Monetary Policy in a World with Different Financial Systems*

Ester Faia†
Universitat Pompeu Fabra.

June 2003
First draft: December 2000.
ECB w.p. 183

Abstract

Major currency areas are characterized by important differences in financial structure that are clear in microeconomic data. Surprisingly, this fact is seldom discussed in the analysis of the international transmission of shocks. This paper attempts to fill this gap. First, I examine some stylized facts about financial diversity and cyclical correlations among OECD countries. Data show a negative relation between cyclical correlations and differences in financial systems. Second, using a two-country model with sticky prices, imperfect financial integration and borrowing constraints on investment, calibrated to US and euro area data, I analyze the international transmission of shocks with different degrees of financial fragility in the two economies. I find, first, that financial diversity can account for heterogenous business cycle fluctuations and reproduce the negative relation found in the data. Differential responses to shocks are shown to occur with independent monetary policies - Taylor rules or rigid inflation targets -. The result is robust under different degrees of economic and financial openness and of correlation of underlying shocks. Credible pegs help to increase synchronization of cycles. The model is successful in accounting for some international business cycle facts, like the output correlations puzzle.

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

Keywords: financial diversity, monetary regimes, differential transmission mechanism, international business cycle.

*I thank Thomas Cooley, Dale Henderson, Mark Gertler, Tommaso Monacelli and Fabrizio Perri. I also thank seminar participants at the Bank of England, Bank of International Settlements, Duke University, European Central Bank, Federal Reserve Board, Federal Reserve of St. Louis and San Francisco, New York University, Stern School of Business, Stockholm School of Economics, Tilburg University, University of Quebec a' Montreal, Universitat Pompeu Fabra, Society for Economic Dynamic Conference in New York, European Economic Association conference in Venice, Konstanz seminar in Monetary Theory and Policy. This paper was the first chapter of my Ph.D. thesis. I acknowledge financial support from the DSGE grant. All errors are mine.

†Correspondence to: Department of Economics, Universitat Pompeu Fabra, Ramon Trias Fargas 25-27, Barcelona, Spain, 08005. E-mail address: ester.faia@upf.edu.

1 Introduction

Different countries and currency areas are typically characterized by different financial structures, as a result of history, legal frameworks, collective preferences, politics[1]. Financial structures are in turn among the key determinants of bank and asset risks. Micro data[2] for industrialized country show differences in banking systems in terms of return on assets, loan loss provisions, availability of external finance and efficiency indicators. At the same time, remarkable asymmetries in economic fluctuations have been documented across industrialized countries mostly during the last decade. For instance some countries like the UK and the US have highly correlated business cycle fluctuations, while other regions like the US, the Euro area and Asian countries are characterized by low or negative correlations over the cycle.

Financial markets may play a role in shaping the patterns of international transmission of shocks across countries[3]. However, asymmetries in the financial systems and corporate risk have not been incorporated in the analysis of the international transmission of shocks and of macro policy interdependence. The open economy literature has studied international business cycle properties under different settings, but very little work has focused on the role of financial fragility and even less on the effect of asymmetries in such fragility. This paper explores this concept and argues that financial diversity can account for heterogenous business cycle fluctuations and help to explain some of the features of the international transmission mechanism across countries.

To this aim I, first, present evidence of the presence of differences in financial markets and for the fact that they account for asymmetries over the business cycle. Data show that a negative and significant relation exists between the correlation of output gaps and financial gaps, defined as the difference between indicators of banking efficiency. Secondly, I examine an artificial economy with two countries characterized by different degree of financial fragility and identical policies that allows me to isolate the effect of financial differences over the business cycle. In an otherwise standard two country model of stochastic dynamic general equilibrium with optimizing agents[4] characterized by nominal rigidities in an imperfectly competitive framework and incomplete international markets for bonds, I introduce agents' heterogeneity, borrowing constraints on investment and financial

[1] La Porta, Lopes-de Silanes, Shleifer, Vishny (1997), (1998), La Porta, Lopez-de Silanes, Shleifer (1999), Pagano and Volpin (2000).

[2] See dataset Bankscope from IBCA Fitch and OCSE Bank Profitability Report.

[3] This aspects is stressed, for example, in the latest IMF World Economic Outlook: "*Several observations hint at the role that structural factors and policy regimes play in determining the strength of the international business cycle linkages.... Co-movements in output gaps in United States, Canada and United Kingdom remained positive during the entire 1990's...The close affiliation in the business cycle of the United Kingdom with that of the United States, despite much more important trade links with Euro area countries may have been the result of strong financial market linkages..... Asymmetries in business cycles fluctuations across industrialized countries are likely to reflect differences in country sizes and financial depth"; IMF (2001), chapter 2.*

[4] Many contributions are in the area of the New Open Economy whose aim is to build up a new generation of open economy models relying on stochastic general equilibrium frameworks with microfoundations -i.e. see Obstfeld and Rogoff (1985).

diversity. Sticky prices are introduced for two reasons. First, they allow for a meaningful comparison with the existing literature in the new open economy. Secondly, they are essential when studying endogenous monetary policy or comparing different monetary policy regimes as it is in this case. Borrowing constraints on investment are due to the presence of asymmetric information between borrowers and lenders[5]. Financial differences are modelled in terms of cost of bankruptcy, riskiness of investment projects and failure probability of firms. These elements are in turn determinants of the return on asset, the size of the loan loss, the size of the borrowing limit and its elasticity with respect to collateral. The sensitivity of the borrowing limit to the conditions of collateral is the key determinant of the link between financial fragility and business cycle. More precisely, higher sensitivity leads to more volatile and persistent business cycles.

The model is calibrated on the US and the Euro area, for two reasons. First, the macroeconomic and policy interactions between these two areas have become, after the creation of the euro in 1999, the key issue in international economics[6]. Second, the asymmetries in the financial structure between these areas are well documented, and have often been advocated to explain the differences in the domestic transmission mechanism of monetary policy[7].

I find that differential responses occur under identical and independent policies and for different degrees of economic and financial openness. The correlations of output decrease when financial differences among countries increase. This result is robust to different parametrization and holds for any value of correlation of the underlying shocks. The negative relation found in the model recalls the one in the data.

The intuition for this result in the model is linked to the role of financial asymmetries. Having different degrees of borrowing constraints generates different degrees of persistence and volatilities for the responses of variables even with symmetric and correlated shocks.

To better understand the transmission mechanism of the model I start from analyzing the case of asymmetric shocks and symmetric financial systems. When a positive technology shock hits the home country the demand shift between domestic and foreign goods induces a decrease in foreign inflation. The endogenous response of the foreign monetary policy reduces interest rates. As a result, the foreign economy experiences a fall in the cost of loans that boosts investment, asset prices [8] and employment in the foreign country. In addition the improvement in collateral

[5] Borrowing constraints on investment have been extensively explored in the closed economy literature. They generally lead to higher volatility and persistence of output, investment and asset prices. Among others see Bernanke, Gertler and Gilchrist (1998), Cooley and Nam (1998), Kiyotaki and Moore (1998), Carlstrom and Fuerst (1998).

[6] A main contribution in the study of the international transmission mechanism between US and Europe is Chari, Kehoe and McGrattan (2000).

[7] Cecchetti and al. (1999) provide an empirical study of the presence of asymmetries inside US, Europe and between the two areas as whole.

[8] The new open economy literature does not provide explanation of the link between total factor productivity shocks in the US and asset prices in Europe. This link is well documented and examined in other areas of macroeconomics: see for example Greenwood and Jovanovic (1999). This paper's model is able to account for this fact.

conditions and the ease in the borrowing limit exacerbate the increase in investment, thereby raising output. The positive financial effect can partly or completely offset the negative impact of the demand shift on the foreign country business cycle. The magnitude of this *indirect financial spillover* will depend on both the relative degree of financial differences between the two countries and the business cycle sensitivity of the foreign country. Whenever the two countries have similar financial systems the positive financial spillover is able to offset the negative switching expenditure effect hence generating positive output correlations. In this respect the model is successful in matching international business cycle facts. In fact traditional models of international business cycle are plagued by a discrepancy between the correlations of output, employment and investment - i.e. always negative in the model - and the ones in the data - i.e. mostly positive[9]. The channels responsible for the negative correlations in those models are given by the following two effects. The first effect - i.e. known as *switching expenditure effect* - occurs because a positive productivity shock in home country, by reducing domestic inflation, generates a demand shift unfavorable to the foreign country. The second effect is due to the flows of capital toward the country that benefits of the technology improvement. Even when adjustment costs are introduced to dampen the second effect, negative output correlations might still persist due to the switching expenditure effect. The present model is able to overturn the correlations under reasonable degrees of financial similarity since it is enriched with an "*indirect financial spillover*" effect[10].

When moving to the case of countries with different financial systems the model is able to reproduce, under both technology and monetary policy, a wide range of output cross-correlation values that are monotonically decreasing with respect to the degree of difference between financial systems. This happens independently of the correlation values for the underlying shocks[11]. The main channel responsible for the result has to be found in the differential business cycle sensitivity generated by the credit channel. In fact, I also find that the difference in volatilities between the countries is an increasing function of the financial differences. This is due to the fact that different elasticities of credit availability to collateral conditions produce different degrees of business cycle responsiveness.

In order to check the robustness of the results I provide several experiments by allowing for different monetary rules - i.e. Taylor rules versus rigid inflation targeting and credible pegs-, for different degrees of economic openness - i.e. as calibrated by the steady state balance trade ratio of exports over GDP - and financial openness - as parametrized by the ratio of foreign currency denominated loans over total loans. Under all the experiments business cycle correlations decrease

[9] See Backus, Kehoe and Kydland (1992), Baxter and Crucini (1995) and Stockman and Tesar (1995).

[10] Heathcote and Perri (2002a) made advances in this respect, though their results are obtained under the extreme assumption of financial autarchy.

[11] Heathcote and Perri (2002b) provide an alternative explanation for asymmetric cycles. They show that an increase in financial globalization reduces business cycle synchronization. Although financial globalization in their model is endogenously determined by the correlation of the underlying shocks.

significantly when financial differences increase. The only exception is found in the case of credible pegs that helps cycle synchronization by increasing the absolute values of output correlation and reducing the steepness of its relation with the financial gap.

The paper is organized as follows. Section 2 presents some statistical evidence, documenting the presence of differences in financial markets and their link with asymmetries over the business cycle. Section 3 and 4 present the model economy. Section 5 shows calibration. Sections 6 and 7 present the results. Conclusion, tables, graphs and appendices are reported at the end of the paper.

2 Evidence For The Presence and The Effect of Heterogenous Financial Markets

Extensive evidence exists in the international business cycles literature showing that the extent of bilateral trade is not the sole - e.g. and not even the most important - determinant of business cycle co-movements[12]. Some attempts have been done to look for other sources of international transmission rather than trade. Some authors show that either multi-sector models with intermediate good trade[13] or that variable capital utilization and factor hoarding[14] can improve the performance of the models by generating correlations of output, employment and investment that are closer to the ones in the data. Others stress the importance of the business cycle diversity across countries[15] and argue that geography is a better candidate - i.e. rather than trade or shock transmission - for explaining proximity in fluctuations[16].

Recently several authors are exploring the role of financial factors and institutions. Most of the literature has concentrated on the effects of financial openness or foreign direct investment on cross-correlations[17] and a few have looked at institutions[18]. The effects of financial diversity have recently been explored in the context of currency areas[19].

The purpose of this section is to show that financial diversity can be classified among the sources of international business cycle co-movements. First, I report various stylized facts for industrialized countries that characterize both the profile of financial market institutions and the

[12] Among others see Canova and Dellas (1993), Baxter (1995), Schmitt-Grohe (1998), Imbs (1999), Ambler, Cardia and Zimmerman (2002).

[13] Ambler, Cardia and Zimmerman (1998).

[14] Baxter and Farr (2001).

[15] See data surveys from Dellas (1986), Cantor and Mark (1987,1988), Canova and Dellas (1990), Gerlach (1988) and Head (1995).

[16] See Zimmerman (1995). See Rey and Portes (2001) for the effects of financial distance.

[17] See Mendoza and Calvo (2000), Mendoza (2001), Heathcote and Perri (2002b), Hoffman (2000), Imbs (2002).

[18] Artis and Zhang (1996) show the link between proximity in institutional agreements and conformity in business cycle. Rodrik, Subramanian and Trebbi (2002) show the link between institutions and income levels across countries.

