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Abstract

This paper stresses a new channel through which global financial linkages contribute to the co-movement in economic activity across countries. We show in a two-country setting with borrowing constraints that international credit markets are subject to self-fulfilling variations in the world real interest rate. Those expectation-driven changes in the borrowing cost in turn act as global shocks that induce strong cross-country co-movements in both financial and real variables (such as asset prices, GDP, consumption, investment and employment). When firms around the world benefit from unexpectedly low debt repayments, they borrow and invest more, which leads to excessive supply of collateral and of loanable funds at a low interest rate, thus fueling a boom in both home and foreign economies. As a consequence, business cycles are synchronized internationally. Such a stylized model thus offers one way to rationalize both the existence of a world business-cycle component, documented by recent empirical studies through dynamic factor analysis, and the factor's intimate link to global financial markets.

Keywords: World Interest Rate, International Co-Movement, Self-Fulfilling Equilibria

JEL codes: E21, E22, E32, E44, E63

[*]This article has been written in honor of Roger Farmer, whose intellectual curiosity, academic achievements and generous friendship have both enriched and inspired us. We thank very much Jess Benhabib, Kazuo Nishimura and Makoto Yano for inviting us to contribute to this special issue, as well as Stéphane Auray for discussions. The usual disclaimer applies. Correspondence: Patrick Pintus, Email: papintus@gmail.com. Yi Wen: yi.wen@stls.frb.org. Xiaochuan Xing: xiaochuan.xing@yale.edu.

1 Introduction

Empirical evidence suggests that there exists a set of common factors behind business cycles across nations. This set of global factors has affected simultaneously national outputs of many countries over the last 50 years. For example, Kose, Otrok and Whiteman (2003) document the existence of a distinct world business cycle, in a 60-country sample that spans seven regions of the world over the period from 1960 to 1990. More specifically, they show that on top of country-specific shocks, a world factor is also important and accounts for a significant fraction of country-specific business-cycle variations. In particular, this global factor accounts for about 35% of the variances of output and of consumption in the US, which turns out to be more than what the regional or the country-specific factors can explain.

Kose, Prasad and Terrones (2003) report similar results and further show that financial linkages between countries are more important for international business-cycle transmissions in economies that are more open to international capital flows (see also Imbs, 2004). More recently, Crucini, Kose and Otrok (2011) also confirm that the world-wide business cycle is as important as the nation-specific business cycles and they also find that "real interest rates are dominated by a common G-7 component, with two-thirds of the variance attributable to the common factor and almost none attributed to the nation-specific component " (page 167). In other words, in G7 countries real interest rates exhibit variations that appear to be driven by a common global factor. Therefore, not only national outputs and consumptions follow a world component, financial variables do as well.

In sum, the existing body of empirical evidence strongly points to the existence of a few world common factors that explain international co-movements of both output and financial variables. In addition, financial linkages between countries through international capital and debt markets, are suspected to play a key role in explaining these common factors. Of striking importance is the fact that a common component drives much of co-movements in different countries' interest rates, at least in developed economies.

However, little is known theoretically about the nature of such common factors behind the world real output and financial variables, uncovered through dynamic factor analysis in the studies reviewed above. One obvious candidate is global technology shocks. But such an hypothesized existence of global technology shocks suffers from the lack of micro-level empirical evidence that innovations at the firm level are synchronized globally despite different institutional arrangements, such as patent laws and government efforts to protect technological secrets. It is not obvious that different countries' technology frontiers progress and regress at the same time.

International trade is another possible source of global business cycle propagation (e.g., Miyamoto and Nguyen, 2017). But it takes time for goods and services to move across borders, shipping time often takes weeks if not months from one country to another. So the role of shocks to the speed of global shipping or trade costs in generating world business cycle is also likely to be limited.

This paper proposes that the existence of a global financial market sets the condition for the rise of financial and real global factors that cause global business cycles. We show how the existence of a global financial market makes possible for investors' expectations to be coordinated around all corners of the planet. In particular, global sentiments originating from the world financial market can simultaneously drive both global interest rates and national outputs across the world. Intuitively, financial markets are much more tightly and timely connected across nations than goods and labor markets, yet within each country its goods and labor sectors are closely connected to its financial sector. As a result, animal spirits in the world financial market can simultaneously affect the financial and real variables in each country (especially across developed economies, which are more financially globalized).

To that end, we develop a very simple setting with two countries that are open to international financial capital flows, within which cross-national credit borrowing and lending operate under collateral constraints to alleviate defaults. We deliberately assume that production factors such as labor, land, and capital are not mobile across national borders to highlight the role of global financial linkages in generating global real business cycles.

More specifically, we assume that in each country households are international lenders and firms are international borrowers, through a global bond market, under the standard assumption that the former are more patient than the latter (à la Kiyotaki and Moore, 1997). Although borrowing and lending are channeled through a world financial market, production factors in each country cannot be traded across countries. In other words, in each country firms (households) can borrow (lend) internationally (subject to a collateral constraint) and the world interest rate on financial debt adjusts to reflect the tightness of the global supply and demand for loans.

We show that in this setting expectations about future world real interest rate are self-fulfilling. As a result, sunspot/belief shocks to the world interest rate can simultaneously cause movements in asset prices, output, consumption, employment, and investment to go in the same direction in all countries. In other words, the optimistic/pessimistic views about the world interest rate can generate global credit expansion/contraction, so that countries' outputs, consumption, labor and capital investment co-move together. Key to our results is the endogenous response of credit supply to credit demand that renders the real interest rate counter-cyclical—a stylized fact and a long-standing puzzle in the existing literature (see, e.g., Boldrin, Christiano and Fisher, 2001, Pintus, Wen and Xing, 2016). In contrast, we show that country-specific shocks to productivity or leverage do not induce co-movement across countries in output and other key aggregates, unless strong direct (spill-over) effects are assumed. This is because an expansion in the home economy due to, say, an increase in productivity, raises the world interest rate, which in turn hurts the foreign economy.

Related Literature: This paper contributes to the literature on open-economy extensions of the seminal analysis in Kiyotaki and Moore (1997). We extend the small open-economy settings of, inter alia, Kocherlakota (2000), Pintus and Wen (2013), Kaas, Pintus and Ray (2016), by considering a two-country model. The reason why self-fulfilling equilibria arise in our two-country model is essentially similar to that detailed in the closed-economy version studied in Pintus, Wen and Xing (2016). Both our papers build upon and extend the seminal analysis in Benhabib and Farmer (1994) on self-fulfilling equilibria in standard business-cycle theory by introducing credit market frictions and global financial linkages. In addition, we use the technique proposed by Farmer, Khramov and Nicolò (2015) to solve for the model with local indeterminacy.

Our emphasis on global financial linkages in explaining international co-movements accords with the existence of a global financial cycle documented in particular by Rey (2013), Miranda-Agrippino and Rey (2015), in addition to the studies using dynamic factor analysis reviewed above. Differently, earlier explanations of international co-movements rely on productivity shocks that are highly correlated across countries, as in Backus and Kehoe (1992), Backus, Kehoe, and Kydland (1995). More recently, Kollman (2018) shows in a complete-market two-country model with Epstein-Zin-Weil preferences and a muted wealth effect that country-specific productivity shocks generate synchronized business cycles. In contrast, the recent evidence and our paper put international financial markets at the center stage to explain how financial spill-over effects help synchronize business cycles across countries.

2 Two-Country Model

The world economy is divided into two countries, home and foreign, that are each composed of households/lenders and entrepreneurs/borrowers. We assume that installed capital, land and labor are internationally immobile. To save space, we report below the problems faced by each agent in the home country only, given that the foreign country has an identical structure. All variables with upper index "$*$" are related to the foreign economy while variables without refer to the home country.

