U.S. I will let this weight to move from 0 to 0.5.

takes a longer time. The positive effect of a technology shock causes a real and nominal depreciation. Under fixed exchange rates the nominal interest rate goes up as a result of the active role of monetary policy: this induces a decrease in investments, net worth, price of capital and output. The decrease in inflation leads to a decrease in the terms of trade. Notice that output follows a pattern pretty similar in the shape to that of investment and net worth. The nominal exchange rate and, consequently, the price of the international traded bond is much more unstable under floating exchange rates, while the price of capital looks much more unstable under fixed exchange rates.

When I shut off the risk premium the impulse responses look pretty similar to the ones in the model with agency costs: with a home technology shock under fixed exchange rates the destabilization effect due to agency costs is not significant. On the contrary, as I will explain later, under a foreign technology shock the acceleration effect is very strong. The explanation of the difference in the acceleration effect between the two shock can be mainly found in the following intuition: a positive technology shock in the home country should imply a fall in the nominal and consequently in the real interest rate that should boost the economy, although this does not happen under fixed exchange rates because the interest rate is pegged to the world interest rate[32]. On the other side with a foreign technology shock there is a direct impact on the interest rate that can't be controlled by a monetary authority subject to external constraints.

Figure 2 shows the pattern of the variables in the same experiment in the model without capital and financial frictions. In this case output looks more destabilized under floating exchange rates than under fixed and follows a pattern pretty close to the pattern of consumption. In the previous model capital and net worth were key determinants of output: movements in the interest rate due to the active monetary authority had a destabilizing effect on capital and consequently on output. In the model without capital, consumption is a key determinant of output: movements of nominal exchange rates determine movements in the price of the international bond, destabilizing consumption and consequently output. Notice that even the sign of the transmission of shocks under fixed exchange rates is dif-

[32] Faia E. and Monacelli T. (2001) show that in a small open economy with positive degree of financial exposure (a positive fraction of debt denominated in foreign currency) under a home technology shock fixed exchange rates can work as a stabilizer compared to flexible exchange rates.

ferent in the model with capital from that in the model without capital: negative in the first one and positive in the second. In the setup with capital and with financial frictions in both countries a foreign monetary authority following an interest rate rule that targets endogenous variables such as output gap and inflation, should pursue a stronger active role. In response to a positive technological shock in the home country the central bank reacts by increasing the interest rate more than in the model without capital. Under pure fixed exchange rates the foreign interest rate provides an anchor inducing similar movements in the interest rate of the home country. The strong increase in the interest rate in the home country depresses output and consumption.

Figure 3 shows the impulse response of the variables in the model with capital and financial frictions when the monetary authority adopts a smoothing parameter factor of 0.8/0.9 on the lagged interest rate. The pattern of variables looks more stable than in the previous case (Figure 1) and comes closer to the pattern of variables in the model without capital. This shows that the monetary authority can improve financial stability by smoothing the interest rate even without reacting to asset price variability: the destabilization effect of a variable price of capital and the presence of an external finance premium can be mitigated by tuning the interest rate closely.

Productivity Shock in the Foreign Country. Figure 4 shows the impulse response functions of the home country variables in a model with capital and agency costs to a 1 percent shock in the technology process (with an autoregressive parameter of 0.9) for the foreign country under both floating and fixed exchange rate regimes and a smoothing parameter of 0 on the interest rate. Under fixed exchange rate regimes almost all macroeconomic variables, apart from exchange rate and trade balance show, a higher persistence and volatility. In order to match a decline of the interest rate abroad the output in the home country shows a big expansion that also leads to an increase in inflation. Due to the expansion in inflation there is a decline in the terms of trade that depress the trade balance. The increase in output and the decrease in the nominal interest rate produce an increase in net worth and in the price of capital. Under floating exchange rates all the variables, apart from nominal exchange rate, terms of trade and trade balance, show a low degree of persistence.

I have repeated the same experiment in the model with capital by assuming a zero external finance risk premium (Figure 5): the impulse responses are much more stable. The jump on impact of output is 2, while in the model with a positive external finance risk premium is 4. Inflation declines on impact and the persistence in the movements of the terms of trade declines. When I shut off the risk premium the economy looks much more stabilized mostly under fixed exchange rates, while there is no such big difference in the impulse responses under floating exchange rates. Finally one should notice that as long as we increase the interest rate smoothing the difference in the impulse responses between the two models, with and without agency costs, decreases.

A comparison with the model without capital shows that the insulation property of the floating exchange rate looks even stronger in a model with variable price of capital and agency costs. Figure 6 shows the impulse response of the model without capital: the output has the same shape under both regimes but the jump on impact is much smaller. Under a floating exchange rate inflation looks more stable in the model with capital than in the model without capital. Finally one can notice an increase of the terms of trade in the model with capital and a decrease in the model without capital.

Again repeating the same experiment in the model with capital and agency costs assuming a smoothing parameter factor of 0.8/0.9 (Figure 7) shows that the economy approaches the economy without capital in terms of stability: the jump on impact of both, output and inflation, declines. We can recognize a monotonic relation between the coefficient of interest rate smoothing and the volatility of output: when the coefficient increase given the presence of financial frictions the volatility of output decreases.

Monetary Shock in the Foreign Country, Demand Shock and Credibility Shock. The mundellian theory recognizes a dichotomy between real shocks, that affects the interest rate, and nominal shocks, identified as shocks to money demand. With real shocks the insulation property of floating exchange rates holds, while with nominal shocks movements in the exchange rates can destabilize the entire economy. In a model where money is endogenously determined a monetary policy shock is identified as a random process that enters the monetary policy rules. For this reason its impact on the economy will look very much like the impact of a real shock. In this sense the classical dichotomy should be reinterpreted. A 1 percent shock to the monetary policy of the foreign country generates impulse responses of the home country variables that are very similar to those generated by a 1 percent foreign technology shock. When the process for the monetary shock is autoregressive instead than i.i.d. the destabilizing property of the fixed exchange rates is even stronger than in the case of the foreign technology shock.

I perform simulations of the model with both , a home and a foreign shock to preferences[33]: this will impact consumption demand and will act as a demand shock. In both cases still fixed exchange rates look more destabilizing. A negative demand shock in the home country generates, under fixed exchange rates, a recession with big destabilizing effect. A negative demand shock in the foreign country has a positive impact in the home country: the reduction of the foreign demand, induces a reduction in the foreign interest rate and trough the uncovered interest parity it also induces a reduction in the home interest rate. The fall in the home interest rate generates a positive acceleration effect to the home economy.

Finally I perform simulation of the model under credibility shocks[34] (shocks to the exchange rates in the UIP). Even in this case fixed exchange rate regimes are more destabilizing. Under fixed exchange rates, a positive shock to the expectation of devaluation generates an increase of the home interest rate and depresses the economy.

6 Managed Exchange Rates Versus Floating and Versus Fixed Exchange Rates

The purpose of this section is the comparison of managed exchange rate regimes with floating and with fixed exchange rate regimes. For simplicity I will assume that only the monetary authority of the home country is reacting to the exchange rate.

Productivity shock in the home country and abroad. Figure 8 and 9 shows the impulse response to a home and foreign technology shock, under 0.8 persistence of the shock, of the model with capital and financial frictions under floating, fixed and two kind of managed exchange rates, one pegging the level and the other pegging the change in the exchange rate[35].

[33]To see how the shock enters the loglinear demand for consumption see equations 47 and 48 in Appendix 9.1.

[34]To see how the shock enters the UIP see equation 53 in Appendix 9.1.

[35]I assume as benchmark a weight on the exchange rate of 0.5. I then let the weight vary to check robustness.

There appears to be a monotone ranking of the three regimes in terms of stabilization: floating exchange rate regimes look more stabilizing than managed regimes and managed regimes look more stabilizing than fixed exchange rate regimes in terms of output and inflation persistence. Management of the change in the nominal exchange rate yields more stabilization than managements of the level and leads to impulse response functions that are closer to those with floating exchange rates. Given that the exchange rate is a non-stationary variable a reaction to the change in levels helps the monetary authority to get rid the non-stationary elements.

We can conclude that management of the level of the exchange rates delivers almost the same destabilization effect than a system of pure fixed exchange rate appearing equally undesirable for the monetary authority.