[19] Several authors have argued that the euro area monetary transmission mechanism is uneven across euro area countries. See Cecchetti (2001), Giovannetti and Marimon (2000) and Mihov (2001).

international business cycle. Secondly, a relation is shown to exist between micro data on financial differences and macro data on international business cycle correlations. The micro data will also be used to calibrate the parameters that in the model characterize the banking and financial system.

Micro data for financial markets and banking industry. Financial systems can be mainly characterized by bank health and asset risk. A more fragile system is indeed associated with lower bank efficiency and higher asset risk and as a consequence with higher borrowing constraints on investment. The following data stress heterogeneities in the degree of borrowing constraints, in bank structure and riskiness of investment.

Table 3 shows data for corporate debt securities for the main currency areas[20]. It is already evident that borrowing constraints are tighter in the Euro area and Japan with respect to US and UK. Even though the Euro area and US are very similar in terms of population and economic activity, the markets for loans are much thinner in European countries.

A close look at the data for the credit industry and the riskiness of investment projects reveal more specific dissimilarities across the countries. Table 4[21] shows data on return of assets - i.e. return on investment projects for banks - and loan loss provisions as percentage of total bank liabilities, on external finance as percentage of GDP and on the Thomson rating. The Thomson rating is an indicator of bank health. A lower value for this statistic identifies a more efficient banking system. Data are shown for EMU countries, the Euro area as a whole, the UK, the US and Japan. First notice that there are many similarities between the American and British banking systems, while more pronounced differences emerge among the three major currency areas. For instance returns on assets are bigger than one in the US and the UK, but are lower than one for Japan, the Euro area as a whole and the vast majority of European countries. Loan loss provisions are very low for the US and the UK but are higher for Japan and for the Euro area. Also, availability of external finance is much higher for English speaking countries. The Thomson rating assigns the lowest value - i.e. highest banking efficiency - to the US and the highest value to Japan.

In the model I will present later loan loss provisions are used to calibrate bankruptcy costs, the availability of external finance is identified by the borrowing limit and the return on assets corresponds to the return on investment.

Differences in business cycles. Along with the documented heterogeneity between financial markets stands some heterogeneity in business cycle fluctuations. Table 5 shows cross-correlations of output gaps for industrialized countries computed with the approximate bandpass filter proposed by Baxter and King (1999)[22]. The table shows that cross-correlations between U.S. and U.K. are much higher than the ones between the U.S. and the euro area or Japan. Similarly cross-correlations

[20] Data are taken from Angeloni, Gaspar, Issing and Tristani (2000).

[21] These data are draw from S. Cecchetti (1999), "Legal Structure, Financial Structure, and The Monetary Policy Transmission Mechanism". The ultimate source of the data are dataset Bankscope from IBCA Fitch and OCSE Bank Profitability Report. In each country banks were chosen according to 1997 assets.

[22] Calculations are drawn from the Economic Outlook report of the IMF for the 2001.

among European countries are higher than the ones among those countries and the U.S. or the U.K.. Notice that this happens despite the fact that U.K. is trading much more with the euro area than with the U.S..

This *relative* ranking persists even when filtering data with the Hodrick-Prescott and even when considering different sample periods. The evidence suggests that a link exists between financial diversity and heterogenous business cycles.

In the model presented later a higher bankruptcy cost and riskiness of investments determines an higher elasticity of the borrowing limit to financial conditions. Tighter borrowing constraints are in turn determinant of higher sensitivity in business cycles.

Empirical relation between financial diversity and business cycle asymmetry. A link exists between asymmetries in the business cycles and financial differences. The measure of the asymmetries in the business cycle is obtained using cross-correlation in output gaps. Output gap is defined as the difference between the series for the log of the real GDP and the trend calculated with the Hodrick-Prescott filter. The data used for GDP are quarterly data from the 1985 to 2000. I plot cross-correlations of output gaps over a measure of financial gap. The scatter plot and the regression line in figure 1 show a *negative relation* between asymmetries in business cycles and differences in financial system. The financial gap showed here is the *average* over the 1989-1999 of the bilateral differences for the return on assets[23]. I choose this one for two reasons. First, it is the one that more closely mimic the financial gap measure in the model. Financial gaps in the model are obtained through differences in the external finance premium that determines the returns on asset. The external finance premium is in turn determined by bankruptcy costs and availability of external finance. The return on asset is then a synthetic measure of the type of frictions introduced in the model. Secondly, this index is the only one for which the IBCA Bankscope dataset provides the longest and most regular series. Notice that the relation is robust to the inclusion, singularly or in the form of weighted averages, of the bilateral differences of the other indices shown in table 4. In particular the Thomson rating performs as well as the return on asset.

The negative relation persists even when output gaps are calculated using annual data from the 1960 onward.

Table 6 shows that the relation is significant. Table 7 and 8 also show that the relation is robust to the inclusion of trade and a dummy for language. Trade is not significant and does not affect the significance level of the financial gap. The dummy variable reduces slightly the significance level of the financial gap. The reason for this has to be found in the fact that financial institutions are often similar inside regions sharing the same language.

An important remark is that the regression results are not affected by problems of endogeneity between business cycle and financial differences. In fact the data used for the financial institutions

[23]Data are obtained by the IBCA Bankscope dataset.

vary across countries but not across years. This is because they are mainly determined by legal structures.

3 A Model Economy with Financial Heterogeneity

There are two regions of equal size. Each country is inhabited by a continuum of agents with measure one. Each economy is symmetric for everything apart from the microfoundations of the contracting problem between borrowers and lenders. Asset markets are incomplete both, domestically and internationally.

Each economy is populated by two sets of agents, workers and entrepreneurs. Each agent is simultaneously consumer, investor and owner of a production sector in the economy. The presence of heterogeneity is essential in order to model the lender-borrower relationship. Indeed the workers provide funds to the intermediary who pools resources and supplies loans to the entrepreneurs. Loans are used by the entrepreneurs to finance acquisition of physical capital.

There are two different units of the production sector. The first unit acts as a competitive sector that produces a homogenous good using capital and labor. The second unit acts as a monopolistic competitive sector that produces a differentiated good using the homogenous good as an input and sets prices facing Rotemberg adjustment costs.

Let $s^t = \{s_0, ...s_t\}$ denote the history of events up to date t, where s_t denotes the event realization at date t. The date 0 probability of observing history s^t is given by ρ_t. The initial state s^0 is given so that $\rho_0 = 1$. Henceforth, and for the sake of simplifying the notation, let's define the operator $E_t\{.\} \equiv \sum_{s_{t+1}} \rho(s^{t+1}|s^t)$ as the mathematical expectations over all possible states of nature conditional on history s^t.

3.1 Workers Behavior in Home and Foreign Country

Workers are risk averse and infinite lived. They consume a variety of goods, supply labor and run the monopolistic production unit. Workers invest in a risk free bond, denominated in foreign consumption index[24]. In addition I assume that they invest in deposits since the demand for this asset comes from the presence of the intermediary[25].

Aggregate consumption, C, is an aggregate of domestic and imported goods assembled according to the following Dixit-Stiglitz:

$$C_t = \left((1-\gamma)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{1}$$

[24] The presence of this bond will allow to derive the uncovered interest rate parity.

[25] The introduction of deposits is redundant from an asset pricing perspective but it is necessary to satisfy market clearing conditions for the general equilibrium. Demand for deposits is in fact required by the demand for loans.

where $C_{H,t} \equiv \left(\int_0^1 C_{H,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$ and $C_{F,t} \equiv \left(\int_0^1 C_{F,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$ are composite aggregates of domestic and imported consumption goods respectively. Optimal demand for each variety of the final good and for the factions of domestic and foreign consumption goods are given by:

$$C_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\varepsilon} C_{H,t}; \quad C_{F,t}(i) = \left(\frac{P_{F,t}(i)}{P_{F,t}}\right)^{-\varepsilon} C_{F,t} \tag{2}$$

$$C_{H,t} = (1-\gamma)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \; ; \quad C_{F,t} = \gamma\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t \tag{3}$$

where $P_{H_t} \equiv \left(\int_0^1 P_{H,t}(i) di\right)^{\frac{\varepsilon}{\varepsilon-1}}$, $P_{F,t} \equiv \left(\int_0^1 P_{F,t}(i) di\right)^{\frac{\varepsilon}{\varepsilon-1}}$, $P_t \equiv [(1-\gamma)P_{H,t}^{1-\eta} + \gamma P_{F,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ are the respective price indices. Agents in country $s = H, F$, maximize the following expected discounted sum of utilities:

$$E_t\left\{\sum_{t=0}^{\infty} \beta^t U\left(C_t\right) - V(N_t)\right\} \tag{4}$$

where N denotes total labor hours. U is increasing, concave and differentiable and V is increasing, convex and differentiable. The household receives at the beginning of time t a labor income of $W_t N_t$, where W_t is the nominal wage. In order to finance consumption at time t she invests in deposits, D_t, expressed in units of domestic consumption index, that pay $R_t D_t$ one period later and one period maturity real bonds, B_t^* , denominated in units of foreign consumption index, that pays a returns R_t^F. The sequence of budget constraints reads as follows:

$$C_t + D_t + e_t^r B_t^* \leq \frac{W_t}{P_t} N_t + R_{t-1} D_{t-1} + R_t^F e_t^r B_{t-1}^* + \frac{\Theta_t}{P_t} \tag{5}$$

where Θ_t are the nominal profits of the domestic monopolistic firms, whose shares are owned by the domestic residents and $e_t^r = \frac{e_t P_t^*}{P_t}$ is the real exchange rate. Households choose the set of processes $\{C_t, N_t, D_t, B_t^*\}_{t=0}^{\infty}$ taking as given the set of processes $\{P_t, W_t, R_t, R_t^F\}_{t=0}^{\infty}$ and the initial wealth D_0, B_0^* so as to maximize (4) subject to (5). First order conditions read as follows:

$$U_{c,t} \frac{W_t}{P_t} = -U_{n,t} \tag{6}$$

$$U_{c,t} = \beta R_t E_t \left\{U_{c,t+1}\right\} \tag{7}$$

$$U_{c,t} = \beta R_t^F E_t \left\{ U_{c,t+1} \frac{e_{t+1}^r}{e_t^r} \right\} \tag{8}$$

Equation (6) is the optimality condition with respect to labor supply. Equations (7) and (8) give the optimality conditions with respect to deposits and foreign bonds.

Due to imperfect capital mobility and/or in order to capture the existence of country risk domestic workers pay a spread between the interest rate on the foreign currency portfolio and the interest rate of the foreign country. This spread is proportional to the (real) value of the country's net foreign asset position:

$$\frac{R_t^F}{R_t^*} = -\zeta \left(e_t^r B_t^* \right) \tag{9}$$

where $\zeta > 0$[26], $\zeta' > 0$. In addition I assume that the initial distribution of wealth between the two countries is symmetric.

Aggregating the budget constraints of the workers and substituting for (9) we obtain the following law of motion for the accumulation of bonds:

$$e_t^r B_t^* \leq R_t^* \zeta \left(e_t^r B_t^* \right) e_t^r B_{t-1}^* + [\frac{\Theta_t}{P_t} + \frac{W_t}{P_t} N_t] - [D_t - R_{t-1} D_{t-1}] - C_t \tag{10}$$

Workers in the Foreign Region. I assume throughout that all goods are traded, that both countries face the same composition of consumption bundle and that the *law of one price* holds. This implies that $P_H(i) = eP_H^*(i), P_F(i) = eP_F^*(i), P(i) = eP^*(i)$ for all $i \in [0, 1]$, where e is the nominal exchange rate. Foreign agents face a maximization problem similar to the one of the domestic agents. However they do not face any additional cost of portfolio allocation so that they always receive the same interest rate, R_t^*.

The efficiency condition for bond and deposit holdings will read as follow:

$$U_{c,t}^* = \beta R_t^* E_t \left\{ U_{c,t+1}^* \right\} \tag{11}$$

Substituting (9) into (8) and equating (8) to (11) we obtain the following condition:

$$E_t \left\{ \frac{U_{c,t+1}^*}{U_{c,t}^*} \right\} = E_t \left\{ \frac{U_{c,t+1}}{U_{c,t}} \frac{e_{t+1}^r}{e_t^r} \right\} \zeta \left(e_t^r B_t^* \right) \tag{12}$$

[26] As shown in Schmitt-Grohe and Uribe (2001) and Benigno (2002) this assumption is needed in order to maintain the stationarity in the model. Schmitt-Grohe and Uribe (2001) also show that adding this spread - i.e. whose size has been shown negligible in Lane and Milesi-Ferretti (2001) - does not change significantly the behavior of the economy as compared to the one observed under the complete asset market assumption or under the introduction of other inducing stationarity elements - see Mendoza (1991), Senhadji (1994), Ghironi (2001) .

which states that under imperfect financial integration marginal utilities are equalized only up to the level of the country risk.