Production technology is given, in each period t, by

$$Y_t = A_t K_t^{\alpha} L_t^{\gamma} N_t^{1-\alpha-\gamma} \tag{1}$$

where K_t denotes capital, L_t is land, and N_t is worked hours. Total land supply is fixed and given by $\bar{L}$, with country-specific price Q_t.

The entrepreneur, who takes care of production, hires labor in the domestic market with wage rate W_t, and accumulates both productive capital and productive land. He participates in an international bond market where a one-period bond is exchanged, which earns the gross rate R^w_{t+1} that will be realized at date $t+1$. Under the assumption that the entrepreneur is more impatient than the household, he turns out to be a borrower near steady state. The entrepreneur's bond demand is denoted by B_{et+1}.[1] Finally, the entrepreneur enjoys consuming C_{et} in each period. The borrowing firm solves the following problem:

$$\max_{\{C_{et},K_{t+1},L_{et+1},B_{et+1},N_t\}_{t=0}^{\infty}} E_0\left[\sum_{t=0}^{\infty}\beta_e^t \frac{C_{et}^{1-\sigma_b}}{1-\sigma_b}\right]$$

under the budget constraint:

$$C_{et} + K_{t+1} - (1-\delta)K_t + Q_t(L_{et+1} - L_{et}) + R^w_t B_{et} \leq B_{et+1} + Y_t - W_t N_t \tag{2}$$

as well as the collateral constraint:

$$E_t[R^w_{t+1}]B_{et+1} \leq \Theta_t E_t[Q_{t+1}]L_{et+1} \tag{3}$$

which says that expected debt repayment cannot exceed a fraction Θ_t of the market value of land that is expected to materialize next period.

Denoting Λ_{et} and Φ_{et} the Lagrange multipliers associated to firm's budget constraint (2) and collateral constraint (3), respectively, the following set of equations gives the firm's first-order conditions for interior solutions:

$$C_{et}^{-\sigma_b} = \Lambda_{et} \tag{4}$$

$$\Lambda_{et}Q_t = \Phi_{et}\Theta_t E_t[Q_{t+1}] + \beta_e E_t\left[\Lambda_{et+1}\left(\gamma\frac{Y_{t+1}}{L_{et+1}} + Q_{t+1}\right)\right] \tag{5}$$

$$\Lambda_{et} = \beta_e E_t\left[\Lambda_{et+1}\left(\alpha\frac{Y_{t+1}}{K_{t+1}} + 1 - \delta\right)\right] \tag{6}$$

$$\Lambda_{et} = \beta_e E_t[\Lambda_{et+1}R^w_{t+1}] + \Phi_{et}E_t[R^w_{t+1}] \tag{7}$$

$$W_t = (1-\alpha-\gamma)\frac{Y_t}{N_t} \tag{8}$$

Each country also has a representative household, who derives utility from consumption C_{ht} and land holding L_{ht}. The household supplies labor N_t, which entails some loss in utility. She supplies labor to domestic market and has access to the international bond market so as to transfer consumption across time. Household's demand for international bonds is given by B_{ht+1}.

Because the household is more patient than the entrepreneur in each country (that is, $\beta_h > \beta_e$), she acts as a lender and solves:

$$\max_{\{C_{ht},L_{ht+1},B_{ht+1},N_t\}_{t=0}^{\infty}} E_0\left[\sum_{t=0}^{\infty}\beta_h^t\left(\frac{C_{ht}^{1-\sigma_l}}{1-\sigma_l} + \psi\frac{L_{ht}^{1-\sigma_w}}{1-\sigma_w} - \zeta\frac{N_t^{1+\eta}}{1+\eta}\right)\right]$$

[1] To be parsimonious, we uses indices h and e only for variables that differ across households and entrepreneurs in equilibrium. For example, since production comes from entrepreneurs only, Y_t is not indexed by "e". Similarly, N_t refers to hours worked in equilibrium.

subject to the budget constraint:

$$C_{ht} + Q_t(L_{ht+1} - L_{ht}) + B_{ht+1} + \frac{\phi}{2}(B_{ht+1} - B_{et+1})^2 \leq R_t^w B_{ht} + W_t N_t \tag{9}$$

Note that land enters the household's utility, and in his budget constraint (9) there appears a quadratic adjustment cost, the size of which is parameterized by ϕ. This quadratic cost is expressed in terms of the net foreign asset position (or surplus), which we will denote by $S_t = B_{ht} - B_{et}$. Whenever S_t is positive (negative), this means that the home economy is lending to (borrowing from) the foreign economy. Of course, in that case the foreign counterpart S_t^* is negative (positive). Similarly, if the deviation of S_t from steady state is positive (negative), then either the home country's lending goes up (down) or its borrowing goes down (up). The response of the foreign economy's net foreign asset position is again the mirror image of the home economy's.

The main reason we include a quadratic cost in terms of the net foreign asset position is to make the model stationary. Absent this cost (that is, if $\phi = 0$), the model's dynamic system has a unit root which comes from the fact that the steady-state net foreign asset position in each country is indeterminate. In such a case, the model determines only the world demand for bonds but not how it is split between countries. A unit root in our two-country setting is neither new nor surprising since there is only one world interest rate that equalizes the demand and supply of bonds at the world level, not within countries. A similar picture arises in the two-country model of, e.g., Baxter and Crucini (1995). We set $\phi = 0.0001$ throughout, so that the quadratic cost is negligible for all practical purposes.

Therefore, the household's first-order conditions are given, assuming interior solutions, by:

$$C_{ht}^{-\sigma_l} = \Lambda_{ht} \tag{10}$$

$$\Lambda_{ht} Q_t = \beta_h E_t[\psi L_{ht+1}^{-\sigma_w} + \Lambda_{ht+1} Q_{t+1}] \tag{11}$$

$$\Lambda_{ht}[1 + \phi(B_{ht+1} - B_{et+1})] = \beta_h E_t[\Lambda_{ht+1} R_{t+1}^w] \tag{12}$$

$$\Lambda_{ht} W_t = \zeta N_t^{\eta} \tag{13}$$

where Λ_{ht} is the Lagrange multiplier associated to the budget constraint (9). Note that the first-order condition with respect to international bond demand, that is, equation (12), also holds in the foreign country. This implies, because the world interest rate is common in both country, that a unit root arises in the dynamics of the ratio of home and foreign consumptions when there is no cost of holding a nonzero foreign asset position (that is, when $\phi = 0$).[2]

Given that:

$$S_{t+1} \equiv B_{ht+1} - B_{et+1} \tag{14}$$

[2] To see this, set $\phi = 0$ and log-linearize equation (12) as well as its foreign analog around steady state, which gives $c_{ht} - c_{ht}^* = E_t[c_{ht+1} - c_{ht+1}]^*$, where c_{ht} denotes the deviation of $\log C_{ht}$ from steady state.

national net exports are then:

$$X_t \equiv Y_t - C_{ht} - C_{et} - I_t - \frac{\phi}{2} S_{t+1}^2 \tag{15}$$

The above definitions and relations apply to the foreign country symmetrically.