7 Volatility of Variables under Different Regimes and Welfare Comparison

Most of the positive analysis of this paper has centered on comparison of the time paths that the variables would follow under different regimes and on comparison among the different degree of persistence shown by the variables in their response to a shock. The purpose of this section is to evaluate from a normative point of view the behavior of different monetary policies in an open economy and in presence of financial frictions. I will first evaluate the stabilization properties of the different regimes by comparing the volatilities of the variables[36]. I compute the second moments of the calibrated model.

Table 1 and 2 show the second moment[37] of the model with capital, financial frictions and in absence of interest rate smoothing under home and foreign technology shock. Fixed exchange rates appear to be the more destabilizing than any other regime even in terms of volatilities. The volatilities of all variable, in general, are the lowest under floating exchange rates. Volatilities under different kind of managed regimes lie between volatilities under fixed and floating exchange rate regimes.

The stabilization analysis gives suggestions on the undesirability of fixing or even managing exchange rate for the home country. A more stringent result on the desiderability of floating exchange rate as stabilization tools comes from the welfare evaluation.

I will adopt a measure of the welfare costs of business cycles given by the fraction of non-steady state consumption that households would be willing to give up in order to be indifferent between a constant sequence of consumption and working hours and the stochastic sequences of the same variables under the monetary regime considered. Appendix 9.5 shows

[36]Volatility was computed using the following approximation procedure over the matrix of the second moments. Lets define the reduced form of the loglinearized model as follows:

$$E\{X_t\} = AX_{t-1} + b\varepsilon_t$$

where $X_t$is the matrix of the endogenous variables at time t, A is the transition matrix and ε_t is the vector of the exogenous shocks which are assumed i.i.d. with unitary covariance. Let $\Psi = b * \Sigma_\varepsilon * b'$ denote the variance covariance matrix of exogenous shocks. The matrix of the second moments Ω of the endogenous variables is:

$$\Omega_{as} = \lim_{k \longrightarrow \infty} \{\sum_{i=0}^{k} (A^i)\Psi(A^i)'\}.$$

I calculated the second moments by approximating Ω_{as} by Ω_{k+1} so that the $\max[\Omega_{k+1} - \Omega_k] \geq 1.0e - 0.8$, where max stands for the maximum distance between any two elements of the matrix $\Omega_n - \Omega$.

[37]For this experiment I calibrated the persistence of the shock as 0.9, that is a reasonable value for any persistent shock. The variance of the shock is the same for the two economies and normalized so that the second moments of the variables result to be less than one. Values of the volatilities that range between zero and one will be useful to deliver positive number for the welfare comparison and will help to give a more clear interpretation of the welfare ranking. Different values for this variance will generate the same relative ranking among volatilities even with higher absolute values.

the derivations of the welfare measure that assumes the following form:

$$\upsilon = 1 - [\frac{1}{2}((1-\sigma)E(\overset{\wedge}{c_t})^2 + (1+\phi)E(\overset{\wedge}{n_t})^2] \tag{35}$$

Given the parametrization of the calibrated model, where σ has been set equal 1 in order to get steady state balanced growth, the welfare measure is mainly determined from the volatility of labor. Table 3 shows the welfare gains for home and foreign technology shocks under different regimes in presence of financial frictions and interest rate smoothing. One can clearly see that the stabilization properties of floating exchange rates deliver the highest gain (and the lowest welfare cost that is the specular image), while fixed exchange rate regimes imply the higher welfare cost. The welfare gains from managed exchange rates lie between the two even tough they are much closer to the ones under floating exchange rates[38]. In addition one can notice that managing the change in the exchange rate improves welfare compared to management of the level as a result of the benefic effect on consumption of a higher stabilization in the price of the international bond[39].

Tables 4 and 5 provide a systematic assessment of the welfare costs associated to fixed exchange rate regimes under different degrees of financial frictions and interest rate smoothing for both, home and foreign technology shocks. The welfare gains strongly decrease when we move to the model with endogenous capital accumulation and to the model with both, adjustment costs and agency costs. Higher degrees of interest rate smoothing tend to increase the welfare gains (and decrease welfare costs that are a specular image) across models and induce a very similar welfare gains in the models with and without agency costs. Finally table 6 shows that the difference in the welfare costs between fixed and floating exchange rates decreases when there are no agency costs or when an higher interest rate smoothing is applied. Notice that with an high interest rate smoothing the welfare differential between the two exchange rate regimes is almost the same both, in the model with agency costs and in the model without agency costs. This proves that when the monetary authority smooths the interest rate the impact of financial frictions is almost insignificant.

[38]From the stabilization analysis they appeared much more destabilizing because the stabilization analysis looked at output and inflation volatility, while the welfare measure looks only at employment volatility.

[39]Management in the change in the exchange rate helps the monetary authority to get rid of non stationary elements in the exchange rates and consequently in the price of the international bond.

We can then conclude that in presence of financial frictions fixed exchange rates deliver the highest welfare cost and that this cost tend to decrease when we shut off financial frictions or when we increase the degree of interest rate smoothing.

8 Conclusions

The paper addresses the issue of policy stabilization in terms of optimal choice of exchange rates regimes and the transmission mechanism of shocks in a two country model where financial frictions are explicitly microfounded. Financial stability can be a concern for the policy makers as long as the presence of financial frictions can impact the overall stability of the economy. In choosing the monetary regime a central bank of an open economy should take into account the impact of its choice on the real economy facing financial frictions. In presence of adjustment costs and agency costs, movements in real interest rates due to management of the exchange rates have a large impact on investment and net worth that are an important determinant of the business cycle. The insulation property of the mundellian theory holds also in a model without capital even though a model characterized by adjustment costs, that determine an endogenous variation in capital stock, and agency costs, that generate amplification in the cycle of the economy, enhances the result, provides a much richer explanation of the transmission mechanism behind this result and accounts for different sign in the transmission of external shocks. A clear ranking is identified among different monetary regimes in terms of persistence in the patterns of the impulse response, of volatilities of variables and welfare costs of the business cycle. In addition both, stabilization and welfare analysis, show that the presence of financial frictions destabilizes the economy and induces an extra burden mostly under fixed exchange rate regimes. The paper shows that interest rate smoothing can be a key determinant in stabilizing the economy. When the monetary authority adopts higher interest rate smoothing the dynamic properties of the economy with capital and financial frictions approach to those of the economy without capital and the welfare costs tend to decrease.

The paper seems to imply that if one country unilaterally adjusts its nominal interest rate in order to manage or fix exchange rates while the other country follows a Taylor rule, there can be large destabilizing effects when the economy is hit by foreign shocks. This suggests that large currency areas that are relatively closed should take advantage of the insulation properties of exchange rate regimes.

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9 Appendix

9.1 Derivation of the Complete Loglinearized Model

9.1.1 Aggregate Demand Equations

The households solve a three stage problem. I show the result for the home country: a similar solution holds for the foreign country.

First stage. To get the optimal quantity $C_{s,t}$, with $s = H, F$, we solve:

$$\max(C_{s,t} = \left(\int_0^1 C_{s,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}) \tag{36}$$

$$s.t.P_{s,t}C_{s,t} \leq E_{s,t} \tag{37}$$

where $C_{s,t}$ is a CES aggregator and $E_{s,t}$ is the amount of expenditure allocated to the good $C_{s,t}$. The solutions of the two maximization problems are:

$$C_{s,t}(i) = (\frac{P_{s,t}(i)}{P_t})^{-\varepsilon} C_t \tag{38}$$

where $P_{s,t} = \left(\int_0^1 P_{s,t}(i)^{1-\epsilon} di\right)^{\frac{1}{\varepsilon-1}}$ is defined as the price that minimize the expenditure given the optimal quantity of consumption. Since there is no international price discrimination $P_{F,t}(i) = e_t P^*_{H,t}(i)$, $\forall i \in [0,1]$, where e_t is the nominal exchange rate expressed as the price of foreign currency in terms of the home currency and $P^*_{H,t}(i)$ is the price of foreign good i denominated in foreign currency.