Finally the nominal interest rate are defined as $R_t^{n*} = R_t^* \frac{P_t^*}{P_{t+1}^*}$, $R_t^n = R_t \frac{P_t}{P_{t+1}}$.

3.2 The Entrepreneurs in the Home and Foreign Country

The second set of agents are Entrepreneurs. They consume, invest in capital markets and run production in the competitive unit. In each period they rent to firms in the competitive unit the existing capital stock that they own and finance investment in new capital. To finance the purchase of new capital they need to acquire a loan from a competitive intermediary that raises funds through deposits. The return on capital is subject to an idiosyncratic shock, ω^j[27]. 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. For the relationship with the lender is subject to an agency cost problem the Entrepreneur needs to pay an external finance premium on the loan. Finally I assume that Entrepreneurs are risk neutral[28] and they have a probability of dying ς[29].

Each Entrepreneur chooses a sequence $\{C_t^e, I_t, K_t, L_t\}_{t=0}^{\infty}$ to maximize

$$E_0 \sum_{t=0}^{\infty} (\varsigma\beta)^t C_t^e, \quad \varsigma\beta \leq \beta \tag{13}$$

subject to the following sequence of constraints:

$$MPK_t K_{t-1} + L_t + \Sigma_t = C_t^e + Q_t I_t + R_t^L L_{t-1} \tag{14}$$

$$K_t = (1-\delta)K_{t-1} + I_t - \Phi\left(\frac{I_t}{K_t}\right) K_{t-1} \tag{15}$$

Equation (14) is the Entrepreneurs' budget constraint in units of domestic consumption goods. Wealth is derived from rental income $MPK_t K_t$ for production, new loans L_t and a transfer of wealth, Σ_t, from old agents. The presence of the transfer Σ_t assures that aggregate net wealth are different from zero in the steady state, even tough its presence does not play any particular

[27]Entrepreneurs are heterogenous for two reasons. First they own sectors that are subject to idiosyncratic shocks. Secondly, being finite lived, they have different accumulation of assets.

[28]This assumption is required by the specific form of the contract between lenders and borrowers that is a costly state verification contract.

[29]In this respect I follow Kiyotaki and Moore (1997) and Carlstrom and Fuerst (1998). This assumption assures that entrepreneurial consumption occurs to such an extent that self-financing never occurs and borrowing constraints on loans are always binding.

role along the cycle. Expenditure is allocated in final good consumption C_t^e, investment I_t (where Q_t is the real price of new capital) and in the service of the predetermined loan debt $R_t^L L_{t-1}$. Constraint (15) indicates that, when investing in capital, entrepreneurs face adjustment costs. The cost function $\Phi(\cdot)$ is convex and satisfies $\Phi(\delta) = 0$ and $\Phi'(\delta) = 0$, where δ is the depreciation rate of capital.

Let's define $\{\lambda_t, \xi_t\}_{t=0}^{\infty}$ as the sequence of Lagrange multipliers on the constraints (14) and (15) respectively. The first order conditions of the above problem read as follows:

$$\lambda_t = 1 \tag{16}$$

$$\lambda_t = \varsigma E_t \left\{ R_t^L \lambda_{t+1} \right\} \tag{17}$$

$$\xi_t \left[1 - \Phi' \left(\frac{I_t}{K_t} \right) \right] = \lambda_t Q_t \tag{18}$$

$$\xi_t = \gamma E_t \left\{ MPK_{t+1} + \xi_{t+1} \left(1 - \delta + \frac{I_{t+1}}{K_t} \Phi' \left(\frac{I_{t+1}}{K_t} \right) - \Phi(\frac{I_{t+1}}{K_t}) \right) \right\} \tag{19}$$

where λ_t is the lagrange multiplier on constraint (14). Equation (16) simply states that, due to risk neutrality, the marginal utility of additional real income is constant. Equation (17) is the Euler efficiency condition on the loan holding. Equations (18) and (19) are the efficiency conditions on capital investment. Notice that the lagrange multiplier Q_t denotes the real shadow value of installing new capital and thus plays the role of the implicit price of capital (or asset price).

In order to derive the aggregate consumption function it is worth to notice that the probability of dying for the entrepreneurs corresponds, by law of large numbers, to the fraction of entrepreneurs that die in each period. The population is held steady by the birth of a new entrepreneur for each dying one. Under those assumption entrepreneurs behave as permanent income consumers since they consume a constant fraction, ς, of their end of period wealth, NW_t :

$$C_t^e = \varsigma (NW_{t-1} - \Sigma_t) \tag{20}$$

Loans demand, return on assets and aggregate net wealth accumulation. In the current period domestic Entrepreneurs need to finance an investment value $Q_t K_{t+1}$.To this end they employ existing collateral NW_t and resort to external funds via a financial intermediary. The amount of capital investment that needs to be financed is therefore, in real terms, $Q_t K_t - NW_t$.

Let's define L_t as the total amount borrowed by each entrepreneur against the required capital investment during time t. Hence

$$L_t^j = Q_t K_t^j - NW_t^j \tag{21}$$

Let's define $E_t\left\{R_{t+1}^k\right\}$ as the expected aggregate return on capital investment[30]. To derive an expression for the aggregate return on capital we first substitute (16) into (17) to obtain $E_t\left\{R_t^L\right\} = \varsigma^{-1}$. Then substituting the latter and (18) into (19) and imposing arbitrage condition between the expected return on the loans and the one on capital, we obtain the following equation for the return on capital:

$$E_t\left\{R_{t+1}^k\right\} = E_t\{\frac{MPK_{t+1} + Q_{t+1}\left(1 - \delta + \frac{I_{t+1}}{K_t}\Phi'\left(\frac{I_{t+1}}{K_t}\right) - \Phi(\frac{I_{t+1}}{K_t})\right)}{Q_t}\} \tag{22}$$

Aggregation in this model is feasible considering that the fraction of entrepreneurs that remains alive in every period is equal to the constant $(1-\varsigma)$. To derive aggregate net wealth we substitute (15), (21) and (22) into (14). After aggregating the net wealth accumulation of the economy reads as follows:

$$NW_t = \varsigma[R_t^k Q_{t-1}K_{t-1} - R_t^L(Q_{t-1}K_{t-1} - NW_{t-1}) - \Sigma_t] \tag{23}$$

3.3 The Production Sector

The competitive production unit. There is a continuum of firms indexed by j. Each domestic entrepreneur owns one of the firms of the intermediate-goods producing sector. Firms have an exogenous probability of failure that correspond to the probability of dying for entrepreneurs (ς). Each of these firms assembles labor and entrepreneurial capital to operate a constant return to scale production function:

$$Y_t^j = A_t F(N_t^j, K_{t-1}^j) \tag{24}$$

where A_t is a productivity shifter common to all entrepreneurs. The optimizing decision of labor and capital is made by solving a static optimization problem for cost minimization. First order conditions for K^j and N^j are:

$$\frac{1}{mc^j}\frac{W}{P_H} = (1-\alpha)\frac{Y^j}{N^j}; \frac{1}{mc^j}MPK = \alpha\frac{Y^j}{K^j}$$

where $mc \equiv \frac{MC}{P_H}$ is the shadow unit cost of production - i.e. the real marginal cost.

[30] The expected value is taken with respect to the idiosyncratic shock.

The monopolistic competitive production unit. Each firm in this sector has monopolistic power in the production of its own variety, i, and therefore has leverage in setting the price. In so doing it faces a quadratic cost equal to:

$$\varkappa_t(i) \equiv \frac{\theta}{2}\left(\frac{P_{H,t}(i)}{P_{H,t}} - 1\right)^2 \tag{25}$$

where the parameter θ measures the degree of nominal price rigidity. The higher θ the more sluggish is the adjustment of nominal prices. In the particular case of $\theta = 0$ prices are flexible. The problem of each domestic monopolistic firm is the one of choosing the sequence $\{P_{H,t}(i)\}_{t=0}^{\infty}$ in order to maximize expected discounted real profits $\Theta_t \equiv P_{H,t}(i)Y_t(i) - MC_t - \varkappa_t(i)$.

$$MaxE_0 \sum_{t=0}^{\infty} \beta^t \frac{\Theta_t}{P_{H,t}} \tag{26}$$

subject to the constraint

$$Y_t(i) = (\frac{P_{H,t}(i)}{P_{H,t}})^{-\varepsilon}(X_t^W) \tag{27}$$

where $X_t^W = C_{H,t} + C_{H,t}^* + C_t^e$ is world demand for the domestic intermediate variety i. The first order condition with respect to prices reads as follows:

$$0 = \frac{P_{H,t}(i)}{P_{H,t}}^{-\varepsilon} \frac{X_t^W}{P_{H,t}} \left((1-\varepsilon) + \varepsilon mc_t \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-1}\right) - \theta\left(\frac{P_{H,t}(i)}{P_{H,t-1}(i)} - 1\right)\frac{1}{P_{H,t-1}(i)} \tag{28}$$

$$+\beta\theta E_t\left\{\left(\frac{P_{H,t+1}(i)}{P_{H,t}(i)} - 1\right)\frac{P_{H,t+1}(i)}{P_{H,t}(i)^2}\right\} \tag{29}$$

Notice that the lagrange multiplier mc_t plays the role of the *real* marginal cost of production. For convenience it is also useful to rewrite the above pricing condition in terms of individual producer's relative price and inflation. Let's define $\widetilde{p}_H \equiv \frac{P_H(i)}{P_H}$ as the relative price of domestic variety i and $\pi_{H,t} \equiv \frac{P_{H,t}}{P_{H,t-1}}$ as the gross domestic producer inflation rate. The above condition can be rewritten as:

$$\begin{aligned} 0 \;=\; & X_t^W \widetilde{p}_{H,t}{}^{-\varepsilon}((1-\varepsilon) + \varepsilon mc_t) - \theta\left(\pi_{H,t}\frac{\widetilde{p}_{H,t}}{\widetilde{p}_{H,t-1}} - 1\right)\frac{\pi_{H,t}}{\widetilde{p}_{H,t-1}} \\ & +\gamma\theta\left(\pi_{H,t+1}\frac{\widetilde{p}_{H,t+1}}{\widetilde{p}_{H,t}} - 1\right)\pi_{H,t+1}\frac{\widetilde{p}_{H,t+1}}{\widetilde{p}_{H,t}{}^2} \end{aligned} \tag{30}$$

3.4 The Financial Intermediary and Differences in Financial Systems

The financial intermediary collects deposits from resident households and provides loans to resident firms, by solving a costly state verification problem[31]. An agency problem between the bank and the entrepreneur arises because of the impossibility for the intermediary to observe the idiosyncratic shock, ω^j, without paying a fixed monitoring cost. Since both agents involved in the contract are risk neutral optimality requires that the bank makes zero profit, that the entrepreneur does not suffer losses on average and that there is a unique cut-off value for the idiosyncratic shock dividing default from non-default states. The contract is intrinsically incentive compatible since it is assumed that the entrepreneur pays a fixed repayment in the non-default states -i.e. no incentive to lie - and the bank gets everything is left in the default states - maximum recovery property.

The characteristic of the financial system in each country are defined by three primitive variables: the variance of investment return, defined by the standard deviation of the idiosyncratic shocks to the return on capital, ω^j, the monitoring cost (c_m) that the bank pays in bankruptcy states and the exit probability of firms, ς, that determines the amount of aggregate net wealth available for collateral . The agency problem is solved by assuming that the intermediary chooses the optimal demand for loans L_t^j - i.e. or equivalently the optimal demand of capital - and the repayment schedule - i.e. or equivalently the cut-off value $\overline{\omega}^j$ for the default states[32] - so as to maximize the expected return of the risk neutral entrepreneur subject to a participation constraint for the risk neutral intermediary and a participation constraint for the borrower for given values of R_t^k, Q_t. I assume that the idiosyncratic shock ω^j is distributed according to $F(\omega^j)$[33]. At time t firm j chooses $K_t^j, \overline{\omega}^j$ to

$$MaxE_t\{\int_{\overline{\omega}^j}^{\infty}(\omega^j-\overline{\omega}^j)R_{t+1}^kQ_tK_t^jdF(\omega)\} \tag{31}$$

$$[1-F(\overline{\omega}^j)]Z_tL_t^j+(1-c_m)\int_0^{\overline{\omega}^j}\omega^jdF(\omega)\}R_{t+1}^kQ_tK_t^j=R_tD_t(\frac{P_t}{P_{H,t}}) \tag{32}$$

$$\overline{\omega}^jR_{t+1}^kQ_tK_t^j=Z_tL_t^j \tag{33}$$

[31] The design of the optimal contract in this open economy framework follows the contracting problem considered in Gale and Hellwig (1985). The design of the contract in the general equilibrium follows Bernanke, Gertler and Gilchrist (1998) and Cooley and Nam (1998).