The market clearing condition for land is:

$$\bar{L} = L_{et+1} + L_{ht+1}. \tag{16}$$

In addition, the international debt market clears when

$$B_{ht+1} + B_{ht+1}^* = B_{et+1} + B_{et+1}^*, \tag{17}$$

or equivalently $S_{t+1} + S_{t+1}^* = 0$, while Walras' Law implies that the world output market clears as well, that is:

$$C_{et} + C_{ht} + C_{et}^* + C_{ht}^* + \frac{1}{2}\phi (B_{ht+1} - B_{et+1})^2 + \frac{1}{2}\phi^* (B_{ht+1}^* - B_{et+1}^*)^2 + I_t + I_t^* = Y_t + Y_t^*$$

where $I_t = K_{t+1} - (1-\delta)K_t$ denotes investment net of capital depreciation. This also implies that net exports are equal to the current account (that is, $S_{t+1} - S_t$ minus the interest income from the net foreign asset position $(R_t^w - 1)S_t$), i.e.

$$X_t = S_{t+1} - R_t^w S_t = -(S_{t+1}^* - R_t^w S_t^*) = -X_t^*. \tag{18}$$

The equilibrium allocation is described by the set of variables:

$$\{Y_t, C_{et}, C_{ht}, L_{et}, L_{ht}, K_t, B_{et}, B_{ht}, S_t, X_t, N_t, \Lambda_{et}, \Lambda_{ht}, \Phi_{et}, Q_t, W_t\}_{t=0}^{\infty}$$

for home and

$$\{Y_t^*, C_{et}^*, C_{ht}^*, L_{et}^*, L_{ht}^*, K_t^*, B_{et}^*, B_{ht}^*, S_t^*, X_t^*, N_t^*, \Lambda_{et}^*, \Lambda_{ht}^*, \Phi_{et}^*, Q_t^*, W_t^*\}_{t=0}^{\infty}$$

for foreign, while $\{R_t^w\}_{t=0}^{\infty}$ is the world interest rate. Those 33 variables solve home and foreign versions of equations (1)-(16) and the international debt market clearing condition (17).

3 International Business Cycles

The purpose of this section is to contrast the impulse responses arising under country-specific (fundamental) shocks and under global (expectation-driven) interest rate shocks. More specifically, we assume that country-specific shocks happen under two guises. The home country experiences a positive shock to either TFP (A) or the loan repayment-to-value ratio (Θ, leverage for short), where both variables are assumed to follow an $AR(1)$ process with auto-correlation set to 0.95 for the sake of illustration. Notice that these two shocks to the home country have no direct (spill-over) effect on the foreign economy by construction (that is, they are not correlated across countries).

In contrast, we define a global sunspot shock as a self-fulfilling one-time reduction in the world interest rate (R), which by definition means that the cost of borrowing internationally goes down for both home and foreign firms.[3] Importantly, even though the shock to the world interest rate has no exogenous persistence, the model generates endogenous persistence that is commensurate with that under persistent fundamental shocks.

A second dimension of our simulation exercises is that we compare symmetric and asymmetric countries. In the former case, both the home and the foreign economies share the exact same parameter values, that we report in Table 1. In the asymmetric case, we simply assume that the collateral constraint is tighter in the foreign economy that is otherwise similar to the home economy, and we report the impulse responses to country-specific and global shocks.

The main lesson to draw from this section is that global sunspot shocks channeled through the international credit market are much more conducive to co-movement across countries than country-specific shocks. This is because country-specific shocks that trigger an expansion in the home economy also raise the world interest rate, which adversely affects the foreign economy. In contrast, worldwide expectations of a falling interest rate generate an expansion in both regions of the world, which then co-move.

3.1 Symmetric Countries

Our benchmark calibration for the home economy appears in Table 1. In this section, we focus on the case where the foreign economy's parameters are also given by values reported in Table 1 and the countries are said to be symmetric.

Table 1: Parameter Values

α	γ	δ	β_h	β_e	σ_l	σ_w	σ_b	ψ	η	ζ	ϕ	$\bar{L}$	A	Θ
0.4	0.05	0.025	0.99	0.98	1	1	1	1	10	1	0.0001	1	1	0.8

Many parameter values in Table 1 are standard for a quarterly calibration. The share of capital is set to 0.4 while the share of land equals 0.05, which together imply that the share of labor income is 0.55. Capital depreciation is set to 2.5% while the quarterly interest rate equals 1%, given that

[3] As in Pintus, Wen and Xing (2016), today's interest rate is not uniquely pinned down and there is one-dimensional indeterminacy. Such indeterminacy comes from the fact that loans feature a variable rate. The model is solved by using the technique proposed by Farmer, Khramov and Nicolò (2015), which entails a "fundamental" forecast error ε_t such that $R_t^w = E_{t-1}R_t^w + \varepsilon_t$.

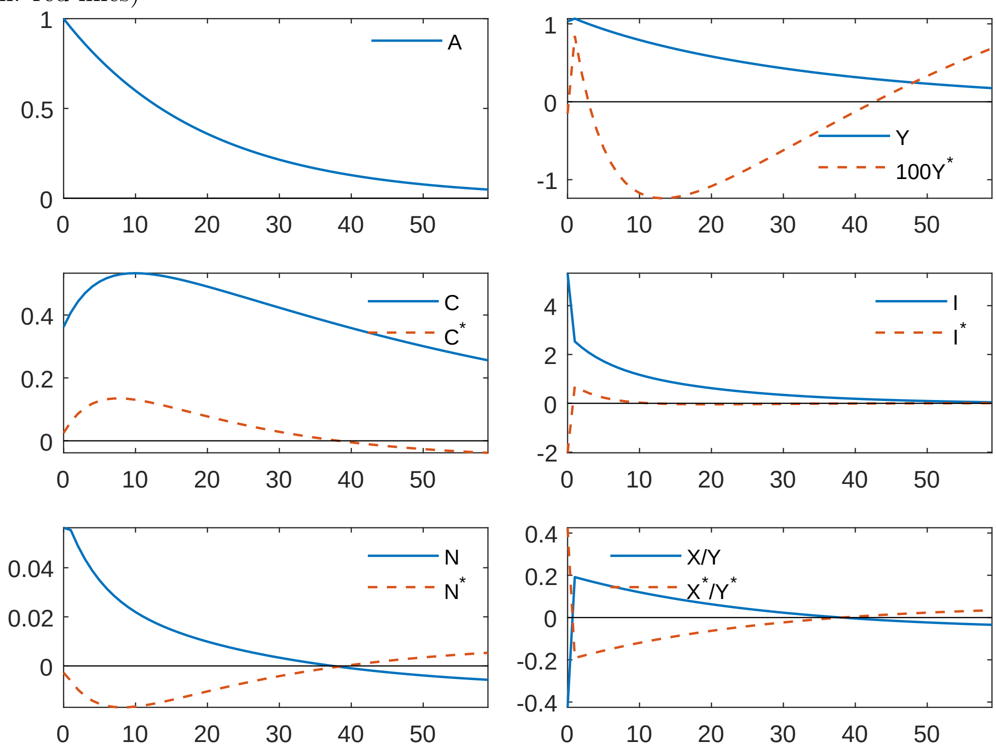
$\beta_h = 0.99$. In addition, the borrower is only moderately more impatient than the lender, with $\beta_e = 0.98$. We focus on log utility and assume that the Frisch elasticity of labor supply is 0.1, in agreement with many micro studies. Finally, the loan repayment to value ratio Θ is set at 0.8, which means that the entrepreneur is able to borrow up to 80% of the market value of his land holdings.

Responses to Country-Specific Shocks.

We show first that country-specific shocks (either a positive TFP shock or a relaxation of the borrowing constraint) cannot generate world-wide co-movements in all key variables. In the following graphs, the blue lines represent the home economy while the red lines denote the foreign responses.