Second Stage. The consumers choose the optimal allocation between home and foreign good. They solve the following problem: choose $C_{H,t}$ and $C_{F,t}$ to:

$$MaxC_t \equiv [(1-\gamma)^{1/\eta} C_{H,t}^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{39}$$

$$s.t.P_t C_t \leq E_t \tag{40}$$

where γ is the share of foreign demand in the consumption index or the degree of openness of the home economy. The solution to this problem gives the optimal demand for home good from the home country and the foreign country:

$$C_{H,t} = (1-\gamma)(\frac{P_{H,t}}{P_t})^{-\eta} C_t; C_{F,t} = \gamma(\frac{P_{F,t}}{P_t})^{-\eta} C_t. \tag{41}$$

Similarly $P_t \equiv [(1-\gamma)P_{H,t}^{1-\eta} + \gamma P_{F,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ is defined as the price that minimizes expenditure given the optimal allocation of consumption. The maximization problem for the foreign country is just the same and the degree of openness of the foreign country is denoted by γ^*. I assume $\gamma^* = \gamma$. The loglinearized expressions for the optimal allocations of consumption between home and foreign goods for the home economy are:

$$\hat{c}{}_t^H = -\eta(\hat{p}{}_t^H - \hat{p}_t) + \hat{c}; \hat{c}{}_t^F = -\eta(\hat{p}{}_t^F - \hat{p}_t) + \hat{c}_t \tag{42}$$

and for the foreign economy:

$$\hat{c}_t^{H*} = -\eta(\hat{p}_t^{H*} - \hat{p}_t^{*}) + \hat{c}_t^{*};\ \hat{c}_t^{F*} = -\eta(\hat{p}_t^{F*} - \hat{p}_t^{*}) + \hat{c}_t^{*}. \tag{43}$$

Let us now define the terms of trade as: $s_t = \frac{P_{F,t}}{P_{H,t}} = \frac{e_t P^*_{F,t}}{P_{H,t}}$. The loglinearized expression for the terms of trade is: $\hat{s}_t = \hat{p}_t^{F} - \hat{p}_t^{H} = \hat{e}_t + \hat{p}_t^{*F} - \hat{p}_t^{H}$. Combining this expression with the loglinearized expression for the consumption index for the home country $\hat{p}_t = [(1-\gamma)\hat{p}^{F} + \gamma\hat{p}^{H}]$ and rearranging the consumption allocation as function os the terms of trade I get:

$$\hat{c}_t^{H} = \eta(1-\gamma)\hat{s}_t + \hat{c}_t;\ \hat{c}_t^{F} = -\eta\gamma\hat{s}_t + \hat{c}_t. \tag{44}$$

Assuming $\hat{s}_t = -\hat{s}_t^{*}$ for the foreign country I get:

$$\hat{c}_t^{*H} = \eta(1-\gamma^*)\hat{s}_t + \hat{c}_t^{*};\ \hat{c}_t^{*F} = -\eta\gamma^*\hat{s}_t + \hat{c}_t^{*}. \tag{45}$$

Third Stage. Households choose total consumption, the quantity of labor and they make portfolio decisions in bank deposits and bonds. The result of this stage of the maximization are the FOC (4), (5). Assuming a utility of the form $U_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1-\phi}}{1-\phi}$ and log-linearizing equations (4) and (8)we obtain the loglinear expressions for the home and foreign consumption demands:

$$\widehat{c}_t^{-\sigma} = E_t\{\widehat{c}_{t+1}\}^{-\sigma} - \frac{1}{\sigma}(\widehat{r}_t^n - E_t\{\widehat{\pi}_{t+1}\});\widehat{c}_t^{*-\sigma} = E_t\{\widehat{c}_{t+1}^*\} - \frac{1}{\sigma}(\widehat{r}_t^{n*} - E_t\{\widehat{\pi}_{t+1}^*\}) \tag{46}$$

If we add a shock to preferences of the form $\overset{\wedge}{\nu}_t = \rho_\nu\overset{\wedge}{\nu}_{t-1} + \varepsilon_t^\nu$ (that enters the utility function in the following way: $E_t\sum_{k=0}^{\infty}\beta^k[\nu_t(U(C_{s,t+k}(C^H,C^F)) - V_s(N_{t+k})])$ we get the following loglinear expressions for the consumption demand:

$$\widehat{c}_t^{-\sigma} = E_t\{\widehat{c}_{t+1}\}^{-\sigma} - \frac{1}{\sigma}(\widehat{r}_t^n - E_t\{\widehat{\pi}_{t+1}\}) - \frac{1}{\sigma}(\nu_{t+1} - \nu_t); \tag{47}$$

$$\widehat{c}_t^{*-\sigma} = E_t\{\widehat{c}_{t+1}^*\} - \frac{1}{\sigma}(\widehat{r}_t^{n*} - E_t\{\widehat{\pi}_{t+1}^*\}) - \frac{1}{\sigma}(\nu_{t+1}^* - \nu_t^*) \tag{48}$$

Let us now look at the loglinearized expression for the UIP. By loglinearizing (7)(under the assumption of certainty equivalence) a standard form of the uncovered interest parity holds:

$$\widehat{r}_t^n - \widehat{r}_t^{n*} = E_t\{\Delta e_{t+1}\} \tag{49}$$

where $\widehat{r}_t^n = \log(\frac{R_t^n}{R^n})$ and $\widehat{r}_t^{n*} = \log(\frac{R_t^{n*}}{R^{n*}})$.By using the terms of trade equation in log deviations and first differencing equation (49) and combining the two expressions I get:

$$\widehat{s}_t = (\widehat{r}_t^{n*} - E_t\{\widehat{\pi}^*_{F,t+1}\}) - (\widehat{r}_t^n - E_t\{\widehat{\pi}_{H,t+1}\}) + E_t\{\widehat{s}_{t+1}\}. \tag{50}$$

In addition one can show that:

$$\pi_t = \pi_{H,t} + \gamma\Delta\hat{s}_t;\ \pi_t^* = \pi^*_{Ft} - \gamma^*\Delta\widehat{s}_t. \tag{51}$$

Defining the real exchange rate as $e_t^R = \frac{e_t P_t^*}{P_t}$ the following relation between the real exchange rate and the terms of trade holds: $\overset{\wedge}{e^R}_t = (1-2\gamma)\hat{s}_t$.By substituting the real exchange rate in the (51) and imposing $\gamma = \gamma^*$ we get:

$$\pi_t = \pi_{H,t} + \frac{\gamma}{1-2\gamma}\Delta\hat{s}_t;\ \pi_t^* = \pi_{F,t} + \frac{\gamma}{1-2\gamma}\Delta\hat{s}_t. \tag{52}$$

By substituting the last relation for the home and foreign country in the UIP we can get an expression of the UIP in real terms. Notice that if we assume the presence of some credibility shocks (shocks to the terms of trade) the UIP can be written in the following way:

$$\widehat{s}_t = (\widehat{r}_t^{n*} - E_t\{\widehat{\pi}^*_{F,t+1}\}) - (\widehat{r}_t^n - E_t\{\widehat{\pi}_{H,t+1}\}) + E_t\{\widehat{s}_{t+1}\} + (f_t). \tag{53}$$

where $f_t = \rho_f f_{t-1} + \varepsilon_f$. Finally we need to derive a loglinear expression for the aggregate demand of both countries. Market clearing in the domestic and the foreign economy, under a symmetric equilibrium, implies:

$$Y_{H,t} = C_{H,t} + C^*_{H,t} + I_{H,t};\ Y_{F,t} = C_{F,t} + C^*_{F,t} + I_{F,t} \tag{54}$$

where I_t is aggregate investment and $C_t^*$is foreign demand. Log-linearization around a steady state with balanced trade implies:

$$\widehat{y}_t = \zeta_{c_h}\widehat{c}_{H,t} + \zeta_{c_{h^*}}\widehat{c}^*_{H,t} + \zeta_{I_h}\widehat{i}_{H,t};\ \widehat{y}_t = \zeta_{c_f}\widehat{c}_{F,t} + \zeta_{c_{f^*}}\widehat{c}^*_{F,t} + \zeta_I\widehat{i}_{F,t} \tag{55}$$

where $\zeta_j$is the share of variable j in total domestic output[40].

9.2 The Calvo Producers

The monopolistic sector producers choose $P_{H,t}(i)$to:

$$Max \sum_{k=0}^{\infty} (\vartheta)^k E_t \left\{ \Lambda_{t,t+k} [Y_{t+k}(i)(P_{H,t}(i) - \mu MC_t)] \right\} \tag{56}$$

s.t.

$$Y_{t+k}(i) = (\frac{P_{H,t}(i)}{P_{H,t+k}})^{-\varepsilon}(C_{H,t+k} + C^*_{H,t+k}) \tag{57}$$

where μ is a mark-up, ϑ is the probability that the price is fixed in each period, $C_{H,t}(i) = (\frac{P_{H,t}(i)}{P_{H,t}})^{-\varepsilon}C_{H,t}; C^*_{H,t}(i) = (\frac{P^*_{H,t}ij)}{P^*_{H,t}})^{-\varepsilon}C^*_{H,t}$, and $\Lambda_{t,t+k} = \beta^k(\frac{C_t}{C_{t+k}})(\frac{P_t}{P_{t+k}})$ is the discount rate and MC_t[41] is the nominal marginal cost ($\frac{W_t}{MC_t} = (1-\alpha)\frac{Y_{H,t}(k)}{N_t(k)}$).