[32] The optimality of the contract is achieved by assuming that the intermediary asks for a fixed repayment schedule over the non-default states. This implies that the contract is incentive compatible. In addition a maximum recovery property is required. In the default states the intermediary gets everything is left. For the optimality of these conditions see Gale and Hellwig (1985). Given those conditions the cut-off value for default states can replace the repayment schedule as choice variable in the maximization.

[33] The distribution has an increasing hazard rate. This assumption ensures uniqueness for the optimal solution of the cut-off value.

$$L_t^j = Q_t K_t^j - NW_t^j \tag{34}$$

where $\overline{\omega}^j$ is value of the shock that divides the random space into default and solvency regions, Z_t is the repayment schedule for loans, c_m is the monitoring cost paid by the lender. Equation (31) is the expected return to the entrepreneur, equation (32) is the participation constraint of the lender, equation (33) is the participation constraint for the borrower.

Using the first order condition one can define a negative relation between the capital/net worth ratio and the "external finance premium"- i.e. the ratio between the return on investment and the return on deposits:

$$\frac{Q_t K_t^j}{NW_t^j} = \Psi^{-1}(\frac{R_{t+1}^k}{R_t}) \tag{35}$$

where $\Psi' < 0$. Aggregating (35) across all Entrepreneurs it yields:

$$\frac{R_{t+1}^k}{R_t} = \psi_t = \Psi\left(\frac{NW_t}{Q_t K_{t+1}}\right) + v_\psi \tag{36}$$

where $\frac{NW}{QK}$ is the aggregate *leverage ratio* and v_x is a constant term that captures the cross-sectional variance of risk premia across Entrepreneurs.

Since $Q_t K_t = NW_t + L_t$ using equation (36) one can derive a relation for the optimal borrowing limit:

$$L_t = NW_t(\Psi^{-1}(\frac{R_{t+1}^k}{R_t^{loan}}) - 1) \tag{37}$$

Notice that the borrowing limit depends positively from the amount of collateral, NW_t, and negatively from the size of the external finance premium.

The net wealth ratio, the cut-off value, the elasticity of the external finance premium and consequently the borrowing limit are functions of the primitive parameters - i.e. the variance of the distribution function $F(\omega^j)$, the business failure probability, ς, and the monitoring cost, c_m. In the parametrization the primitive parameters will change across the two countries in order to define different scenarios in terms of relative financial fragility. A solution to the first order conditions of the contract is in *Appendix 8*.

3.5 The Equilibrium Conditions

I impose market clearing conditions for each variety i and assume that aggregate consumption, investment and output in both countries can be represented through a CES aggregator. By assuming that aggregate output can be approximated by the sum of individuals output at least in a neighborhood of the steady state, the following equilibrium conditions on demand must hold for both country:

$$Y_t = C_{H,t} + C^*_{H,t} + I_t + X_t \tag{38}$$

$$Y^*_t = C_{F,t} + C^*_{F,t} + I^*_t + X^*_t \tag{39}$$

where $X_t = \int_0^{\bar{\omega}} c_m \omega dF(\omega) R^k_t Q_{t-1} K_{t-1}$ is the loss in capital due to the payment of the monitoring cost, c_m, under the default state, $\omega \in [0, \bar{\omega}]$. The real demand for deposits has to be equal to the real supply of loans for both countries:

$$D_t = \frac{P_{H,t}}{P_t} L_t = (Q_t K_t - NW_t) \tag{40}$$

Using (10), the aggregate budget constraint of the entrepreneurs, (14), the relation for the marginal and the average Tobin's q, the equilibrium condition on loans and deposits, (40), the zero profit condition for the intermediary and imposing the exhaustion law it can be shown that total net asset accumulation of the economy, CA_t:

$$CA_t = e^r_t B^*_t - R^*_t \zeta\left(e^r_t B^*_t\right) e^r_t B^*_{t-1} = Y_t - C_t - C^e_t - (I_t - X_t) \frac{P_{H,t}}{P_t} \tag{41}$$

4 The Monetary Policy Rules

To assess the robustness of the link between financial differences and the transmission mechanism I compare different monetary regimes - i.e. independent policies versus fixed exchange rate regimes. The paper will indeed show that heterogenous cycles are more likely to occur under floating exchange rate regimes than under fixed. Since an increasing number of countries under independent policies are adopting price stability rules I also compare Taylor rule versus rigid inflation targeting. As it will be shown later the two rules imply similar conclusions in terms of international transmission mechanism but can generate different volatilities of real variable mostly for very fragile countries.

Under independent policies, an active monetary policy sets the short term nominal interest rate by reacting to endogenous variables. I will consider the general class of the Taylor rules of the following form:

$$(1 + R^n_t) = (\pi_t)^{b_\pi} (e_t)^{\frac{b_e}{1-b_e}} \tag{42}$$

where $R^n_t = R_t \frac{P_{t+1}}{P_t}$, and b_π, b_e are the weights that the monetary authority puts on the deviation of inflation and exchange rate from the target levels. To get determinacy of the equilibrium the parameter on inflation will be set equal to 1.5[34]. I identify a regime of pure *floating exchange rate* with a Taylor rule of the form (42) in which $b^e = 0$. In this case both countries follow the same rule.

When one of the two countries sets $b^e = 0.99$- i.e. $\frac{b_e}{1-b_e} \rightarrow \infty$ - the rule identifies a regime of *fixed exchange rates*[35]. In the limit this rule corresponds to the case in which the monetary authority sets the interest rate equal to the interest rate of the other country.

To fit the case of large currency areas more closely I will explore the effects, under independent policies, of *rigid inflation targeting* - i.e. price stability rules. In this case the policy maker applies an infinite weight on domestic inflation setting the nominal interest rate equal to the wicksellian interest rate. This latter eventually depends on the state of the economy - i.e. exogenous shocks, capital and net worth- and on the foreign country policy rule. In the limit case the price stability rule for the home country will then read as:

$$R_t = f(R_t^*, K_{t-1}, NW_{t-1}, A_t) \tag{43}$$

The foreign country follows the same monetary policy rule. To identify this regimes various techniques have been proposed[36]. Here I will get the dynamics of the variables by imposing zero inflation and marginal cost into the model.

5 Calibration

The model is parametrized as followed. The two country are assumed to be symmetric in preferences and technologies but asymmetric in terms of financial conditions. 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. I set the elasticity of substitution between domestic and foreign goods η equal to 1.5 as in Backus, Kehoe and Kydland (1994). The parameter on consumption in the utility function is set equal to one to generate a log utility. This value is compatible with a steady state trade balanced growth path. The parameter on labor in the utility is set equal to 3. I let the steady state balanced growth ratio of exports over GDP to vary between $\gamma = 0.15$ and $\gamma = 0.3$, the first value being compatible with data for US and Europe. Finally I assume that the steady state net asset position is symmetric between the two countries. Following Schmitt-Grohe and Uribe (2002)

[34] See Woodford (2002).

[35] For a similar specification see Monacelli (1999) and Benigno P. and G. Benigno (2000).

[36] On one side, Neiss and Nelson (2000) show that price stability rules generate a sequence of zero-inflation equilibria from time zero onward. The resulting level of potential output and potential interest rate can be described as moving average processes of exogenous shocks. On the other side, Woodford (2000) points out that the monetary rule should be conditioned on actual predetermined variables as if past equilibria were characterized by sticky price behaviors.

and consistently with Lane and Milesi-Ferretti (2002) I set the elasticity of the spread on foreign bonds to the net asset position equal to 0.000742.

Production. The share of capital in the production functions, α, is equal to 0.3. The quarterly depreciation rate, δ, is set equal to 0.025. The latter implies an annual depreciation rate of roughly 10%, a value compatible with empirical estimates for the US economy. Following Basu and Fernald (1997) I set $\mu = 0.2$ for the value added mark-up of prices over marginal cost. This generates a value for the price elasticity of demand, ε, of 6. The coefficient of the marginal in the Phillips of the model is given by $\frac{N}{\theta\mu}$. The steady state solution to the current model generates a value for the fraction of time allocated to work of $N = 0.18$. Given the assigned value for μ and consistently with estimates by Sbordone (1998), I set $\theta = 17.5$. The elasticity of the price of capital with respect to investment output ratio, $\varphi = [(\Phi(\frac{I}{K})^{-1})'(\frac{I}{K})/(\Phi(\frac{I}{K})^{-1})'']$, is set equal to 0.5. The latter has been chosen so as to generate a volatility of investment higher than the volatility of consumption as observed in the data.

Financial frictions parameters. The asymmetries between the two countries will be build upon assuming three different financial scenarios for the foreign country given one particular scenario for the home country. The financial frictions scenarios are identified according to three primitive parameters: 1) the corporate risk of firms, identified by the variance of the idiosyncratic shock $\overline{\omega}^j$, 2) the bankruptcy cost for the bank, which gives a measure of the loan losses, c_m, 3) the survival rate of firms, ς, which is an indicator of whole corporate risk since is describes the aggregate evolution of the business sector. Of the three primitive parameters the first two affect the contracting problem directly whereas the third affects net wealth directly and the contracting problem indirectly. The solution of the contract in the steady state will lead to values for: 1) the elasticity of external finance premium to collateral, $\Psi(\bullet)$, 2) the steady state leverage ratio, $\frac{L}{NW}$, 3) the steady state external finance premium, ψ^{ss}, 4) the optimal cut-off value $\overline{\omega}^j$ and consequently the default probability $F(\overline{\omega}^j)$. A very fragile system in the foreign country is identified by a situation in which either monitoring costs for banks, or perceived financial risk and/or exit ratio for firms are high. In the solution to the financial contract this leads to high values for the elasticity and the steady state value of the external finance premium, low leverage, high default probability. Finally low leverage and high elasticity of external finance premium to collateral generate tighter borrowing limits.

For further clarification figures 2 to 3 show the effect on the solution to the contract of changes in the bankruptcy cost while taking as given values for the volatility of idiosyncratic shock and for the exit probability. Values are on annual basis. As it stands clear when the bankruptcy cost increases the cut-off value decreases since banks are less eager to monitor. On the other side, banks demand higher external finance premia. As a consequence firms reduce the leverage.

Figures 4 to 5 show the effect on the solution of the contract of changes in the volatility of

Table 1: **Financial scenarios for primitive parameters.**

Primitive parameters	Scenario 1	Scenario2	Scenario3
$\sigma_{\overline{\omega}^j}$	0.26	0.28	0.28
c_m	0.05	0.12	0.3
ς	0.973	0.973	0.973

Table 2: **Financial scenarios for financial contract parameters in the steady state.**

Model parameters	Scenario 1	Scenario2	Scenario3
$\frac{K}{NW}$	2.5	2.1	1.9
ψ^{ss}	270	320	350
$\psi(\bullet)$	0.029	0.053	0.08

idiosyncratic shock while maintaining the same bankruptcy cost. When the uncertainty about the return on investment projects raises banks ask a higher external finance premium and consequently firms reduce their leverage. In order to reduce risk banks decrease the optimal cut-off value. The latter produces an increase in the default probability.

Since the survival rate affects the contract only indirectly it does not have significant effects on the financial scenarios.

The parametrization strategy[37] of the financial scenarios used to characterize the dynamic of the model is based on the following criterion. I set the bankruptcy costs using as reference values the micro data presented before on loan losses as percentage of bank liabilities. I keep the survival rate fixed. I then set the volatility of idiosyncratic shock so as to generate steady state values for the external finance premium that approximate data values for the difference between the rate on Treasury bill and the prime lending - i.e. a value of 300 annual basis points for the US economy -. The following tables[38] 1,2, show the parametrization for three possible financial scenarios for the foreign country given the a baseline parametrization for the home country.

Exogenous shocks: I consider an aggregate productivity shocks A_t that affects the production of the economy, $Y_t = A_t K_t^{1-\alpha} N_t^{\alpha}$, and follows an $AR(1)$, whose persistence is varied between

[37] The first order conditions for the contract are three equations in three variables. One needs to specify the three primitive parameters to get the three unknowns. There are infinite combinations of these values. Mainly those three situations can arise. a) Both the monitoring cost and the volatility of the idiosyncratic shocks increase and as a result the external finance premium and its elasticity increase. b) Only the monitoring cost increases while the volatility of the idiosyncratic shock remains fixed or decreases. As a result both the external finance premium and its elasticity increase. c) Only the volatility of the idiosyncratic shock increases while the monitoring cost remains fixed. As a result the external finance premium and its elasticity increase.