When countries are symmetric, temporary country-specific TFP shocks have very persistent effects, as can be seen in Figure 1. Additional impulse-response functions (IRFs for short) are reported in Appendix 5.2, Figure 7. But the home and foreign economies do not co-move along some key variables, such as output, investment and labor.This is because the boom in the home economy generated by rising productivity raises the world interest, which adversely affect the foreign economy in the absence of technological spill-over effects. When the home entrepreneur benefits from

Figure 1: IRFs to a positive TFP shock in home economy – Symmetric countries (Home: blue lines; Foreign: red lines)



higher TFP, his demands for capital, land and labor go up, which in turn raises the price of land and the wage. The combination of a higher land price and of holding more land implies that the entrepreneur has more collateral, thus raising his demand for credit. In sum, because at home land is reallocated towards production, entrepreneurs accumulate more capital and households work harder, output goes up. A boom in household consumption also follows because of as strong income effect from a higher return on savings, just like what would happen in a closed economy. However, in our two-country setting, the home economy has access to a global credit market and the rise in home demand for international bonds pushes the interest rate up next period (see Figure 7 in Appendix 5.2).[4] In the foreign economy, the rise in tomorrow's interest rate generates a positive income effect on the household/lender. Being richer and facing a rising return on lending, the household consumes more, works less (which pushes the wage up), and lends more. In contrast, a rising interest rate and a rising wage both hurt the entrepreneur in the foreign economy, who cuts on investment and faces a decreasing labor supply. Therefore, output falls in the foreign economy.[5]

As a consequence, initially, part of the boom in the home economy is financed by the foreign economy since the home net foreign asset position goes down. This is consistent with the fact that financial resources initially flow into the home economy since it is more productive. However, pretty soon the home economy ends up with a trade surplus and a rising net foreign asset position. The reason is that while foreign households initially supply more loanable funds, this pattern is quickly reversed because both the wage income and the bond return overshoot their steady state levels. In terms of co-movement, consumptions in the home and foreign economies move in the same direction, at least during a few quarters after the positive TFP shock hits the home economy, both for households and for entrepreneurs. Similarly, land prices co-move across countries. However, national outputs, labor supplies and investment levels do not co-move.

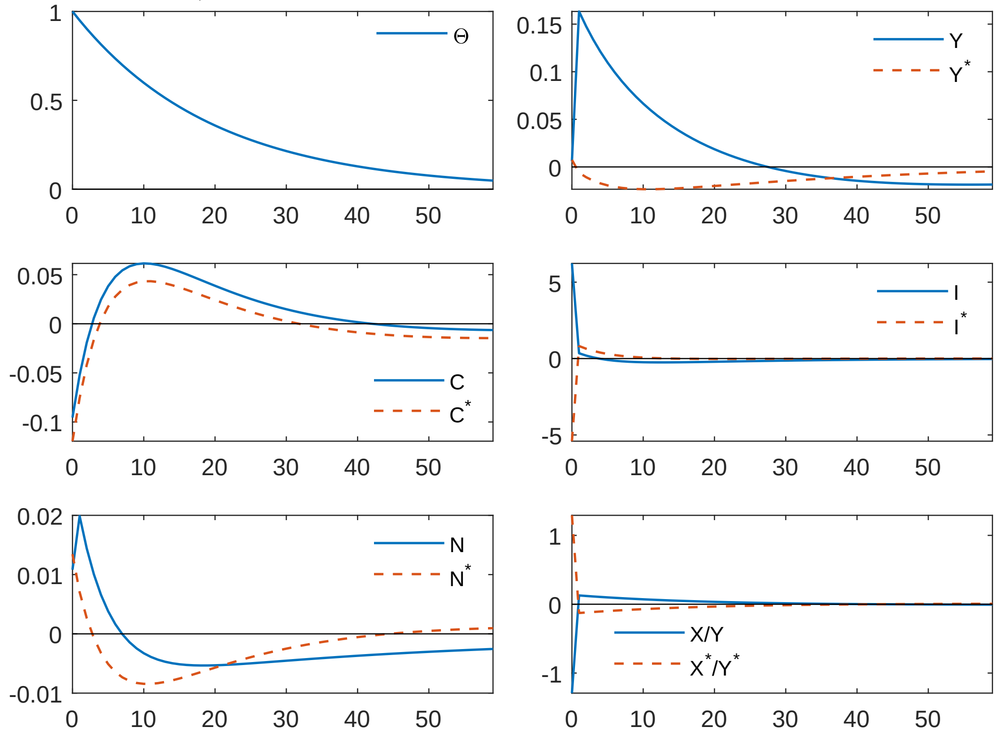
Similarly, when countries are structurally symmetric and the home economy benefits from a temporary relaxation of the collateral constraint, key variables do not co-move, as shown in Figure 2. Specifically, while consumptions move together across countries, just as the land price does, home and foreign outputs are negatively correlated. Essentially, when the collateral constraint is relaxed in the home economy, the entrepreneur borrows more and produces more. As in the case of a positive TFP shock, the associated credit boom in the home economy raises the world interest rate (see Figure 8 in Appendix 5.2). This again hurts the foreign economy. In contrast with the case of the TFP shock, however, labor supplies now co-move but wages move in opposite direction.[6]

[4] Note that because the interest rate is subject to belief shocks, it becomes predetermined and fundamental shocks affect today's expectations of tomorrow's interest rate.

[5] Note that because households are willing to lend more in the foreign economy, the land market adjusts and land is reallocated to the entrepreneur, just as in the home economy. As a consequence, a one-period boom in output materializes before a long-lasting recession in the foreign economy.

[6] Another difference is that the land price goes down at impact under a positive leverage shock, as shown in Figure 8 in Appendix 5.2. This is required because the supply of collateral goes up when Θ goes up.

Figure 2: IRFs to a positive leverage shock in home economy – Symmetric countries (Home: blue lines; Foreign: red lines)

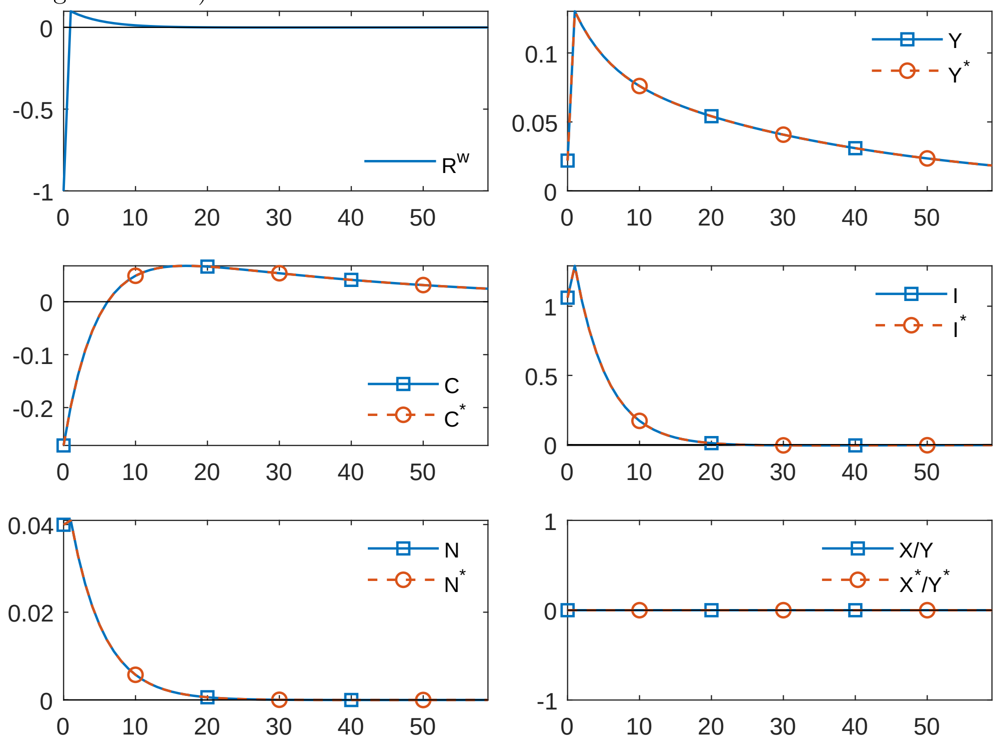


Responses to Global Interest Rate Shocks

In contrast to what happens under country-specific TFP or leverage shocks, the responses of the home and the foreign economies coincide under a sunspot shock to the world interest rate, as shown in Figure 3. In other words, all variables in the home and foreign economies co-move, except of course net foreign asset positions and net exports.