Maximization yields the following first order condition in terms of stationary variables:

$$\sum_{k=0}^{\infty} (\vartheta\beta)^k E_t \left\{ (C_{t+k})^{-\sigma} Y_{t+k}(i)[(P_{H,t}(i)/P_{H,t} - \mu(\frac{P_{t+k}}{P_t})mc_t)] \right\} = 0. \tag{58}$$

Since $(1-\vartheta)$ firms change their prices the price index can be written as: $P_{H,t} \equiv [\vartheta P^{1-\epsilon}_{H,t-1}(i) + (1-\vartheta)P^{1-\epsilon}_{H,t}(i)]^{\frac{1}{1-\epsilon}}$. Loglinearizing the price index and the condition (58) around a perfect

[40]These coefficients are function of the degree of openness and the steady state ratio of the variables. In particular:

$$\zeta_h = (1-\gamma)[1 - \frac{\delta\alpha}{\mu(R-1+\delta)}]$$

$$\zeta_{h^*} = \frac{\gamma}{1-\gamma}\zeta_h$$

$$\zeta_I = \frac{\delta\alpha}{\mu(R-1+\delta)}$$

[41]The marginal cost for the monopolistic sector is actually equal to the unit price of the homogenous good used as input. Although the homogenous good is produced by a competitive sector that sets the price of the homogenous good equal to the marginal cost of labor.

foresights, zero inflation, steady state trade balance, after some algebra, we obtain the following aggregate supply equation:

$$\widehat{\pi}_{H,t} = \beta E_t\{\widehat{\pi}_{H,t+1}\} + \lambda\widehat{mc}_t \tag{59}$$

where $\lambda \equiv \frac{(1-\vartheta)(1-\beta\vartheta)}{\vartheta}$.

9.3 The Financial Intermediary

The agency problem is solved by assuming that the intermediary chooses the quantities of loans and the repayment schedule (or alternatively the capital demand) so as to maximize the expected return of the risk neutral entrepreneur subject to a participation constraint for the risk neutral intermediary[42] and a participation constraint for the borrower[43]. Firm j chooses K^j_{t+1}, $\bar{\omega}^j$ to

$$MaxE\{\int_{\bar{\omega}^j}^{\infty}(\omega - \bar{\omega}^j)R^{k,j}_{t+1}Q_tK^j_{t+1}dF(\omega)\} \tag{60}$$

$$\{[1 - F(\bar{\omega}^j)](R^j_{L,t+1}L^j_{t+1}) + (1-m)\int_0^{\bar{\omega}^j}\omega dF(\omega)\}R^{k,j}_{t+1}Q_tK^j_{t+1} \tag{61}$$

$$= R_{t+1}D^j_{t+1}(\frac{P_t}{P_{H,t}})$$

$$\bar{\omega}^j R^k_{t+1}Q_tK^j_{t+1} = R^j_{L,t+1}L^j_{t+1} \tag{62}$$

[42] We can look at this participation contraints from two different perspectives. On one side it says that the expected return that the risk neutral intermediary gets from the loan activity has to be equal to the expected return that he would get from a risk free portfolio: in equilibrium the firm extracts all the surplus and the intermediary is just indifferent. On the other side, the intermediary acts as a competitive agent so we need to impose a zero-profit condition stating that the expected return from the investment in risky projects has to be equal to the return that the intermediary has to pay on deposits: the intermediary is just an interface between the investors and firms and its existence is justified by the fact that by pooling different investment projects the intermediary is able to get an expected return that in the limit, for n that approaches ∞, becomes known.

[43] The borrower acts in a competitive manner so its return on capital has to equate the total payments from loans. Looking at it from another perspective we can say that the firm has to be indifferent between investing in capital goods and investing in a balanced portfolio.

$$(Q_t K_{t+1}^j - \Pi_{t+1}^j) = L_{t+1}^j \tag{63}$$

where ω^j is the idiosyncratic shock faced by the entrepreneur and distributed with function $F(\omega)$, $\bar{\omega}^j$ is value of the shock that divides the random space into default and solvency regions, $R_{L,t+1}^j$ and $R_{L,t+1}^j$are the repayment schedules required for loans denominated in domestic and foreign currency, L_t and L_t^* are the amount of loan denominated in domestic currency and foreign currency, (m) is the monitoring cost paid by the lender, Π_{t+1}^j is the net worth of the entrepreneur, finally ξ is the fraction of loans denominated in foreign currency, finally $R_{t+1}^k(j) = (\frac{mc_t(j)\gamma\frac{\alpha A_t K(j)_t^\alpha L(j)_t^{1-\alpha}}{K_t(j)} + Q_{t+1}(1-\delta)}{Q_t})$ where A_t is subject to an aggregate shock. Equation (60) is the expected return to the entrepreneur, equation (61) is the participation constraint of the lender, equation (62) is the participation constraint for the borrower, finally equation (63) and (**??**) define the amount of loans in both domestic and foreign currency. All quantities are expressed in term of home consumption goods.

Lets define $\int_{\bar{\omega}^j}^{\infty}(\omega - \bar{\omega}^j) = (1 - F(\bar{\omega}^j)) \equiv (1 - \Gamma(\bar{\omega}^j)), \tilde{a}$ as the random variable for the aggregate shock to technology A_t, $\Phi = \frac{R^k}{R(\frac{P}{P_H})}$ as the ratio between the return on capital and the cost of loan and $k = \frac{QK}{W}$ as the ratio between the value of capital and the net worth.Given this and using the equilibrium conditions for loans and deposits, we can rewrite the maximization problem for each borrower j in the following way:

$$Max_{k,\bar{\omega}^j} E(1 - \Gamma(\bar{\omega}^j))(\Phi k \tilde{a}) \tag{64}$$

$$s.to[\Gamma(\bar{\omega}^j) - mF(\bar{\omega}^j)](\Phi k \tilde{a}) = [k - 1] \tag{65}$$

The first order conditions with respect to $k, \bar{\omega}^j$ and the Lagrange multiplier λ are:

$$E\{([(1 - \Gamma(\bar{\omega}^j)] + \lambda(\Gamma(\bar{\omega}^j) - mF(\bar{\omega}^j))] * (\Phi\tilde{a})) - \lambda\} = 0 \tag{66}$$

$$\Gamma'(\bar{\omega}^j) - \lambda[\Gamma'(\bar{\omega}^j) - mF'(\bar{\omega}^j)] = 0 \tag{67}$$

$$[\Gamma(\bar{\omega}^j) - mF(\bar{\omega}^j)](\Phi k\widetilde{a}) - [k-1] = 0 \tag{68}$$

Solving the first order conditions, one can prove that a linear inverse relation exists between the net worth/ capital ratio (k) and the risk premium adjusted to take into account the normalization effect due to the terms of trade (Φ).

9.4 The Steady State of the Economy

Let us characterize the perfect foresight steady state of the two country world economy, taking Y (where $Y = Y_H = Y_F$ in steady state), the output level in the flexible price case for both countries, as given and $A = 1$. I will use variables without time subscripts to refer to steady state values. Markups are constant in the steady state, implying a product wage $MC = \frac{1}{\mu}$. From the Euler in steady state we get $R = \frac{1}{\beta}$.Given that $Q = 1$ and $MPK = mc * \alpha\frac{Y}{K} = \frac{1}{\mu} * \alpha\frac{Y}{K}$, the return on capital in steady state is $R^k = \frac{1}{\mu}\alpha\frac{Y}{K} + (1-\delta) = R + \varkappa$,where $\varkappa$ is the risk premium in steady state. From that I get $\frac{Y}{K} = \frac{\mu(R^k-1+\delta)}{\alpha}$. The law for capital accumulation in the steady state holds as $K = K(1-\delta) + \phi(\frac{I}{K})k$ and $\frac{I}{K} = \delta$ in the steady state. Using the last ratio we get that:$\frac{I}{Y} = \frac{\delta\alpha}{\mu(R^k-1+\delta)}$. Consider a steady state where initial costs are normalized so that $e^R = 1$ and $s = 1$. This implies that in a balance growth path trade balance are equal to zero or that $C_F = C_{H^*}$. Given this assumption the following equality holds: $\frac{C_H}{Y} = \frac{\gamma}{1-\gamma}\frac{C_F}{Y} = \frac{\gamma}{1-\gamma}\frac{C_{H^*}}{Y}$. Using this equality and the resource constraint in steady state we find that in steady state the following ratios hold: $\frac{C_H}{Y} = \gamma[1 - \frac{\delta\alpha}{\mu(R^k-1+\delta)}]$; $\frac{C_F}{Y} = (1-\gamma)[1 - \frac{\delta\alpha}{\mu(R^k-1+\delta)}] = \frac{C_{H^*}}{Y}$. In the loglinearized version of the resource constraint $\zeta_h = \frac{C_H}{Y}$, $\zeta_{h^*} = \frac{C_{H^*}}{Y}, \zeta_{I_h} = \frac{K}{Y}$.