[38] Values on quarterly basis.

0.8 and 0.9. Secondly, I consider a monetary shock that affects the interest rate and is assumed with zero persistence. The volatility of the shocks is calibrated consistently with estimates for the US and the Euro area. Correlations of shocks are calibrated so as to get values of cross-correlations of output that are close to the ones for industrialized countries[39].

The equilibrium of the model is characterized as the solution of the system of expectation difference equations of the loglinearized form[40]. For a solution of the steady state of the model see *Appendix 9.* Finally *Appendix 10* provides the definition of the competitive equilibrium and an outline of the loglinearized version of the model.

6 Asymmetric Shocks with Symmetric Financial Systems

To examine the impact of financial differences the discussion will proceed according to the following steps. First, I explore the case of two countries with symmetric financial systems and asymmetric shocks. This allows me to clarify the intuition behind the transmission mechanism in the model. Secondly, I show the main result that business cycle heterogeneity occurs under independent policies. Third, I perturb the economy with respect to the benchmark case by considering different monetary regimes and different degree of openness to completely assess the role of financial differences under alternative set-ups. I will consider productivity and monetary shocks.

In this section I examine the impact of shocks when financial frictions are symmetric.

Productivity With Independent Policies. I assume that a 1% positive technology shock hit the home economy and that both countries follow a Taylor type rule. Figure 3 of Annex 1 shows impulse responses for this experiment. Domestic output increases, domestic inflation decreases and this induces, via a Taylor rule, a decrease of nominal and real interest rates. The decrease in cost of the loan increases investment and improves collateral conditions. The consequent reduction in the external finance premium exacerbate the boost in investment and asset prices. The foreign country experiences real and financial effects too. Part of the transmission is explained by a demand effect already present in the previous literature called *switching expenditure effect.* The decrease in domestic inflation shifts demand in the home country in favor of domestic goods. The decrease in foreign goods demand reduces foreign inflation[41]. The sole demand effect would generate a negative correlation of outputs between the two countries. The combination of the switching expenditure effect and of a conventional financial accelerator effect produces an indirect *financial*

[39] A different calibration strategy could also be chosen. Another possibility would be to fix the correlations of shocks and then change the volatilities accordingly so as to generate cross-correlations of output reported in the data. All the results of the model have been tested under different calibration strategies without being affected.

[40] 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).

[41] The *absorption effect,* that increases domestic demand due to increase in income, is negligible since in this model the increase in output is more likely to generate an increase in investment expenditure than an increase in the consumption of workers.

spillover that goes from the home to the foreign country. Indeed, given the decrease in foreign inflation, foreign nominal interest rates decrease in response to monetary policy. The decrease in the nominal interest rate and consequently in the cost of the loan improves financial conditions and generates an increase in investment in the foreign country. The increase in investment also generates an increase in employment, output and an asset price boom. Again the financial boost is exacerbated by the improvement in collateral conditions and by the fall in the external finance premium. Depending on its magnitude the financial spillover effect can partly or completely offsets the negative influence of the shift in demand. Whenever the two countries have similar financial systems - i.e. similar sensitivity of financial variables to shocks - the cross-correlations of output are positive. The subsequent two remarks follow:

Remark 1 *Due to financial spillover effect an increase in total factor productivity for one of the two countries can generate an increase in asset prices for the foreign country.*

The new open economy literature does not provide explanation of the link between total factor productivity shocks in the US and asset prices in Europe. This link is well documented and examined in other areas of macroeconomics - see Greenwood and Jovanovic (1999). The presence of the financial side in this paper's open economy model helps to explain this missing link in open economy models.

Remark 2 *Due to the financial spillover effect an improvement in the technology opportunities for the home countries is also beneficial for output, investment and employment in the foreign country.*

Table 9 compares cross-correlations of output generated by this model with the ones obtained in standard models of international business cycle - i.e. see Backus, Kehoe and Kydland (1995) - and with the ones in the data. In Backus, Kehoe and Kydland (1995) the flow of capital to the country with improved investment opportunities generate negative correlations of the three variables across countries. The present model is able to generate positive correlations of output under asymmetric shocks and under the assumptions that both countries face similar financial conditions on borrowing.

Monetary Policy Shock With Independent. A decrease in the interest rate reduces the cost of the loan, improves collateral conditions and boosts investment demand in the home country and foreign country as before. The only remarkable difference with respect to the productivity shock stems from the persistence of the responses. The jump is bigger on impact since the monetary policy shock directly affects the interest rate. On the other side, the persistence is much lower since the shock is assumed to have zero autocorrelation. Notice that it would be possible to obtain a hump shaped response of output and investment by adding delays in "time to plan".

7 Financial Asymmetries with Identical Policies

We now move to examine the effect of financial asymmetries. The experiments will provide answers to the following questions. Do countries show differential business cycle fluctuations given differences in the financial system? If so, under which conditions are those differential responses more pronounced? By introducing financial diversity an additional dimension enriches the model. Different sensitivities of credit availability to collateral produce different degrees of business cycle responsiveness. To isolate the effect of asymmetries the following analysis assumes identical policies.

Before proceeding to analyze the dynamic responses of the model notice the following remark.

Remark 3 *A country with higher bankruptcy cost or with higher volatility of idiosyncratic shock experiences lower long run income and capital levels.*

With higher bankruptcy costs or riskiness of investment projects the deadweight loss of the economy, $X = \int_0^{\bar{\omega}} c_m \omega dF(\omega) R^k QK$, is higher. Hence this depresses the long run growth of the country - i.e. see *Appendix 10*. This is consistent with empirical evidence reported in Rodrik, Subramanian and Trebbi (2002) who show that institutions are an important determinant - i.e. more than trade and geography - of income levels across countries.

Productivity and Monetary Policy Shocks with Taylor Rules. If the two countries show different degrees of loan sensitivity to collateral differential responses occur.

First, consistently with the data business cycle diversity emerges with differences in volatilities even under symmetric and correlated shocks. In particular when the foreign country is relatively more fragile foreign variables are relatively more volatile - i.e. see table 12, 13, 14. This result is consistent with evidence provided by Mihov (2002) who shows that volatilities of de-trended output across countries is an increasing function of the leverage ratio.

Since the credit channel accounts for the transmission mechanism of this model business cycle fluctuations tend to diverge when higher differences in the financial system emerge. Table 10 and 11 show a systematic comparison of cross-country correlations of output, for productivity and monetary shocks. The home country is set alternatively in scenario 1 and in scenario 2. Cross-correlations decrease whenever the financial distance increases. The negative relation between output correlations and financial distance is of the same magnitude of the one observed in the data- i.e. see figure 1 of Annex 1. Figure 2 of Annex 1 also shows that this relation is independent from the correlations of the underlying shocks. Cross-correlations of output increase when increasing the correlation of productivity shocks. But for any given level of the latter they decrease when the financial distance increases.

Remark 4 *The correlation among the business cycles of two countries is a decreasing function of the degree of financial diversity.*

Trade Openness. A higher degree of openness increases the correlations of cycles (see table 10 to 11). The intuition of this result is as follows. The magnitude of the switching expenditure effect for each unit of consumption is not affected by changes in economic openness since the elasticity between home and foreign goods is the same. On the other side the magnitude of the financial spillover effect is bigger. For instance, under a positive technology shock to the home country higher economic openness leads to a higher fall in exports and a higher decrease in inflation for the foreign country. The higher decrease in inflation generates a higher decrease in interest rates and a higher increase in investment and output for the foreign country.

Remark 5 *A higher degree of trade openness increases the correlation of cycles.*

Financial Openness. To test if asymmetries in business cycle persist with increasing financial market globalization I also assess the role of the financial exposure. In this case I allow for a fraction of loans to be supplied by foreign intermediaries and as such denominated in foreign currency - i.e. see also Faia and Monacelli (2000). An increase in the financial openness - i.e. a positive fraction of loans denominated in foreign currency - enhances the differential responses of home variables due to the additional effect that changes in the exchange rate have on the cost of the loan. To the extent that home loans are denominated in foreign currency any shock that produces a collapse in the exchange rates moves wealth from domestic borrowers to foreign lenders, and viceversa with an increase in the exchange rates. In addition exchange rates are more persistent and volatile when financial differences increase. As a consequence the wealth shift is higher when the financial distance increases thereby leading to more pronounced business cycle asymmetries. This is consistent with empirical results from Heathcote and Perri (2002b) who show that financial globalization leads to more asymmetric cycles.

Remark 6 *A higher degree of financial openness leads to higher asymmetries in business cycle fluctuations across the two countries.*

Productivity and Monetary Policy Shocks with Rigid Inflation Targeting Rules. Table 12, 13, 14 show volatilities for home and foreign variables under the three regimes considered - i.e. Taylor rule, rigid inflation targeting and credible pegs. Under a regime of strict inflation targeting the volatilities of both real and financial variables increase. As in Gali' and Monacelli (2000) and Monacelli (2000) output does seem to respond more under this rule. With zero inflation the nominal interest rate is set on a period by period basis equal to the wicksellian interest rate that reacts to shocks, capital and net worth of firms. The reaction of the nominal interest rate to net worth spreads the financial instability to the all economy.

Remark 7 *A rigid inflation targeting rule increases volatility of both, financial and real variables.*

Productivity and Monetary Policy Shocks with Credible Pegs. Under credible pegs business cycle correlations across countries tend to be more positive than under independent policies. Since the foreign interest rate is set equal to the domestic interest rate the impact of financial differences is mitigated and cycles are more synchronized - see table 15. This happens for two reasons. First, when the nominal exchange rate channel is shut-off the switching expenditure effect is mitigated. Hence output correlations move toward more positive values. Indeed, under a positive technology shock to the home country, real depreciations occur only to the extent that sticky prices generate differences in price dynamics. Secondly, since the foreign monetary authority sets the interest rate equal to the one of the domestic economy the effect of shocks on financial variables tends to be similar.

Remark 8 *Synchronization among cycles increases under credible pegs.*

8 Conclusion

The focus of this paper is on the role that financial market asymmetries play in the international transmission of shocks. Although financial asymmetries are systematically invoked to explain differences in the domestic transmission of monetary policy or other shocks, they have so far not been used in the analysis of international interdependence.

The first step in this paper is to show some stylized facts concerning international correlation of business cycles and financial asymmetries. I find that there is a link between them. Across a sample of OECD countries, there is a significant negative association between correlation of cycles and the differences in financial structures and/or in the degree of financial risk. This link is robust to the inclusion of third factors like bilateral trade integration and geography.

As a second step, I build a two-country stochastic dynamic general equilibrium model with optimizing agents characterized by nominal rigidities, imperfect financial integration, borrowing constraints on investment and financial diversity in terms of fragility of banking systems and riskiness of investment projects. The model is calibrated for the US and the euro area and analyzed under productivity and monetary policy shocks.

Business cycle asymmetries across countries are linked to financial differences. Several facts concerning the international transmission mechanism are well explained by the model. Hence the analysis shows the ability of a set-up that links the trade and the financial side of the economy and that integrates the domestic and the international transmission mechanism.

Although the analysis of this paper is referred to the US and the euro area, the basic ideas have, I believe, more general validity. The model could be directly applied to examine, for example, issues related to the international impact of Japan's financial fragility, or the macroeconomic interaction between financially asymmetric countries linked by a hard peg (e.g. a currency board) or belonging to currency unions.

In addition, the mechanism considered in this set-up has a potential for accounting of additional international business cycle facts, like the exchange rate persistence and volatility puzzle. In fact, differences in financial fragility generate differences in volatility and persistence of the real interest rate. Those differences are absorbed by the real exchange rate through the uncovered interest parity. All this is left for future research.

References

[1] Ambler, S., E. Cardia and C. Zimmermann , 2002, "International Transmission of the Business Cycle in a Multi-Sectoral Model", European Economic Review, 46(2), pages 273-300.

[2] Anderson, G. and G. Moore (1985), "A Linear Procedure for Solving Linear Perfect Foresight Models", *Economics Letters, 17, 247-252.*

[3] Angeloni, I., V. Gaspar, O. Issing and O. Tristiani (2001), Monetary Policy in the Euro Area, Cambridge University Press.