This is because a self-fulfilling reduction in the interest rate means that the cost of borrowing is lowered both for home firms as well as for foreign firms. As a consequence, the demand for loans by entrepreneurs goes up all around the world. Note that the supply of loans from households accommodate demand despite a fall in consumption — and an increase in labor supply — after impact because consumption goes up later. The resulting credit boom in both economies is accompanied by a reallocation of land away from households and towards entrepreneurs, which results in a declining land price (see Figure 9 in Appendix 5.2). Because entrepreneurs borrow more, they accumulate more land and capital and they also benefit from a larger labor supply. Therefore, output goes up in both countries by the same amount since countries are symmetric and face the same reduction in the world interest rate. Last but not least, notice that although the shock to the world interest rate has no built-in persistence, its propagation mechanism generates considerable persistence endogenously. In fact, the effect of an iid interest rate forecast error is at least as persistent as the effect of a highly

Figure 3: IRFs to a negative shock to the world interest rate – Symmetric countries (Home: blue lines; Foreign: red lines)



autocorrelated shock to TFP or leverage.

In addition, while the interest rate turns out to be counter-cyclical under sunspot shocks, as in the data, it is pro-cyclical under either TFP or leverage shocks. Note that when today's interest rate turns out to be lower than expected previously, both home and foreign firms expect a higher borrowing rate tomorrow starting tomorrow, as shown in Figure 3, which is required for lenders to be willing to extend credit today.

The main result from the IRFs reported in this section, therefore, is that country-specific shocks to TFP or leverage do not generate co-movement in output, investment and many other variables across economies. In contrast, global sunspot shocks to the world interest rate do.[7] This is further illustrated in Table 2, in which we report the cross-correlations obtained from stochastic simulations of the model under the three sources of disturbances.

[7]Note also that country-specific shocks generate a credit boom that is short lived in the foreign economy. As a result, cross-country correlation of debt is much weaker than under global interest rate shocks.

Table 2: International correlations between symmetric countries (based on simulations for 10000 periods)

Shock	corr(Y, Y^*)	corr(C, C^*)	corr(I, I^*)	corr(N, N^*)
Home TPF	-0.10	0.25	-0.28	-0.81
Home leverage	-0.48	0.88	-0.94	0.48
Global interest rate	1.00	1.00	1.00	1.00

3.2 Asymmetric Countries

In this subsection, we assume that countries have different Θ's in steady state, thus reflecting different levels of *internal* financial development, that are however not too dissimilar (think about two developed economies). More precisely, countries are now asymmetric and while the home economy's parameters are still given by Table 1 (with in particular $\Theta = 0.8$), the foreign economy's $\Theta^* = 0.6$. In other words, foreign firms face a tighter borrowing constraint. Note that in the graphs reported below, the blue lines represent the home responses while the red lines denote the foreign responses.

Responses to Country-Specific Shocks

The IRFs to a positive TFP shock hitting the home economy, reported in Figure 4, do not differ much from those in the symmetric case (see Figure 1). Differently though, the recession in the foreign economy is now more brutal and more persistent. See Figure 10 in Appendix 5.3 for IRFs of additional variables. Similarly for responses to a positive leverage shock in the home economy (contrast Figure 5 with Figure 2): the recession in the foreign economy is more brutal (see also Figure 11 in Appendix 5.3). In a nutshell, country-specific shocks do not make all key variables in both economies to co-move, especially for output and investment, when countries are asymmetric. This turns out to be the case despite the fact that, at impact, a credit boom happens simultaneously at home and in the foreign economy.

Figure 4: IRFs to a positive TFP shock in home economy – Asymmetric countries (Home: blue lines; Foreign: red lines)

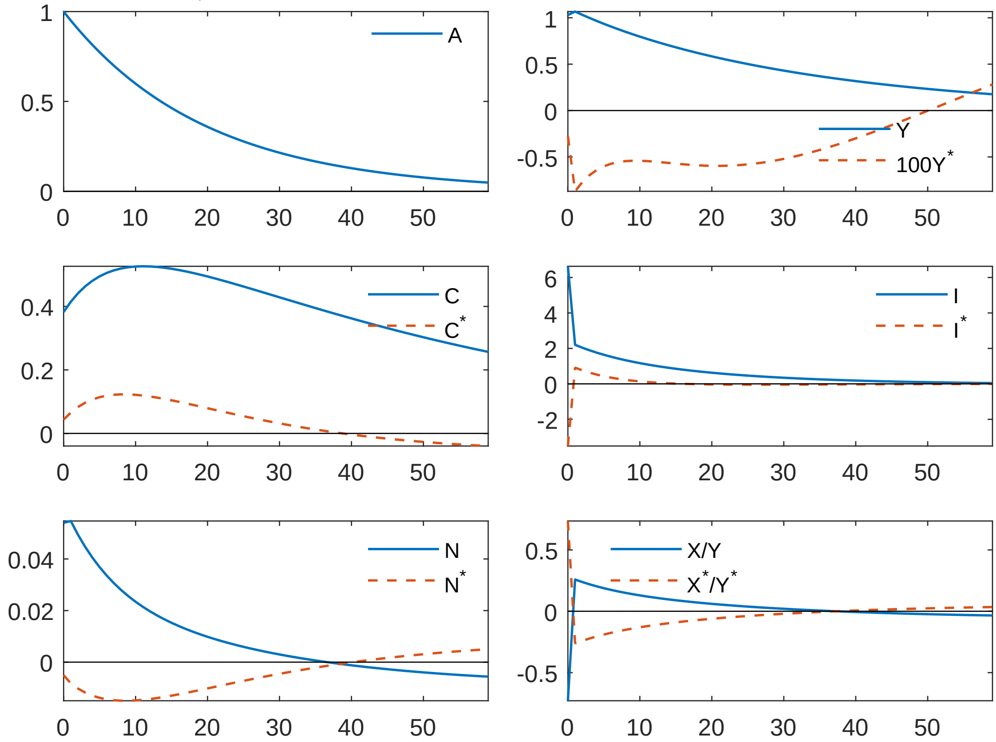
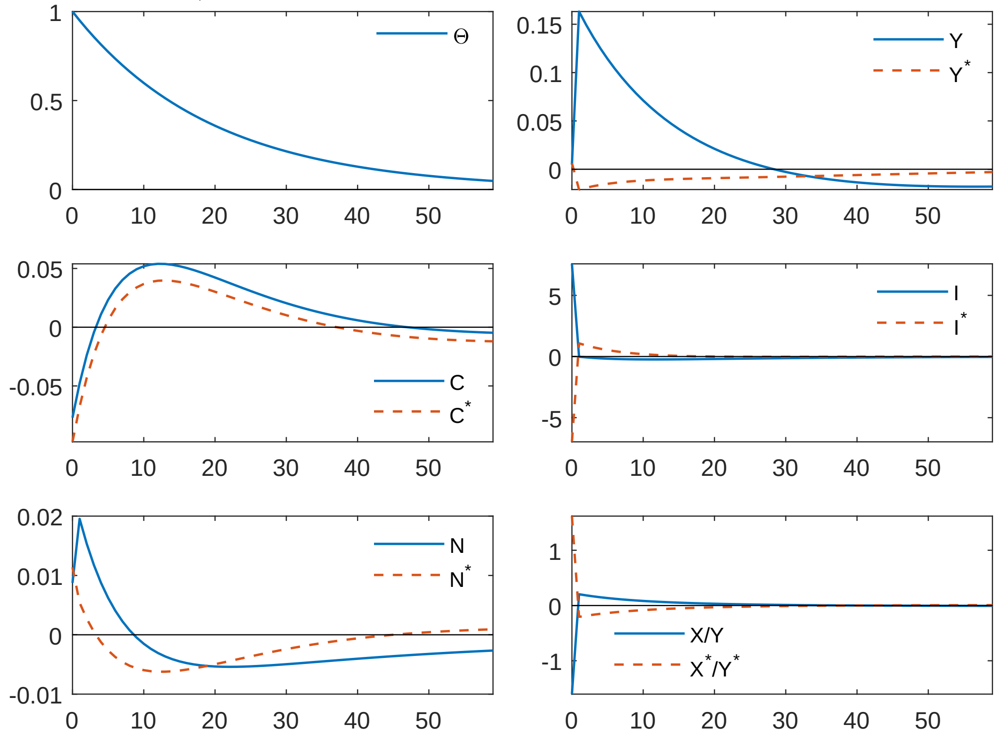
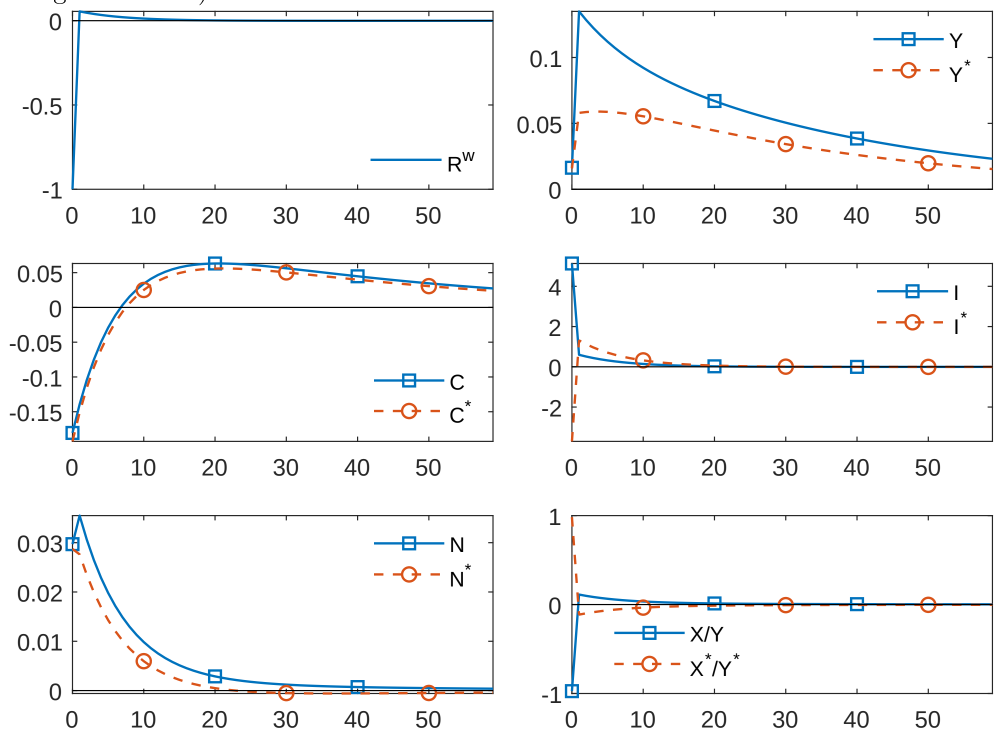