9.5 The Welfare Measure

If C_t and N_t are the equilibrium stochastic processes of consumption and labor corresponding to a particular monetary policy, the cost of business cycles under such policy will be measured by υ that satisfies the certainty equivalence relation:

$$U((1-\upsilon)C_t) - V(N_t) = E_t\{U(C_t) - V(N_t)\} \tag{69}$$

where E_t is the mathematical expectation. The business cycle associated with a particular monetary policy will be costly if υ is positive. Let's assume that consumption and labor are distributed as Gaussians. From the first order approximation to the equation (69), the measure υ can be approximated by:

$$\upsilon \approx \frac{E_t(U(C_t, N_t)) - U(C_{ss}, N_{ss})}{U_{\hat{c}}(\hat{c}_{ss}, \hat{n}_{ss})} \tag{70}$$

where $E_t(U(C_t, N_t))$ is the expected utility, $U(C_{ss}, N_{ss})$ is the utility evaluated at the steady state and $U_{\hat{c}}(\hat{c}_{ss}, \hat{n}_{ss})$ is the first derivative of the utility with respect to the logarithm of C_t around the logarithm of C. Approximating the expected utility with a second order Taylor expansion with respect to the logarithm of C_t and N_t around the logarithm of C and N and substituting the expression in the approximation for υ we get the welfare measure. The Hessian of the utility function with respect to the log deviations of consumption and labor from the steady state is:

$$H = \begin{pmatrix} C_{ss}(1-\sigma)\exp(1-\sigma)\hat{c}_t & 0 \\ 0 & N_{ss}(1+\phi)\exp(1+\phi)\hat{n}_t \end{pmatrix}. \tag{71}$$

Assuming that $\log(\frac{y_y}{y_{ss}}) = 0$ where $y = C, N$, then we can write the second order Taylor expansion for the expected utility as:

$$E_t(U(C_t, N_t)) \approx U(C_{ss}, N_{ss}) + \frac{1}{2}C_{ss}(1-\sigma)\exp(1-\sigma)\hat{c}_t E(\hat{c}_t)^2 \tag{72}$$

$$+\frac{1}{2}N_{ss}(1+\phi)\exp(1+\phi)\hat{n}_t E(\hat{n}_t)^2 +'' O'' \tag{73}$$

where $E(\hat{c}_t)^2$ and $E(\hat{n}_t)^2$ are the second moments of consumption and labor. Assuming the following utility function $U_t = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\phi}}{1+\phi}$ and substituting (72) in (70) we get:

$$\upsilon = 1 - [\frac{1}{2}((1-\sigma)E(\hat{c}_t)^2 + (1+\phi)E(\hat{n}_t)^2]. \tag{74}$$

Table 1

Home Technoogy Shock: Volatility (with financial frictions)*

Exchange Rate Regime	Floating	Fixed	Managed	
Variables			$e_t - \bar{e}$ **	$e_t - e_{t-1}$ ***
Output	0.06	0.35	0.046	0.064
CPI Inflation	0.012	0.27	0.033	0.011
Consumption	0.09	0.33	0.12	0.07
Employment	0.020	0.59	0.044	0.016
Capital	0.008	0.092	0.005	0.025
Investment	0.018	0.66	0.02	0.038
Price of Capital	0.03	1.33	0.04	0.057
Interest Rate	0.006	0.11	0.008	0.008
Return on Capital	0.021	0.73	0.015	0.024
Terms of Trade	0.038	1.19	0.12	0.011

* The calculations have been made assuming a degree of openness of 0.15 and assuming that the foreign country follows a Taylor rule symmetric to the one of the home country.

**This column evaluates volatility under a Taylor rule that reacts to the deviations of the exchange rate from the steady state.

***This column evaluates volatility under a Taylor rule that reacts to the change in the exchange rates from t-1 and t.

Table 2

Foreign Technology Shock: Volatility (with financial frictions)*

Exchange Rate Regime	Floating	Fixed	Managed	
Variables			$e_t - \bar{e}$ **	$e_t - e_{t-1}$ ***
Output	0.011	0.67	0.033	0.008
CPI Inflation	0.0049	0.46	0.034	0.004
Consumption	0.026	0.47	0.05	0.016
Employment	0.015	0.97	0.045	0.012
Capital	0.0085	0.14	0.012	0.004
Investment	0.019	1.10	0.05	0.01
Price of Capital	0.036	2.22	0.1	0.019
Interest Rate	0.0016	0.20	0.005	0.01
Return on Capital	0.011	1.22	0.043	0.018
Terms of Trade	0.05	1.94	0.14	0.020

* The calculations have been made assuming a degree of openness of 0.15 and assuming that the foreign country follows a Taylor rule symmetric to the one of the home country.

**This column evaluates volatility under a Taylor rule that reacts to the deviations of the exchange rate from the steady state.

***This column evaluates volatility under a Taylor rule that reacts to the change in the exchange rates from t-1 and t.

Table 3

Welfare gain comparison of different regimes in the model with agency costs and interest rate smoothing of 0

Welfare	Home Technology Shock	Foreign Technology Shock
Floating Exchange Rates	0.98	0.984
Fixed Exchange Rates	0.41	0.03
Managed on e_t	0.953	0.95
Managed on Δe_t	0.989	0.98

Table 4

Home Technology Shock. Comparison of welfare gains under fixed exchange rates for different degrees of financial frictions and interest rate smoothing

Welfare	Model Without Capital	No Agency Costs	With Agency Costs
$\chi = 0$	0.978	0.51	0.41
$\chi = 0.9$	0.993	0.84	0.84

Table 5

Foreign Technology Shock. Comparison of welfare gains under fixed exchange rates for different degrees of financial frictions and interest rate smoothing

Welfare	Model Without Capital	No Agency Costs	With Agency Costs
$\chi = 0$	0.9736	0.47	0.3
$\chi = 0.9$	0.973	0.849	0.842

Table 6

Welfare differential between fixed and floating under both technology shocks across models

Welfare Differential: υ(fix) -υ(float)	Home Techn Shock	Foreign Techn Shock
Agency Costs,$\chi = 0$	0.57	0.954
No Agency Costs, $\chi = 0$	0.465	0.514
Agency Costs, $\chi = 0.9$	0.136	0.1517
No Agency Costs, $\chi = 0.9$	0.136	0.1445

Figure 1

Impulse response to home technology shock in the model with capital and agency costs: floating (solid line) versus fixed (dashed line)