[4] Akerlof, G. (1970), "The Market for Lemons: Quality Uncertainty and The Market Mechanism", *Quarterly Journal of Economics,* 85, August, 488-500.

[5] Artis, M. and W. Zhang (1996), "Business Cycle, Exchange Rate Regimes and the ERM: Is There a European Business Cycle?", European University Institute w.p. 96-55.

[6] Backus, D.K., P.J. Kehoe and F.E. Kydland, (1992), "International real business cycles", Journal of Political Economy 101, 745-775.

[7] Baxter, M. and M. Crucini (1994), "Business Cycles and the Asset Structure of Foreign Trade", International Economic Review 36, 821-854.

[8] Baxter, M. and R. King (1999), "Measuring Business Cycle: Approximate Band Pass Filters for Economic Time Series", Review of Economic and Statistics, 81:4.

[9] Baxter, M. and D. Farr (2001), "Variable Factor Utilization and International Business Cycles", mimeo.

[10] Ball, L. (1998), "Policy Rules for Open Economies", in J. Taylor, ed., *Monetary Policy Rules*, University of Chicago Press, Chicago, IL.

[11] Benigno, G., P. Benigno (2000), "Monetary Policy Rules and the Exchange Rate", manuscript, Bank of England, New York University.

[12] Bernanke, B. and M. Gertler (1989) "Agency Costs, Net Worth, and Business Fluctuations", *American Economic Review*, 79, March 1989, 14-31.

[13] Bernanke, B., M. Gertler and S. Gilchrist (1999), "The Financial Accelerator in a Quantitative Business Cycle Framework", in J.B. Taylor, and M. Woodford, eds., *Handbook of Macroeconomics*, Amsterdam: North-Holland.

[14] Calvo, G. (1983), "Staggered Prices in a Utility Maximization Framework", *Journal of Monetary Economics*, 12, 383-98.

[15] Canova, F. and H. Dellas (1993), "Trade Interdependence and The International Business Cycle", Journal of International Economics, 34.

[16] Carlstrom, C. and T. Fuerst (1997), "Agency Costs, Net Worth and Business Fluctuations: A Computable General Equilibrium Analysis", *American Economic Review,* 87, 893-910.

[17] Stephen G. Cecchetti, 1999. "Legal Structure, Financial Structure, and the Monetary Policy Transmission Mechanism," NBER Working Papers 7151, National Bureau of Economic Research, Inc.

[18] Chari, V.V., Patrick Kehoe and Ellen R. McGrattan (2000), "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rate", NBER Working Paper 7869.

[19] Clarida, R., J. Gali, and M. Gertler (2000), "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory", *Quarterly Journal of Economics*, 115 (1), February, 147-180.

[20] Cole, H. and M. Obstfeld, 1991, "Commodity Trade and International Risk Sharing: How Much Do Financial Markets Matter?", Journal of Monetary Economics.

[21] Cooley, T. and V. Quadrini (1999), "Monetary Policy and the Financial Decision of Firms", manuscript, New York University.

[22] Faia, E. (2001), "Stabilization Policy in A Two-Country Model and The Role of Financial Frictions", European Central Bank w.p. #56.

[23] Faia E. and T. Monacelli (2002), "Financial Exposure, Exchange Rate Regimes and Fear of Floating", mimeo, New York University and Boston College.

[24] Gale, D. and M. Hellwig (1985), "Incentive-Compatible Debt Contracts: The One-Period Problem", *Review of Economic Studies,* 52, 647-663.

[25] Galí, J. and T. Monacelli (2000), "Optimal Monetary Policy and Exchange Rate Volatility in A Small Open Economy", manuscript, Universitat Pompeu Fabra and Boston College.

[26] M. Gertler, Gilchrist S. and F.M. Natalucci (2001) "External Constraints on Monetary Policy and The Financial Accelerator", mimeo, New York University and Boston University.

[27] Goodfriend M. and R. King (2000), "The Case for Price Stability", European Central Bank Conference on "Price Stability" 2000.

[28] Greenwood, J. and B. Jovanovic, 1999. "The IT Revolution and the Stock Market," RCER Working Papers 460, University of Rochester - Center for Economic Research (RCER).

[29] Heathcote, J. and F. Perri (2001), "Financial Globalization and Real Regionalization", Stern School of Business.

[30] Helpman E. and A. Razin, 1978, "The Protective Effect of a Tariff under Uncertainty", Journal of Political Economy.

[31] Imbs, J., 1998. "Co-Fluctuations, "Cahiers de Recherches Economiques du Département d'Econométrie et d'Economie politique (DEEP), Université de Lausanne, Ecole des HEC, DEEP.

[32] King, R. G. and M. W. Watson, 1996, "Money, Interest Rates and the Business Cycle", Review of Economics and Statistics, p. 35-53.

[33] King, R. G. and A. L. Wolman, 1996. "Inflation Targeting in a St. Louis Model of the 21st Century," NBER Working Papers 5507, National Bureau of Economic Research, Inc.

[34] Kiyotaki, N. and J. Moore (1997), "Credit Cycles", *Journal of Political Economy*, 105, April , 211-48.

[35] La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R. Vishny, 1999. "Investor Protection: Origins, Consequences, Reform," Harvard Institute of Economic Research Working Papers, Harvard - Institute of Economic Research.

[36] La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R. Vishny, 1997. "Legal Determinants of External Finance," NBER Working Papers 5879, National Bureau of Economic Research, Inc.

[37] McCallum, B. and E. Nelson (1999). "Nominal Income Targeting in an Open-Economy Optimizing Model", *Journal of Monetary Economics, 43: 533-578.*

[38] Monacelli, T. (2001), "New International Monetary Arrangements and the Exchange Rate", mimeo, Boston College.

[39] Neiss, K. and E. Nelson, 2001, “The real interest rate gap as an inflation indicator”, Bank of England working paper.

[40] Obstfeld, M. and K. Rogoff, 2000, “New directions for stochastic open economy models”, Journal of International Economics.

[41] Pagano, M. and P. Volpin, 2001. “The Political Economy of Finance,” CSEF Working Papers, Centre for Studies in Economics and Finance (CSEF), University of Salerno, Italy.

[42] Rotemberg, J. and M. Woodford (1997), “An Optimizing Based Econometric Framework for the Evaluation of Monetary Policy”, in B. Bernanke and J. Rotemberg, eds., *NBER Macroeconomics Annual*, Cambridge, MA, MIT Press.

[43] Schmitt-Grohe, S. (1997), “The International Transmission of Economic Fluctuations: Effects of U.S. Business Cycles on Canadian Economy”, Journal of International Economics, 44.

[44] Sims,C. (1999), “Solving Linear Rational Expectations Models, mimeo”, Princeton University.

[45] Taylor, J. (1999), *Monetary Policy Rules,* University of Chicago Press, Chicago, IL.

[46] Townsend, R. M., 1979, “Optimal Contracts and Competitive Markets with Costly State Verification,” Journal of Economic Theory, V.21: 265-293.

[47] C. Zimmermann, 1997, “International Real Business Cycles among Heterogeneous Countries”, European Economic Review, 41(1), pages 319-355.

[48] Woodford, M. (1999), “Inflation Stabilization and Welfare”, manuscript, Princeton University.

Appendix

9 Solution of the Contract in The Steady State

The first order conditions to the maximization problem of the intermediary are derived here. Let us define $k^j = \frac{K^j}{L^j}$ where and $\psi = \frac{R^k}{R}$. Let us rearrange the constraints of the maximization problem using the fact that the last three constraints hold with strict equality. We can then substitute equations (33) and (34) in (31) and in (32). After rearranging the constraints and using Leibniz rule to differentiate the integral function with respect to $\overline{\omega}^j$ we get the following first order conditions with respect to k^j, $\overline{\omega}^j$ and the Lagrange multiplier χ are:

$$E\{(\int_{\bar{\omega}^j}^{\infty}(\omega^j - \overline{\omega}^j)dF(\omega)) + \chi[(1 - F(\overline{\omega}^j)) + (1 - c_m)\int_0^{\bar{\omega}^j}\omega^j dF(\omega^j)]\}(\varkappa) - \chi = 0 \tag{44}$$

$$[1 - F(\overline{\omega}^j)] - \chi[(1 - F(\overline{\omega}^j)) - c_m F'(\overline{\omega}^j] = 0 \tag{45}$$

$$E\{[1 - F(\overline{\omega}^j)] + (1 - c_m)\int_0^{\bar{\omega}^j}\omega^j dF(\omega^j)\}(\psi k^j) = [k^j - 1] \tag{46}$$

There is a one to one relation between the capital/net worth ratio (k^j) and the ratio between the risk free interest rate and the cost of loan (ψ that is the external finance premium) and this relation is negative. Assuming an interior solution for $\overline{\omega}^j$[42] and using equation (45), we can derive χ as an increasing function of $\overline{\omega}^j$. By substituting $\chi(\overline{\omega}^j)$ in (44) one can derive a one to one relation between the external finance premium and $\overline{\omega}^j$, $\psi = f(\overline{\omega}^j)$. By substituting $\omega^j = f^{-1}(\psi)$ in (46) one can derive a one to one relation of the form $k^j = \Psi^{-1}(\psi)$. Inverting the last relation and translating into the dynamic one gets the external finance premium for each firm j:

$$\psi_t = \{\frac{R^k_{t+1}}{R_t}\} = \Psi(\frac{NW^j_t}{Q_t K^j_t}) \tag{47}$$

with $\Psi' < 0$. The negative sign of Ψ' can be proved by simply substituting $\overline{\omega}^j = f^{-1}(\psi)$ into the (46) and taking derivative of k^j with respect to ψ.

[42] The existence of an interior solution can be proved by either of the two following arguments. First, when choosing a specific distribution - e.g. a normal distribution - for $F(\omega^j)$ it is possible to show that a value of $\overline{\omega}^j = 0$ does not satisfies all the three FOC together. Alternatively, one can notice that for the set of points for which the constraint is satisfied with equality the gradient of the objective function is parallel to the gradient of the constraint. This is a necessary and sufficient condition for an interior solution.

The set of first order conditions represents a systems of three equation in three variables. The distribution for the idiosyncratic shock is assumed lognormal with unitary mean so that it can be pinned down simply by choosing the standard deviation. After choosing the values for the variance of $F(\overline{\omega}^j)$ and the monitoring cost , one can get values for the steady state external finance premium, its elasticity to collateral over the cycle and the steady state net wealth/capital ratio.

10 The Steady State of the Economy

Let us characterize the perfect foresight steady state of the two country economy. When financial systems are symmetric we can assume $Y = Y^*$ and derive the same steady state ratios for both economies. When countries face different monitoring costs and variances of idiosyncratic shock, the magnitude of $X = \int_0^{\bar{\omega}} c_m \omega dF(\omega) R^k QK$ is also different. In particular when the home country is less financially fragile than the foreign country $X < X^*$. Hence from the resource constraint we know that:

$$Y > Y^*$$

For both countries we can set $A = 1$. Markups are constant in the steady state, implying a marginal cost $mc = \frac{1}{\mu}$. 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 $R^k = \frac{1}{\mu} \alpha \frac{Y}{K} + (1 - \delta) = R + \psi_{ss}$,where ψ_{ss} is the steady state external finance premium. Using the last equation we get:

$$\frac{Y}{K} = \frac{\mu(R^k - 1 + \delta)}{\alpha}$$

When the foreign country is facing higher monitoring costs and higher volatility of idiosyncratic shocks, $\psi^*_{ss} > \psi_{ss}$, $R^{*k} > R^k$ and $Y > Y^*$. As a consequence:

$$K > K^*$$

The law of motion for capital accumulation in the steady state is given by $K = K(1 - \delta) + \phi(\frac{I}{K})K$ and $\frac{I}{K} = \delta$. Using the last ratio we get that $\frac{I}{Y} = \frac{\delta\alpha}{\mu(R^k - 1 + \delta)}$. Using the Cobb-Douglas production function and the $\frac{Y}{K}$ it is possible to obtain labor hours:

$$N = \left[\frac{\mu(R^k - 1 + \delta)}{\alpha}\right]^{\frac{1-2\alpha}{\alpha}}$$

Finally using labor hours, output and the labor market condition it is possible to obtain consumption:

$$C^\sigma = \frac{N^{\tau+1}}{Y} \frac{\mu}{(1 - \alpha)}$$

where σ and τ are the coefficient on utility for consumption and labor. To obtain exports and imports function consider a steady state where the initial wealth distribution is normalized so that $e^R = 1$ and the terms of trade $tot = 1$. 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:

$$\frac{C_H}{Y} = \gamma[1 - \frac{\delta\alpha}{\mu(R^k - 1 + \delta)} - \frac{C^e}{Y}]; \frac{C_F}{Y} = (1-\gamma)[1 - \frac{\delta\alpha}{\mu(R^k - 1 + \delta)} - \frac{C^e}{Y}] = \frac{C_{H^*}}{Y}.$$

In the loglinearized version of the resource constraint $\zeta_h = \frac{C_H}{Y}$, $\zeta_{h^*} = \frac{C_{H^*}}{Y}, \zeta_{I_h} = \frac{K}{Y}, \zeta_{c^e} = \frac{C^e}{Y}$. It is assumed that $\frac{C^e}{Y}$ is a small fraction of total consumption.