Figure 5: IRFs to a positive leverage shock in home economy – Asymmetric countries (Home: blue lines; Foreign: red lines)



Responses to Global Interest Rate Shocks

Figure 6: IRFs to a negative shock to the world interest rate – Asymmetric countries (Home: blue lines; Foreign: red lines)



As in the symmetric case, both countries still co-move when they are asymmetric, albeit not perfectly now (see Figure 6). More specifically, after the world interest rate falls, the responses of almost all variables are larger in the home economy since it is now more leveraged than the foreign country. This implies that financial amplification is more pronounced at home, compared to abroad. As a consequence, home's output goes up by more than the foreign's. On the other hand, the responses of land price, household's consumption, land holdings are almost indistinguishable. An important difference with the symmetric case, though, is that the more leveraged home economy reduces its net foreign asset position by importing financial resources from abroad. As a consequence, the foreign's capital stock goes down at impact, even though investment booms in a persistent way later on, just as in the home economy. With countries that have different levels of financial development, therefore, a reduction in the world interest rate will create credit booms that materialize simultaneously around the world, the effects of which are more pronounced in a more leveraged economy. See also Figure 12 in Appendix 5.3.

In Table 3 we report the cross-correlations for the case of asymmetric countries. Note that under TFP and interest rate shocks, the correlation of investment across countries is negative due to the responses at impact but becomes positive after. This suggests that investment adjustment costs would improve the model.

Table 3: International correlations between asymmetric countries (based on simulation for 10000 periods)

Shock	corr(Y, Y^*)	corr(C, C^*)	corr(I, I^*)	corr(N, N^*)
Home TPF	-0.12	0.22	-0.43	-0.81
Home leverage	-0.70	0.90	-0.96	0.42
Global interest rate	0.99	0.99	-0.67	0.98

4 Conclusion

The contribution of this paper is twofold. First we show that self-fulfilling equilibria occur in a two-country setting where in each country firms can borrow internationally from households, subject to a collateral constraint. Co-movement happens because a lowered interest rate generates credit booms in all countries connected to the world financial market. Because more credit allows firms to expand their scale of operations, a credit boom in each country translates into booming output, investment, consumption, and hours worked. Thus global financial linkages create international synchronization and financial development means that national economies that are open to cross-border credit flows tend to co-move. In contrast, country-specific shocks to either TFP or to leverage lead to reallocation of world credit resources from one country to another, and as a consequence the home and foreign outputs do not co-move, while consumptions do because of international risk-sharing. Second, we show that the model with countries that differ in their levels of financial development can shed light on the reasons why developed economies are not perfectly synchronized.

While in this paper we modestly report qualitative results, a promising avenue for research would be to consider a seriously calibrated version of the model. We believe that the setting outlined in this paper has interesting predictions regarding why developed countries tend to co-move, while they are much less synchronized with developing countries. For example, it seems sensible to investigate the pressing issue of global imbalances, for example between the US and China, through the lens of our stylized model. One important aspect of the results reported above is that net foreign asset positions and trade surpluses can be quite persistent even if short-run variations in the world interest rate are not. This implies, theoretically, that the effects of financial globalization on business-cycle synchronization depend on the level of financial development within countries, in line with recent empirical evidence.

5 Appendix

5.1 Steady state

Households' Euler equations in both home and foreign countries imply that in the steady state

$$1 + \phi(B_h - B_e) = \beta_h R^w = 1 + \phi(B_h^* - B_e^*), \tag{19}$$

which implies

$$S = B_h - B_e = B_h^* - B_e^* = S^* = 0 \tag{20}$$

So the steady state is characterized by autarky. Then the Euler equations imply that

$$R^w = \frac{1}{\beta_h} \tag{21}$$

Define lower case variables as $x \equiv \frac{X}{Y}$, i.e. the X-output ratio. The other equations imply the following conditions:

$$\Phi = (\beta_h - \beta_e)\Lambda \tag{22}$$

$$Q = \xi \frac{Y}{L_e} \tag{23}$$

$$\xi = \frac{\beta\gamma}{1 - (\Theta\beta_h + (1-\Theta)\beta)} \tag{24}$$

$$Q = \frac{\beta_h \psi c_h^{\sigma_l} Y^{\sigma_l}}{(1-\beta_h)(\bar{L} - L_e)^{\sigma_w}} \tag{25}$$

$$b_e = \beta_h \Theta \xi \tag{26}$$

$$k = \frac{\alpha\beta}{1 - \beta(1-\delta)} \tag{27}$$

$$WN = (1 - \alpha - \gamma)Y \tag{28}$$

$$c_e = \alpha + \gamma - \delta k - (R^w - 1)b_e \tag{29}$$

$$c_h = (R^w - 1)b_e + 1 - \alpha - \gamma \tag{30}$$

$$\Lambda_h = C_h^{-\sigma_l} \tag{31}$$

$$N = \left(\frac{(1-\alpha-\gamma)Y^{1-\sigma_l}}{\zeta c_h^{\sigma_l}} \right)^{\frac{1}{1+\eta}} \tag{32}$$

$$L_e = A^{-\frac{1}{\gamma}} k^{-\frac{\alpha}{\gamma}} \left(\frac{1-\alpha-\gamma}{\zeta} \right)^{-\frac{1-\alpha-\gamma}{\gamma}\frac{1}{1+\eta}} c_h^{\frac{1-\alpha-\gamma}{\gamma}\frac{\sigma_l}{1+\eta}} Y^{\frac{1-\alpha-\gamma}{\gamma}\frac{\sigma_l+\eta}{1+\eta}+1} \tag{33}$$