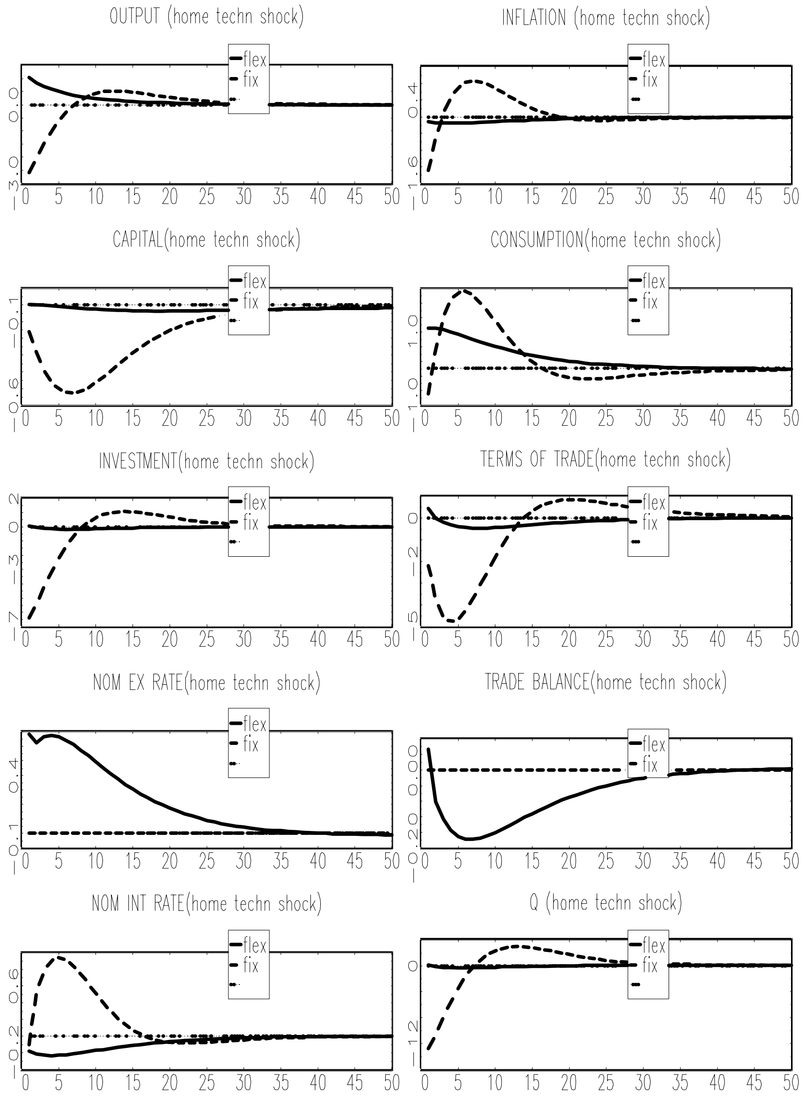


Figure 2

Impulse response to home technology shock in the model without capital: floating (solid line) versus fixed (dashed line) exchange rates

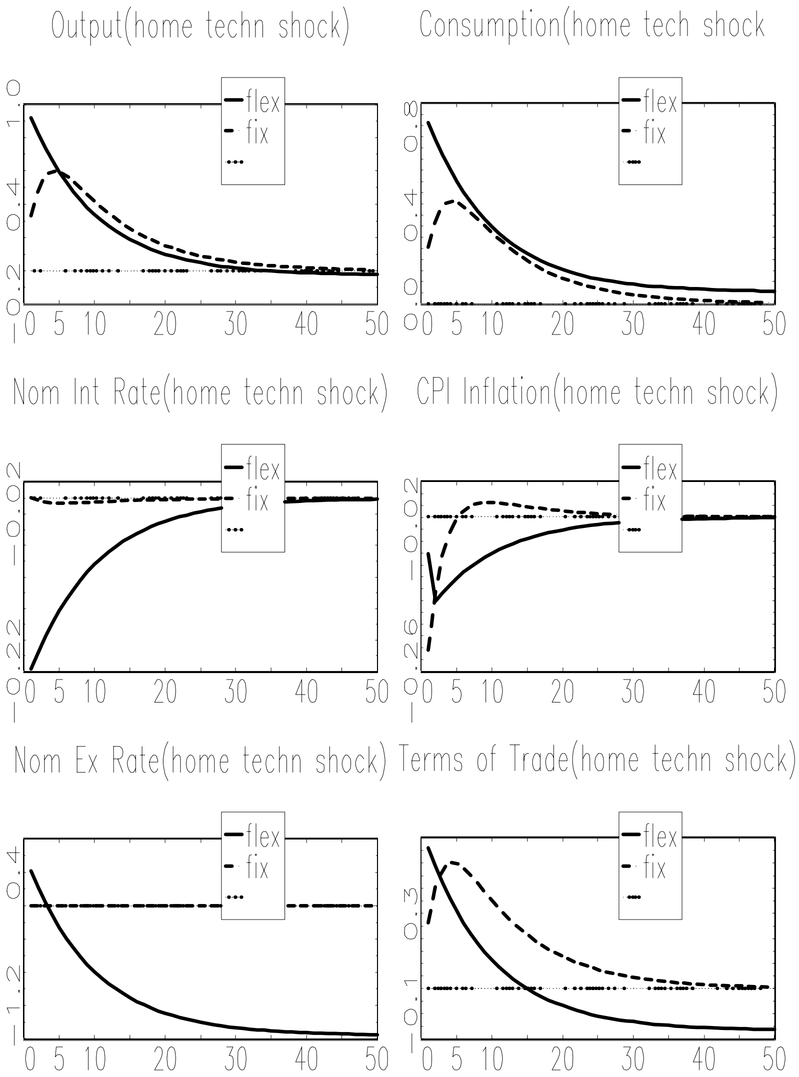


Figure 3

Impulse response to home technology shock in the model with capital, agency costs and interest rate smoothing: floating (solid line) versus fixed (dashed line) exchange rates

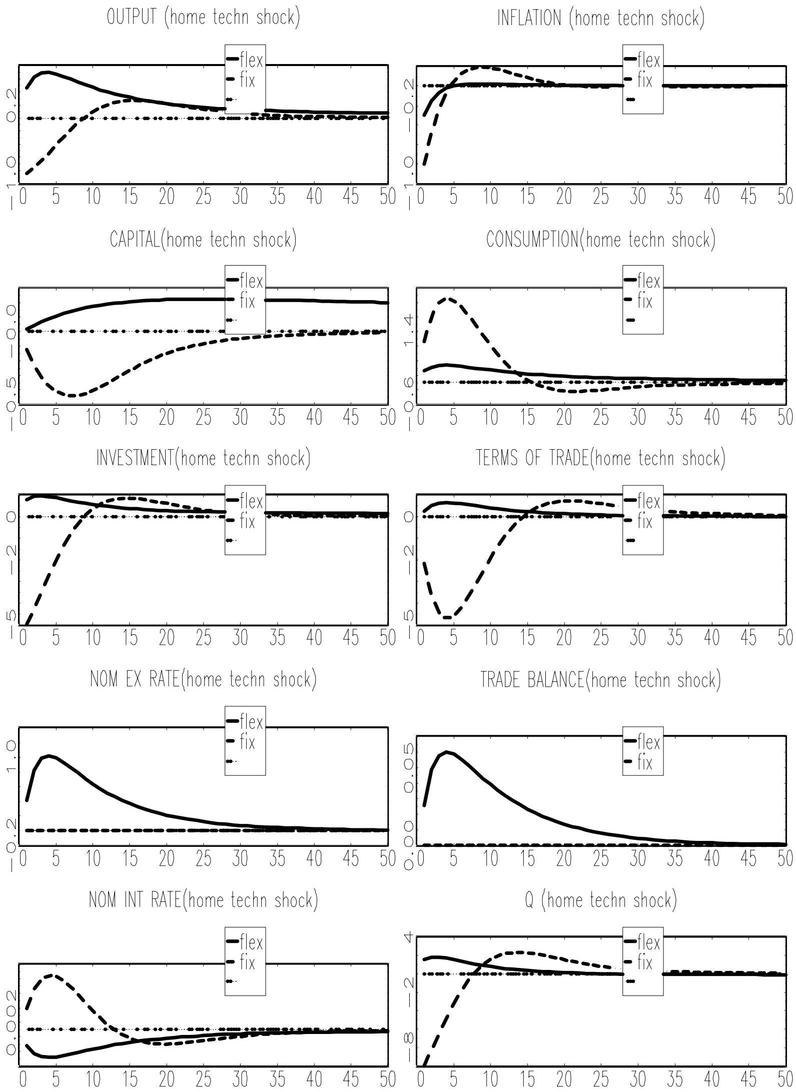


Figure 4

Impulse response to foreign technology shock in the model wsith capital and agency costs: floating (solid line) versus fixed (dashed line) exchange rates