11 The Competitive Allocation and The Loglinearized Version of the Model

Definition 1 *An equilibrium for the economy described is:*

a) A collection of allocations $\{C_t(i), C_{H,t}, C_{F,t}, N_t\}_{t=0}^{\infty}$ *and assets* $\{B_t^*, D_t\}_{t=0}^{\infty}$ *for home workers, a collection of allocations*

$\{C_t^*(i), C_{H,t}^*, C_{F,t}^*, N_t^*\}_{t=0}^{\infty}$ *and assets* $\{B_t^*, D_t^*\}_{t=0}^{\infty}$ *for foreign workers, and an aggregate consumption function for home entrepreneurs* $\{C_t^e\}_{t=0}^{\infty}$ *and for foreign entrepreneurs* $\{C_t^{*e}\}_{t=0}^{\infty}$*;*

b) Allocation and prices for domestic goods $\{Y_{H,t}, P_{H,t}\}_{t=0}^{\infty}$ *and for labor and investment demands in the home country* $\{N_t, I_t\}_{t=0}^{\infty}$*; allocation and prices for foreign goods* $\{Y_{F,t}, P_{F,t}\}_{t=0}^{\infty}$ *and for labor and investment demands in the foreign country* $\{N_t^*, I_t^*\}_{t=0}^{\infty}$*;*

c) aggregate price levels $\{P_t, P_t^*\}_{t=0}^{\infty}$*, asset returns* $\{R_t, R_t^*, R_t^F\}_{t=0}^{\infty}$*, prices of capital* $\{Q_t, Q_t^*\}_{t=0}^{\infty}$*;*

d) predetermined variables $\{K_t, NW_t, K_t^*, NW_t^*\}_{t=0}^{\infty}$*,equilibrium exchange rate* $\{e_t\}_{t=0}^{\infty}$*, and individual transfers and taxes that satisfy the following conditions:*

(i) taking as given prices, workers allocation solve workers' maximization, (ii) entrepreneurs' optimization problem, (iii) each differentiated good producer chooses the price optimally, (iv) input demands solve maximization problem of competitive firms, (vi), given transfer government budget is in balance, (vii) markets clear.

What follows is a list of the complete loglinearized model for the home country. Similarly the relations apply to the foreign country.

- Aggregate Demand.

$$\widehat{y}_t = (\zeta_h - \zeta_{h^*})(\eta(1-\gamma)\widehat{tot}_t) + \zeta_h\widehat{c}_t + \zeta_{h^*}\widehat{c}_t^* + \zeta_{c^e}\widehat{c^e}_t + \zeta_{I_h}\widehat{i}_t \tag{48}$$

$$\hat{c}_t = E_t\{\hat{c}_{t+1}\} - \frac{1}{\sigma}(\hat{r}^n_t - E_t\{\pi_{H,t+1}\}) + \frac{\gamma}{\sigma}E_t\{\Delta \hat{tot}_{t+1}\} \tag{49}$$

$$\hat{c^e}_t = f\widehat{nw}_{t-1} \tag{50}$$

$$E_t(\hat{r}^k_{t+1}) - \hat{r}_t - \gamma \hat{tot}_t = -v[\hat{nw}_t - (\hat{q}_t + \hat{k}_t)] \tag{51}$$

$$\hat{r}^k_{t+1} = (1-g)(\hat{y}_{t+1} - \hat{k}_t + \hat{mc}_{t+1}) + g(\hat{q}_{t+1} - \hat{q}_t) \tag{52}$$

$$\hat{q}_t = \varphi(\hat{i}_t - \hat{k}_{t-1}) \tag{53}$$

$$\hat{tot}_t = (\hat{r}^*_t - E_t\{\pi^*_{F,t+1}\}) - (\hat{r}_t - E_t\{\pi_{H,t+1}\}) - \zeta \hat{b}_t + E_t\{\hat{tot}_{t+1}\} \tag{54}$$

- Aggregate Supply Block.

$$\hat{y}_t = \hat{a}_t + \alpha \hat{k}_{t-1} + (1-\alpha)\hat{n}_t \tag{55}$$

$$\hat{y}_t + \hat{mc}_t - \sigma \hat{c}_t = (1+\tau)\hat{n}_t + \gamma \hat{tot}_t \tag{56}$$

$$\pi_{H,t} = \beta E_t(\pi_{H,t+1}) + \lambda(\hat{mc}_t) \tag{57}$$

- Law of Motion for State Variables.

$$\hat{k}_t = \delta \hat{i}_t + (1-\delta)\hat{k}_{t-1} \tag{58}$$

$$\hat{nw}_t = a_1\hat{r}^k_t + a_2\hat{r}_{t-1} + a_3\hat{q}_t - a_4\hat{k}_{t-1} + a_5\hat{nw}_{t-1} + a_7\Delta \hat{tot}_{t+1} \tag{59}$$

$$b_1\hat{b}_t(1+\beta^{-1}\zeta) = b_1[\hat{b}_{t-1} + \hat{r}_{t-1}] + \hat{y}_t - b_2\hat{c}_t - b_3\hat{c}^e_t - b_4(\hat{i}_t - \gamma \hat{tot}_t) \tag{60}$$

- Evolution of Processes for the Stochastic Variables (such as shock to technology):

$$\begin{bmatrix} \hat{a}_t \\ \hat{a}^*_t \end{bmatrix} = \begin{bmatrix} \rho & \\ & \rho^* \end{bmatrix} \begin{bmatrix} a_{t-1} \\ a^*_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ \varepsilon^*_t \end{bmatrix} \tag{61}$$

with $E_t\{\varepsilon_t, \varepsilon_t^*\} = . \begin{bmatrix} \sigma_\varepsilon^2 & \theta \\ \theta & \sigma_\varepsilon^{*2} \end{bmatrix}$

- $\zeta_h = (1-\gamma)[1 - \frac{\delta\alpha}{\mu(R^k - 1 + \delta)} - \frac{C^e}{Y}]$, $\zeta_{h^*} = \frac{\gamma}{1-\gamma}\zeta_h, \zeta_I = \frac{\delta\alpha}{\mu(R^k-1+\delta)}, \zeta_{c^e} = \frac{C^e}{Y}$;
- $g = \frac{(1-\delta)}{(1-\delta)+\alpha\frac{Y}{K}}$, $\nu = \frac{\Psi(R^k/R)}{\Psi'(R^k/R)}$, $\varphi = [(\Phi(\frac{I}{K})^{-1})'(\frac{I}{K})/(\Phi(\frac{I}{K})^{-1})'']$, $\delta = \Phi(\frac{I}{K}) = \frac{I}{K}$;
- $\lambda = \frac{N\theta}{\mu}$;
- $a_1 = [\varsigma R^k \frac{K}{NW} - \varsigma\psi\frac{K}{NW} + \varsigma\psi], a_2 = [\varsigma\beta^{-1}(\frac{K}{NW} - 1) + \varsigma\psi\frac{K}{NW} - \varsigma\psi], a_3 = [\varsigma R^k \frac{K}{NW} - \varsigma\psi\frac{K}{NW} - \varsigma\frac{K}{NW}\beta^{-1}]$;
- $a_4 = [\varsigma R^k \frac{K}{NW} - \varsigma\beta^{-1}\frac{K}{NW} - \varsigma\psi\frac{K}{NW}], a_5 = [\varsigma\beta^{-1} + \varsigma\psi], a_6 = (1-\xi)\varsigma\beta^{-1}(\frac{K}{NW} - 1)$.
- $b_1 = \frac{B}{Y}, b_2 = \frac{C}{Y}, b_3 = \frac{C^e}{Y}, b_4 = \frac{I}{Y}$.

Equation (48) is obtained by substituting in the loglinearized version of the resource constraint the demand for domestic and foreign consumption good. Equation (49) is the loglinear Euler equation after substituting the expression for the CPI domestic inflation. Equation (50) gives entrepreneurial consumption. Equation (51) is the loglinear external finance premium. Equation (52) is the loglinear expected return on capital. Equation (53) is the loglinear Tobin's q. Equation (54) is the loglinear UIP expressed in real terms. Equation (55) is the loglinear production function of the competitive sector. Equation (56) is obtained by loglinearizing the equilibrium condition for the labor market. Equation (57) is the Phillips curve. Finally equations (58), (59), (60) give law of motion of predetermined variables. In addition the model contains loglinear function for exports and imports demands. For the foreign country we have the same set of equations.

Table 3: **Summary of financial statistics for major industrialized areas.**

Data	Euro Area	US	UK	Japan
Population	292.2	272.9	58.7	126.5
Share of World GDP	18.8	21.9	7.6	3.2
Corporate Debt Security	7.4	31.2	18.4	11

Table 4: **Bank industry health and importance of external finance.**

Data	Return on Assets	Loan loss	External Finance	Thomson Rating
EMU countries				
Austria	0.38	0.59	46	2.38
Belgium	0.52	0.17	60	2
Finland	0.50	0.78	34	2.83
France	0.36	0.24	49	2.28
Germany	0.44	0.18	58	1.97
Greece	1.11	0.18	3	2.50
Ireland	1.57	0.17	13	1.83
Italy	0.33	0.62	37	2.57
Netherlands	0.75	0.26	48	2.10
Portugal	0.91	0.42	19	2.30
Spain	0.76	0.32	11	1.79
Euro area	0.50	0.32	40.76	2.16
UK	1.28	0.18	45	2.04
US	1.42	0.10	64	1.73
Japan	0.01	0.75	39	3.32

Table 5: **Emprical Cross-Correlations of Output Gaps.**

Cross-Correlations	US	Japan	Germany	France	Italy	UK	Canada
United States							
Japan	-0.60						
Germany	-0.57	0.53					
France	-0.10	0.05	0.72				
Italy	-0.28	0.38	0.75	0.74			
United Kingdom	0.68	-0.36	-0.38	-0.14	0.15		
Canada	0.79	-0.66	-0.38	0.15	0.08	0.82	

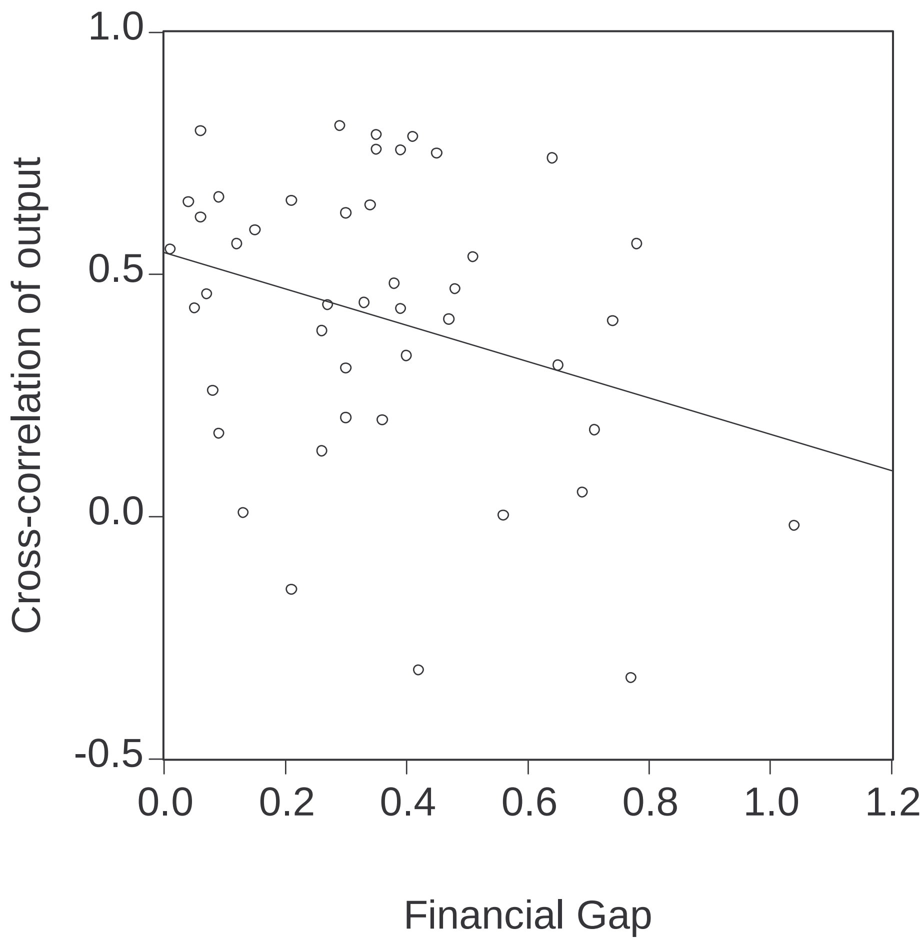

Figure 1: **Relation between cross-correlation of output and financial differences.**