We can solve the steady state Y after plugging L_e and c_h into the following nonlinear equation:

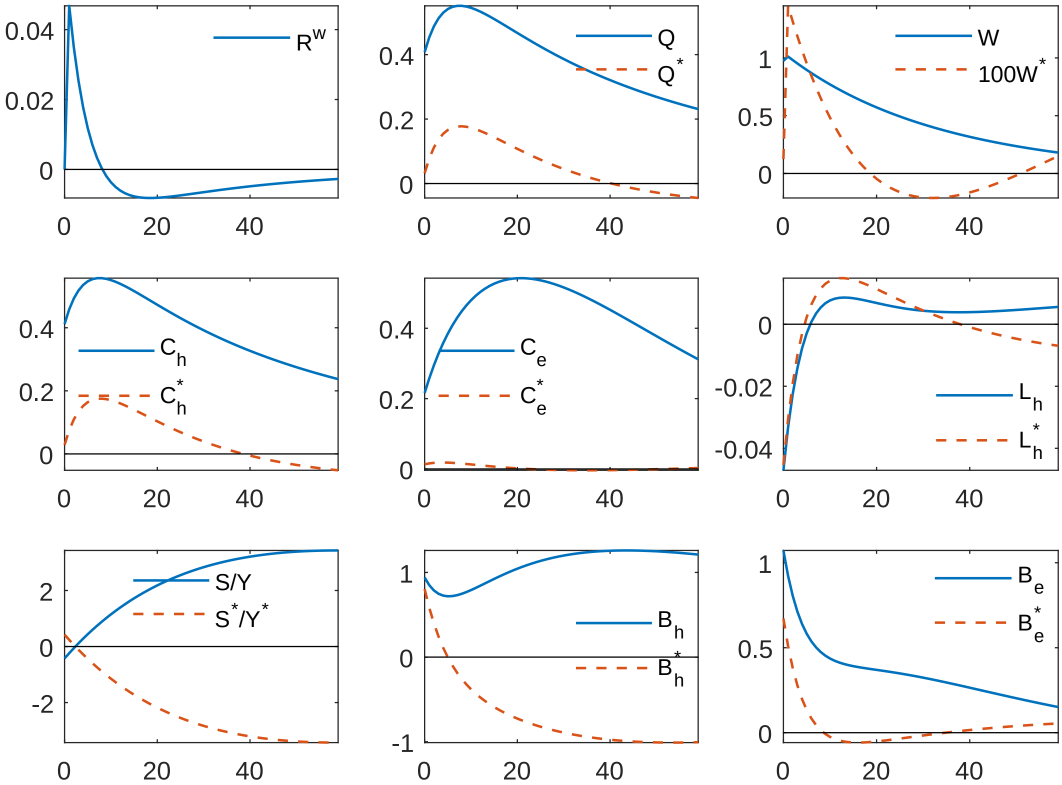
$$\frac{\beta_h \psi c_h^{\sigma_l} Y^{\sigma_l}}{(1-\beta_h)(\bar{L} - L_e)^{\sigma_w}} = \xi \frac{Y}{L_e} \tag{34}$$

After solving for Y, other variables can be solved using the above explicit expressions. The steady state variables of the foreign country can be solved following the same procedures.

5.2 Symmetric Countries: Additional IRFs

In Figures 7-9 are reported IRFs for the case of symmetric countries, which extend those in Figures 1-3. Note that in all graphs reported below, the blue lines represent the home responses, the red dashed lines denote the foreign responses.

Figure 7: IRFs to a positive TFP shock in home economy – Symmetric countries



5.3 Asymmetric Countries: Additional IRFs

In Figures 10-12, we now report IRFs for the case of asymmetric countries, to complement those in Figures 4-6. Note that in all graphs reported below, the blue lines represent the home responses, the red dashed lines denote the foreign responses.

Figure 8: IRFs to a positive leverage shock in home economy – Symmetric countries

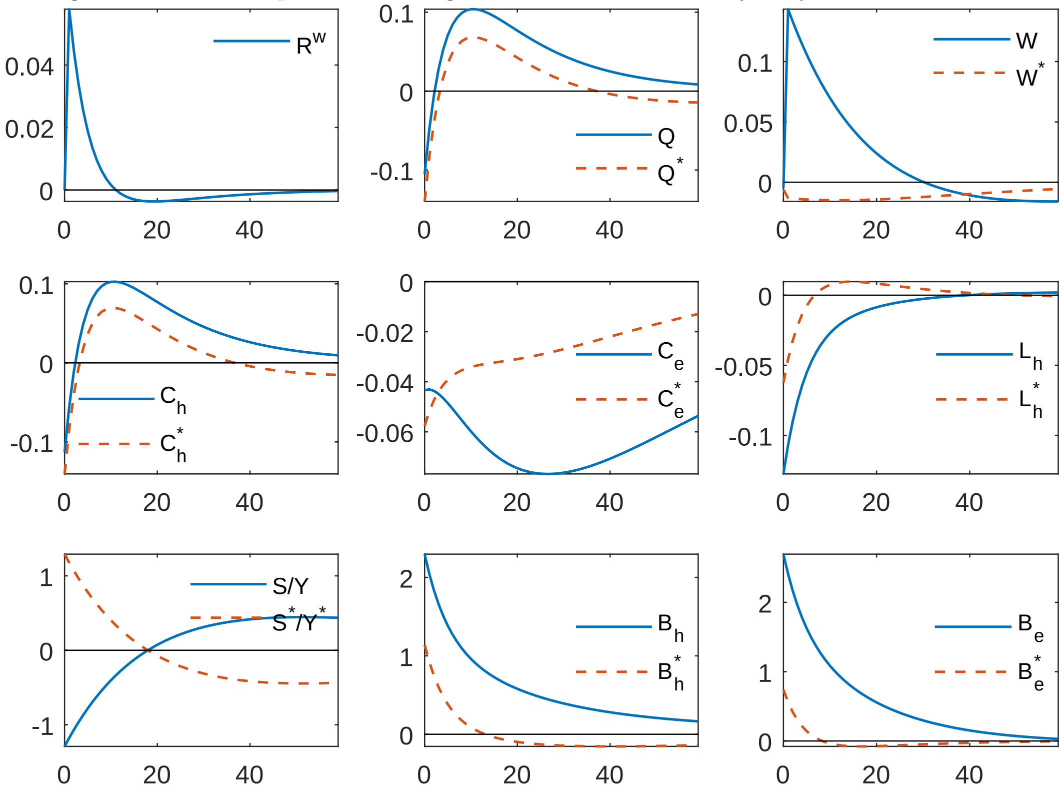


Figure 9: IRFs to a negative shock to the world interest rate – Symmetric countries