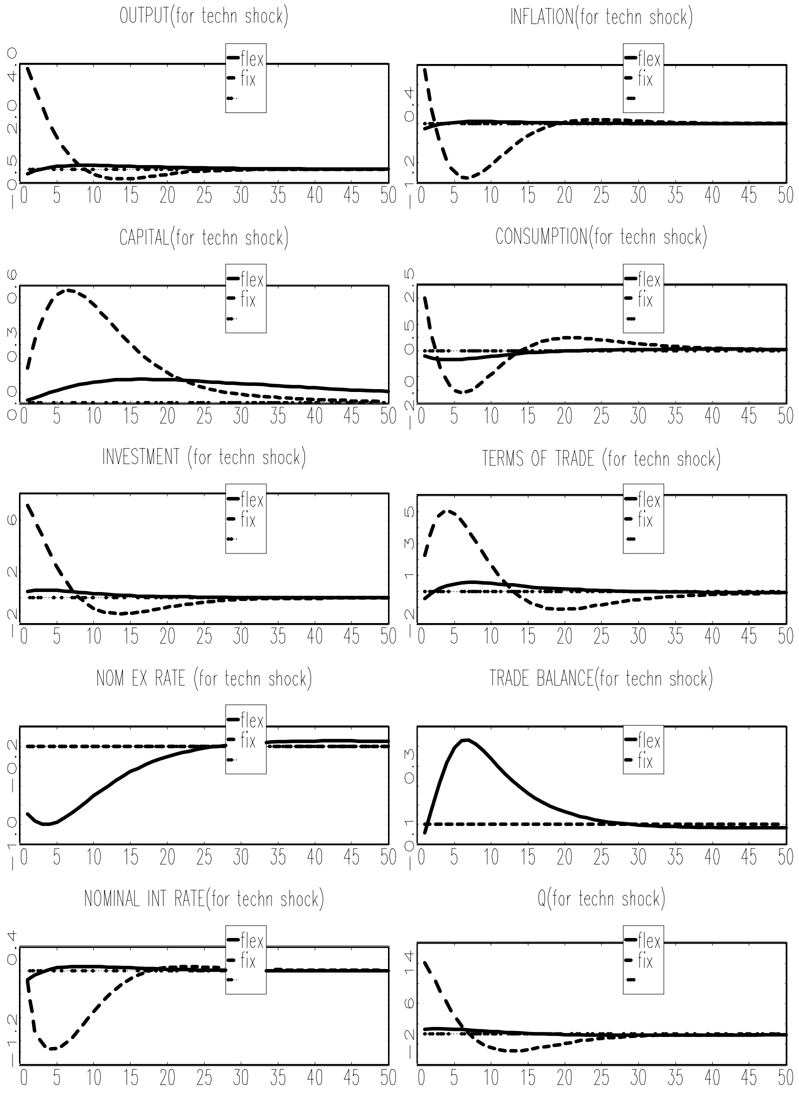


Figure 5

Impulse response to foreign technology shock in the model with capital and no agency costs: floating (solid line) versus fixed (dashed line) exchange rates

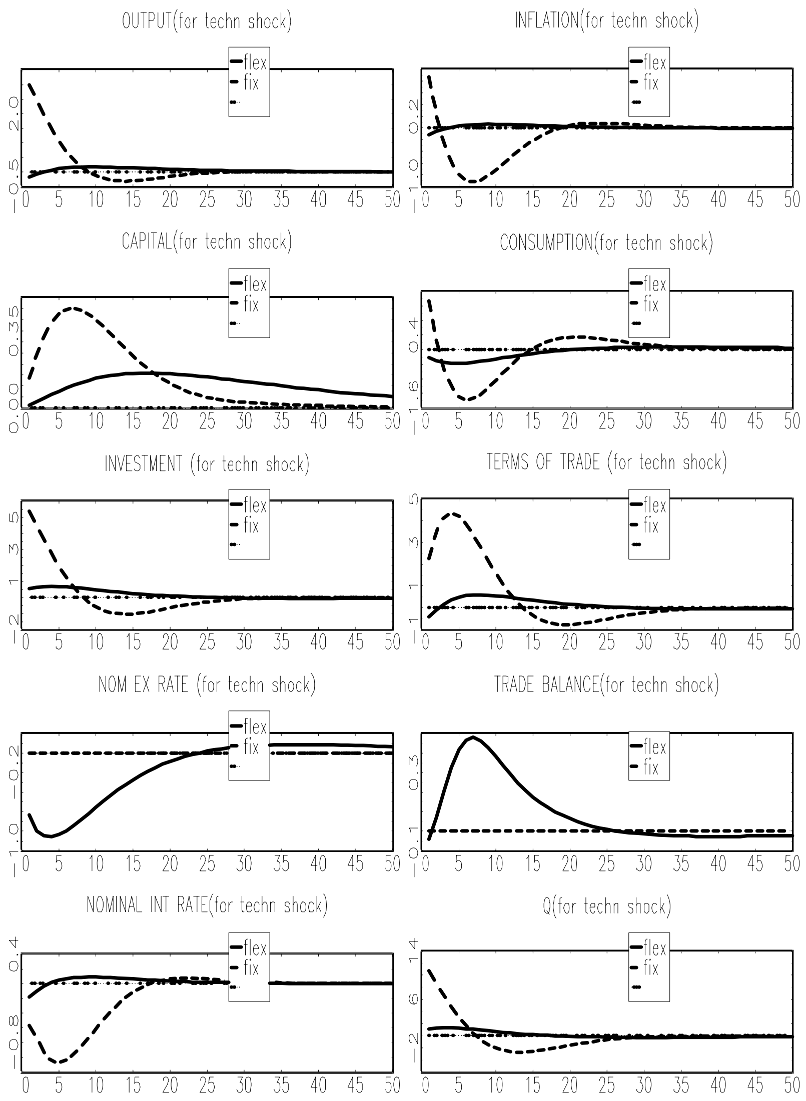


Figure 6

Impulse response to foreign technology in the model without capital: floating (solid line) versus fixed (dashed line) exchange rates

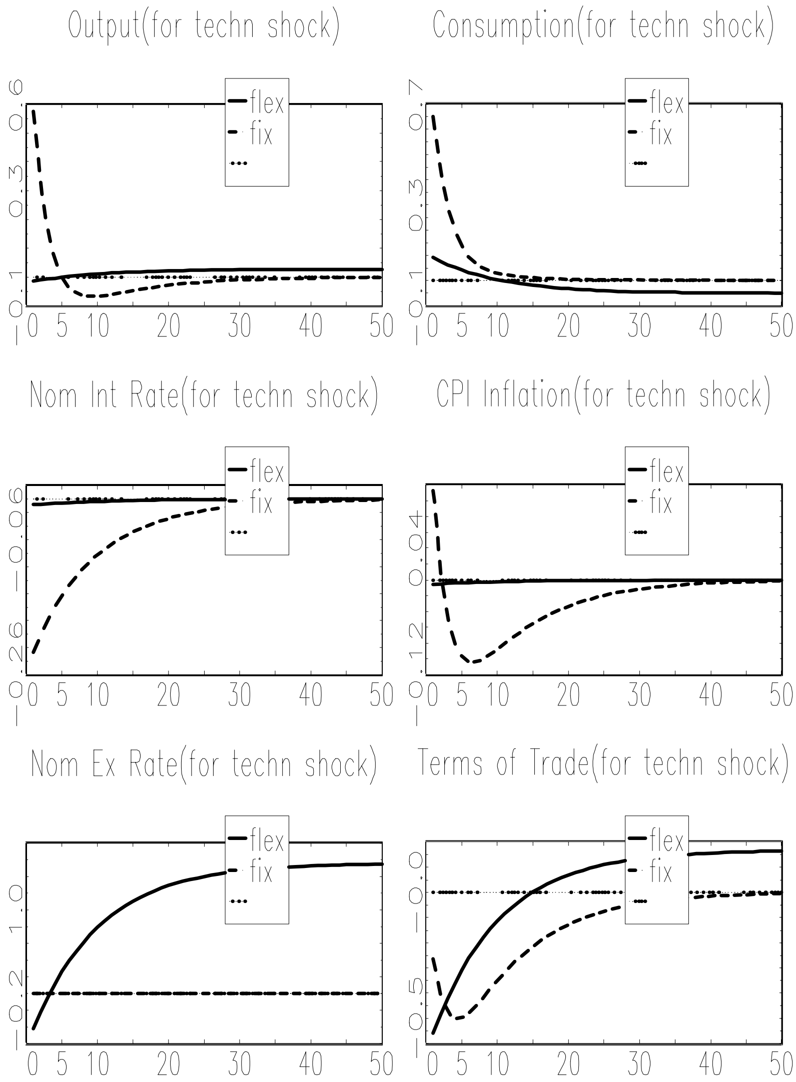


Figure 7

Impulse response to foreign technology shock in the model with capital, agency costs and interest rate smoothing: floating (solid line) versus fixed (dashed line) exhange rates