Table 6: **Regression of correlation of output over financial gap.**

Dep var: Corr of output gap	Coef	St Dev	t-stat	Prob
Constant	0.55	0.09	5.26	0.0000
Financial Gap	-0.37	0.18	-2.07	0.044

Table 7: **Regression of correlation of output over financial gap and trade.**

Dep var: Corr of output gap	Coef	St Dev	t-stat	Prob
Constant	0.55	0.098	5.62	0.0000
Financial Gap	-0.37	0.18	-2.047	0.046
Trade	-0.0.2	0.010	-0.19	0.044

Table 8: **Regression of correlation of output over financial gap, trade and a dummy for language.**

Dep var: Corr of output gap	Coef	St Dev	t-stat	Prob
Constant	1.02	0.28	3.67	0.0007
Financial Gap	-0.30	0.18	-1.61	0.11
Trade	-0.05	0.01	-0.57	0.56
Language Dummy	-0.0.9	0.05	-1.79	0.08

Table 9: **Cross-correlation of output. Home productivity shocks.**

$Corr(y, y^*)$	BKK	Symmetric Financial Systems	Data	
Home Productivity Shock	-0.28	0.44	Median*	U.S./Europe**
Two Correlated Shocks	0.02	0.57	0.29	0.66

*Baxter and Farr (2002).

*Backus, Kehoe and Kydland (1995).

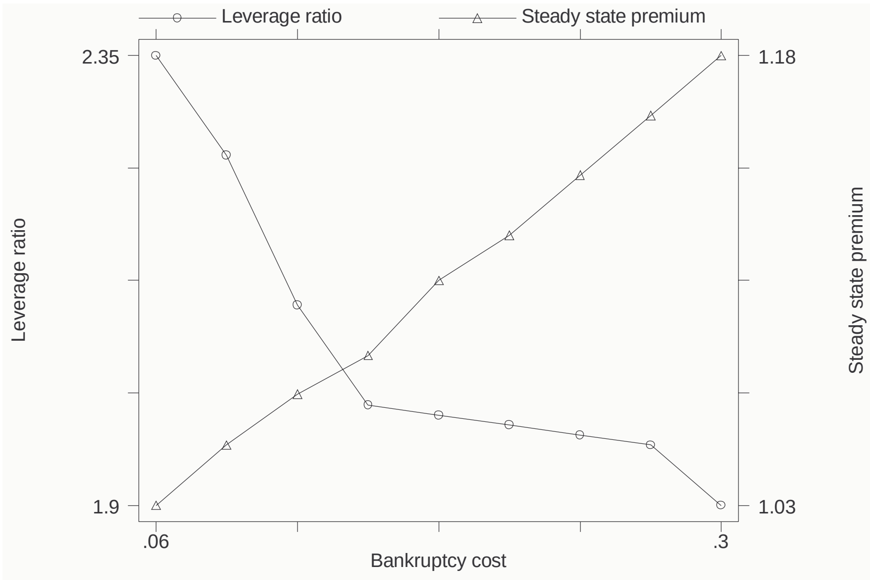

Figure 2: **Effects of changing bankruptcy costs on leverage ratio and external finance premium.**

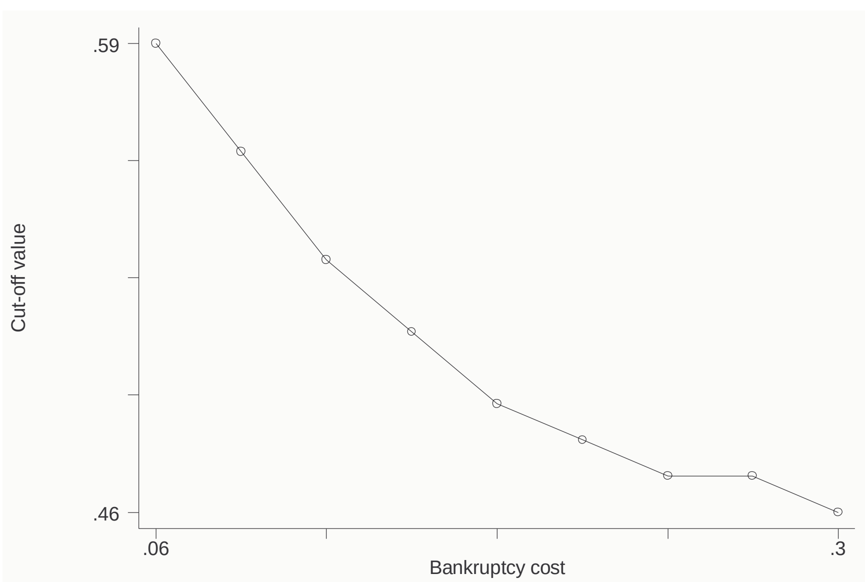

Figure 3: **Effects of changing bankruptcy cost on optimal cut-off value.**

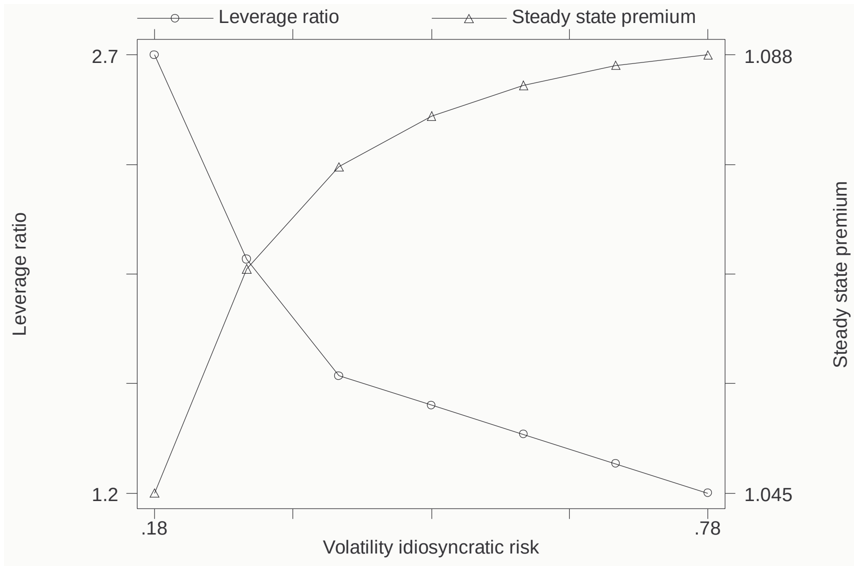

Figure 4: **Effects of changing volatility of idiosyncratic shock on leverage ratio and external finance premium.**

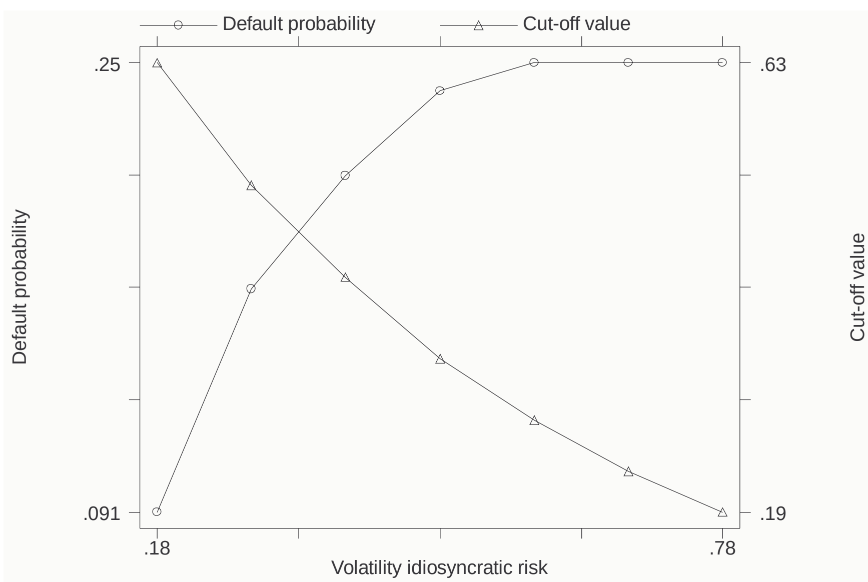

Figure 5: **Effects of changing volatility of idiosyncratic shock on default probability and optimal cut-off value.**

Table 10: **Cross-correlation of output. Symmetric and correlated productivity shocks.**

Symmetric and Correlated Productivity Shocks	Scenario 1	Scenario2	Scenario3
Home country in scenario 1, $\gamma = 0.15$	0.49	0.44	0.34
Home country in scenario 1, $\gamma = 0.2$	0.51	0.48	0.37
Home country in scenario 1, $\gamma = 0.3$	0.50	0.45	0.34
Home country in scenario 2, $\gamma = 0.15$	0.44	0.59	0.57
Home country in scenario 2, $\gamma = 0.2$	0.46	0.62	0.62
Home country in scenario 2, $\gamma = 0.3$	0.47	0.63	0.62

Table 11: **Cross-correlation of output. Symmetric and correlated monetary shocks.**

Symmetric and Correlated Monetary Shocks	Scenario 1	Scenario2	Scenario3
Home country in scenario 1, $\gamma = 0.15$	0.61	0.55	0.56
Home country in scenario 1, $\gamma = 0.2$	0.64	0.58	0.49
Home country in scenario 1, $\gamma = 0.3$	0.68	0.63	0.56
Home country in scenario 2, $\gamma = 0.15$	0.61	0.91	0.89
Home country in scenario 2, $\gamma = 0.2$	0.65	0.85	0.83
Home country in scenario 2, $\gamma = 0.3$	0.71	0.91	0.88

Table 12: **Second moments for domestic and foreign variables with Taylor rules. Correlated productivity shock.**

Second Moments - Taylor rule	Scenario 1	Scenario 2	Scenario3
Domestic Output σ_y^2	1.78	1.78	1.78
Domestic Investment σ_I^2	2.05	2.05	2.06
Domestic Price of Capital σ_q^2	0.89	0.89	0.89
Foreign Output $\sigma_{y^*}^2$	1.78	1.84	1.85
Foreign Investment $\sigma_{I^*}^2$	2.05	2.48	2.53
Foreign Output $\sigma_{q^*}^2$	0.89	1.10	1.13

Table 13: **Second moments for domestic and foreign variables with Inflation Targeting. Correlated productivity shock.**

Second Moments - Inflation Targeting	Scenario 1	Scenario 2	Scenario3
Domestic Output σ_y^2	1.89	1.89	1.89
Domestic Investment σ_I^2	2.26	2.26	2.27
Domestic Price of Capital σ_q^2	0.98	0.98	0.98
Foreign Output $\sigma_{y^*}^2$	1.89	1.96	1.97
Foreign Investment $\sigma_{I^*}^2$	2.26	2.77	2.85
Foreign Output $\sigma_{q^*}^2$	0.98	1.22	1.27

Table 14: **Second moments for domestic and foreign variables with Credible Pegs. Correlated productivity shock.**

Second Moments - Credible Pegs	Scenario 1	Scenario 2	Scenario3
Domestic Output σ_y^2	1.63	1.63	1.63
Domestic Investment σ_I^2	2.03	2.02	2.03
Domestic Price of Capital σ_q^2	0.88	0.88	0.88
Foreign Output $\sigma_{y^*}^2$	1.78	1.85	1.84
Foreign Investment $\sigma_{I^*}^2$	2.15	2.64	2.70
Foreign Output $\sigma_{q^*}^2$	0.94	1.17	1.22

Table 15: **Comparison of cross-correlations for productivity shocks under Taylor Rules and Credible Pegs. Home country in scenario 2.**

Rule	Scenario 1	Scenario 2	Scenario3
Taylor Rule	0.49	0.44	0.31
Credible Pegs	0.52	0.47	0.34