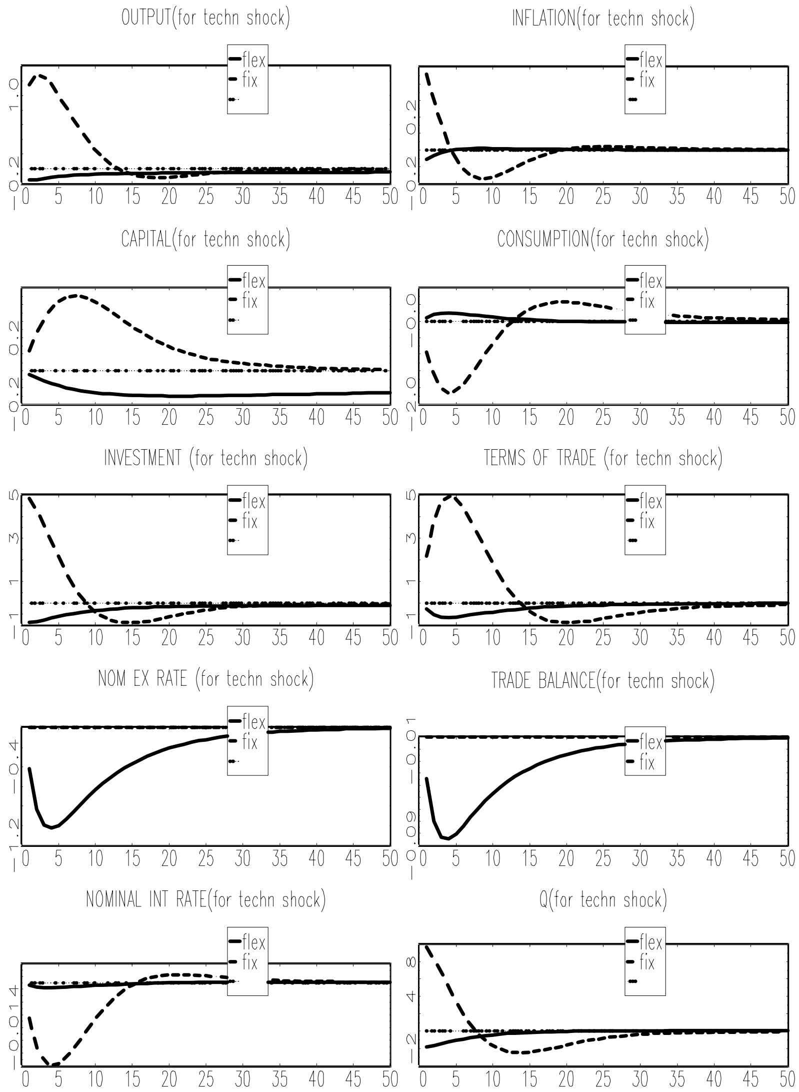


Figure 8

Impulse response to home technology shock in the model with capital and agency costs: floating, versus managed on change, versus on level, versus fixed exchang rates

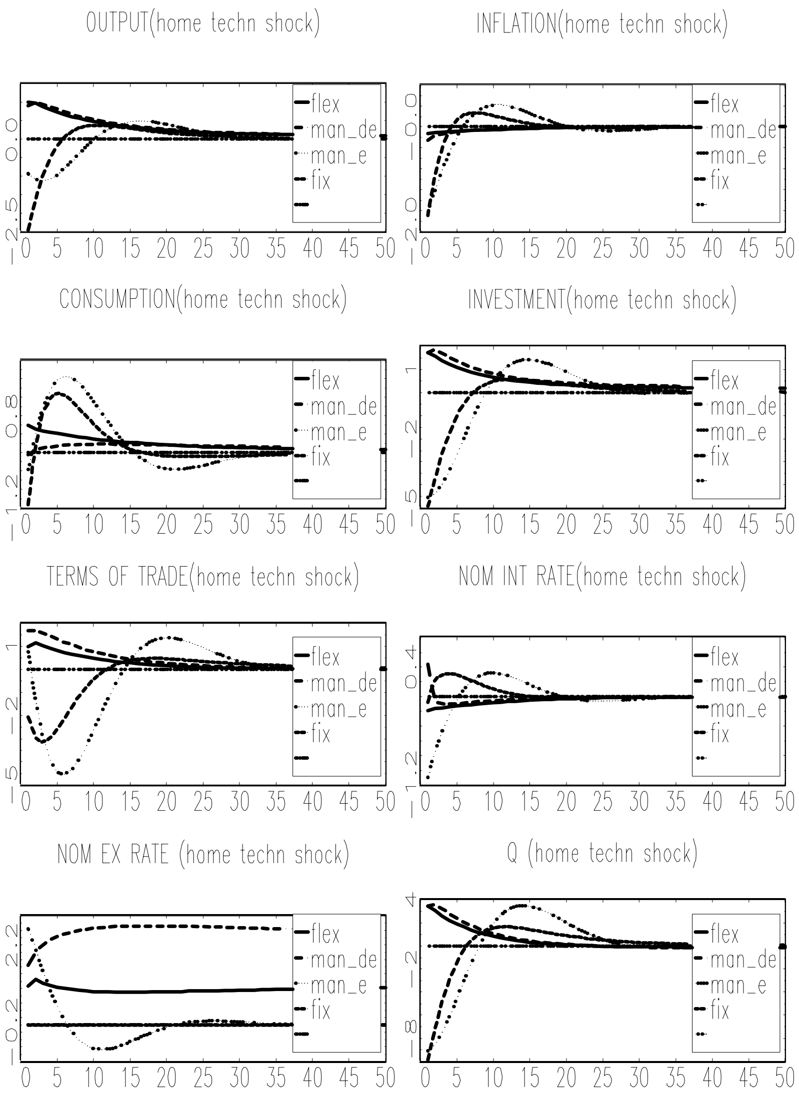
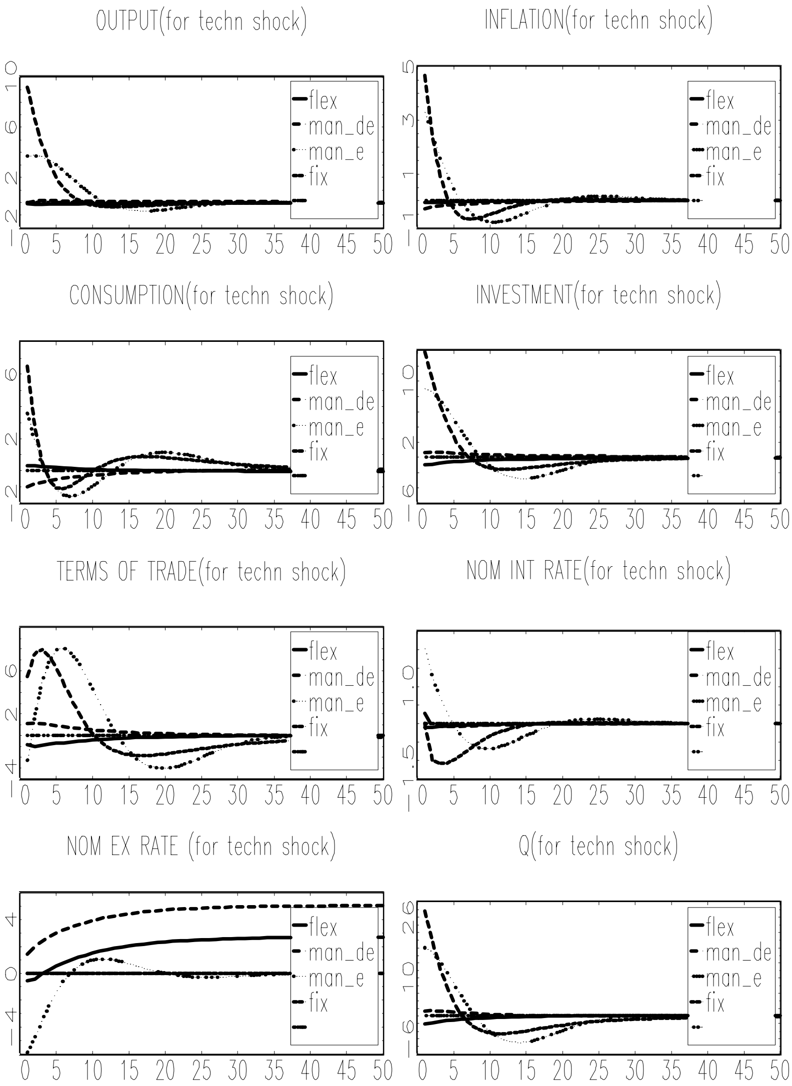


Figure 9

Impulse response to foreign technology shock in the model with capital and agency costs: floating, versus managed on change, versus on level, versus fixed exchange rates



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