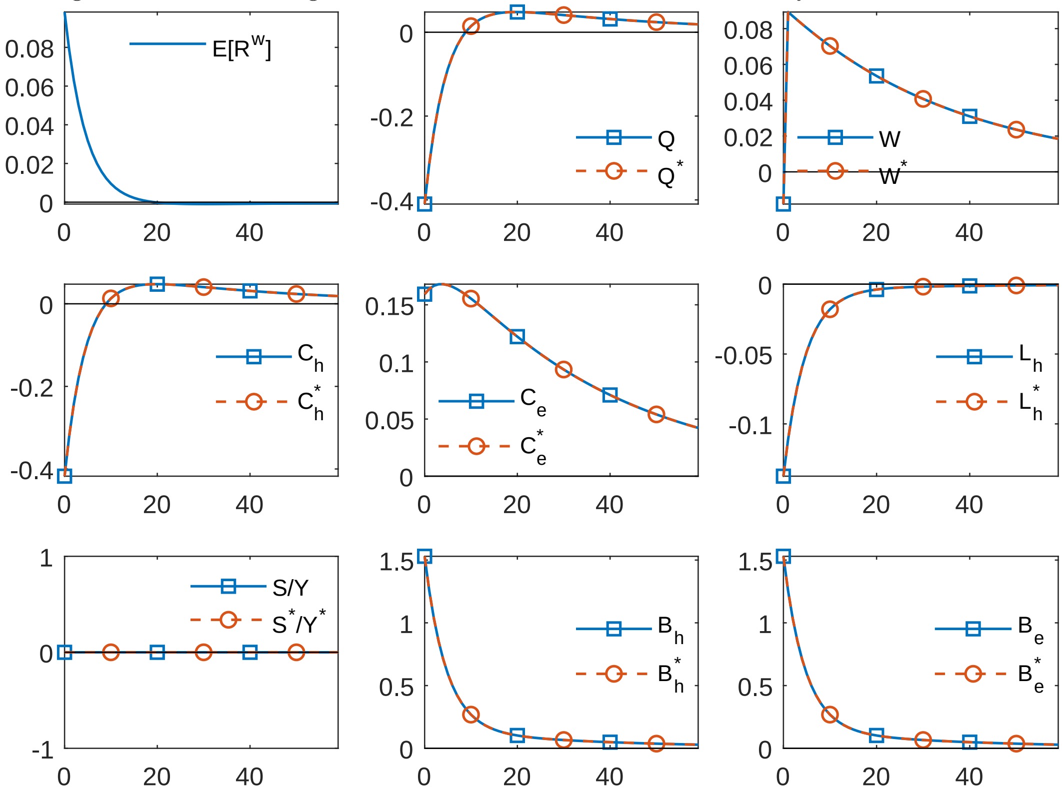


Figure 10: IRFs to a positive TFP shock in home economy – Asymmetric countries

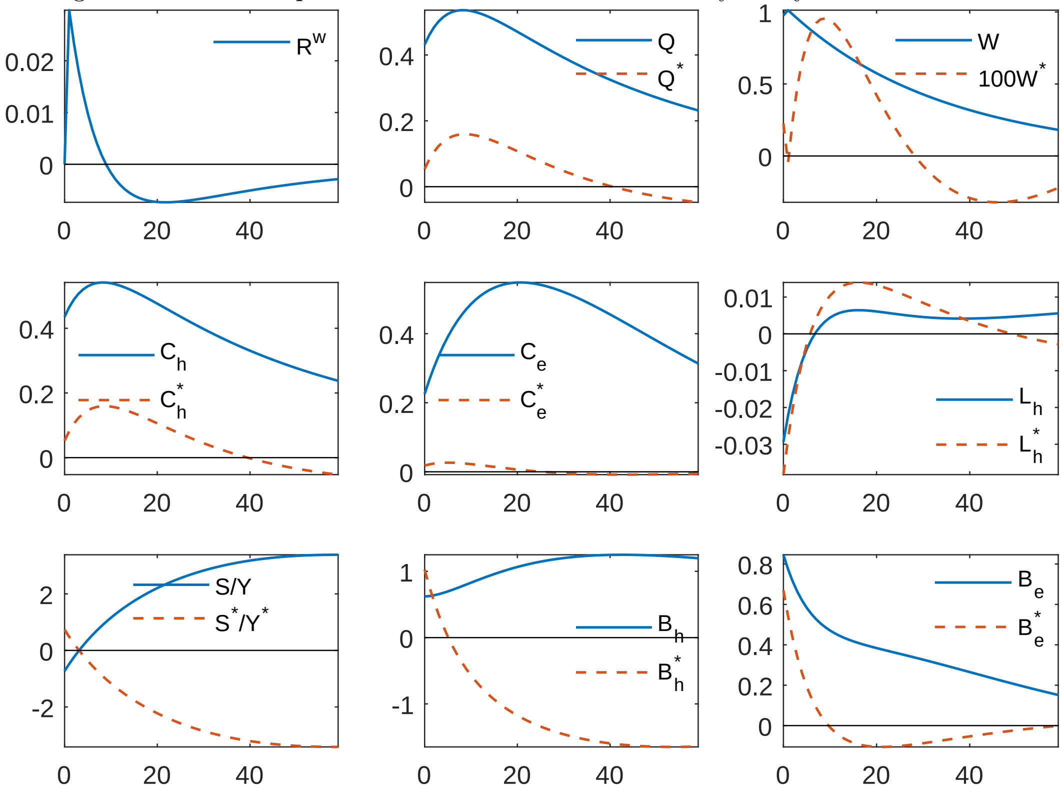


Figure 11: IRFs to a positive leverage shock in home economy – Asymmetric countries

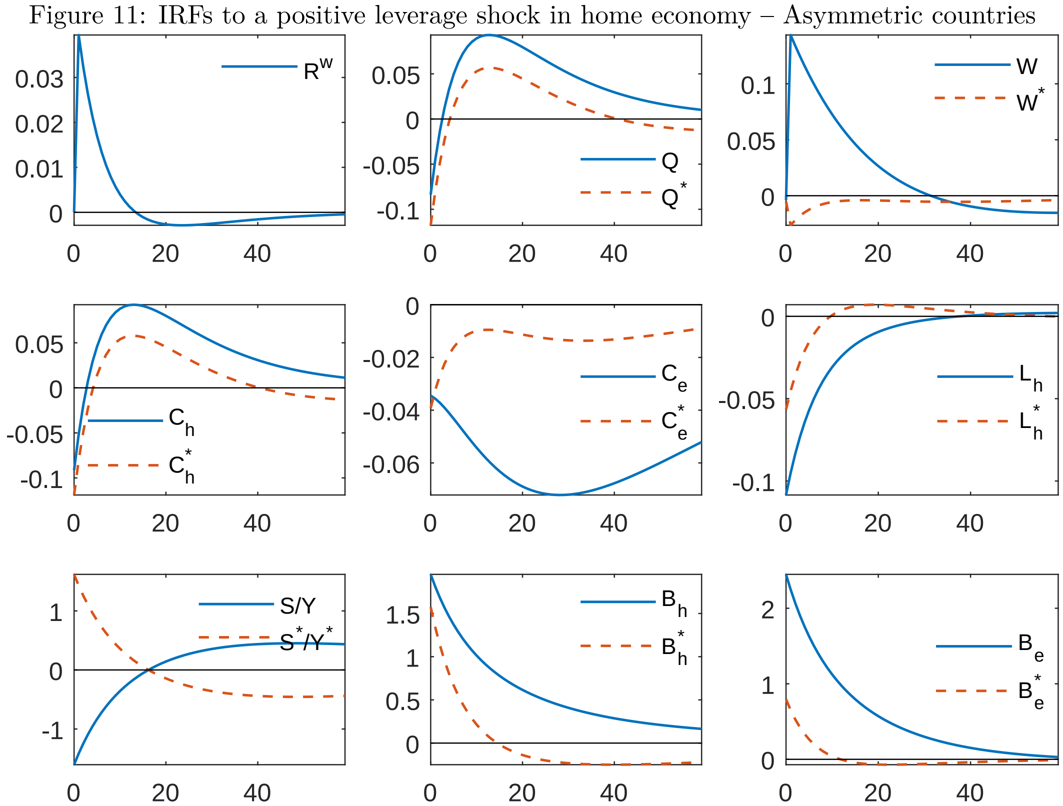
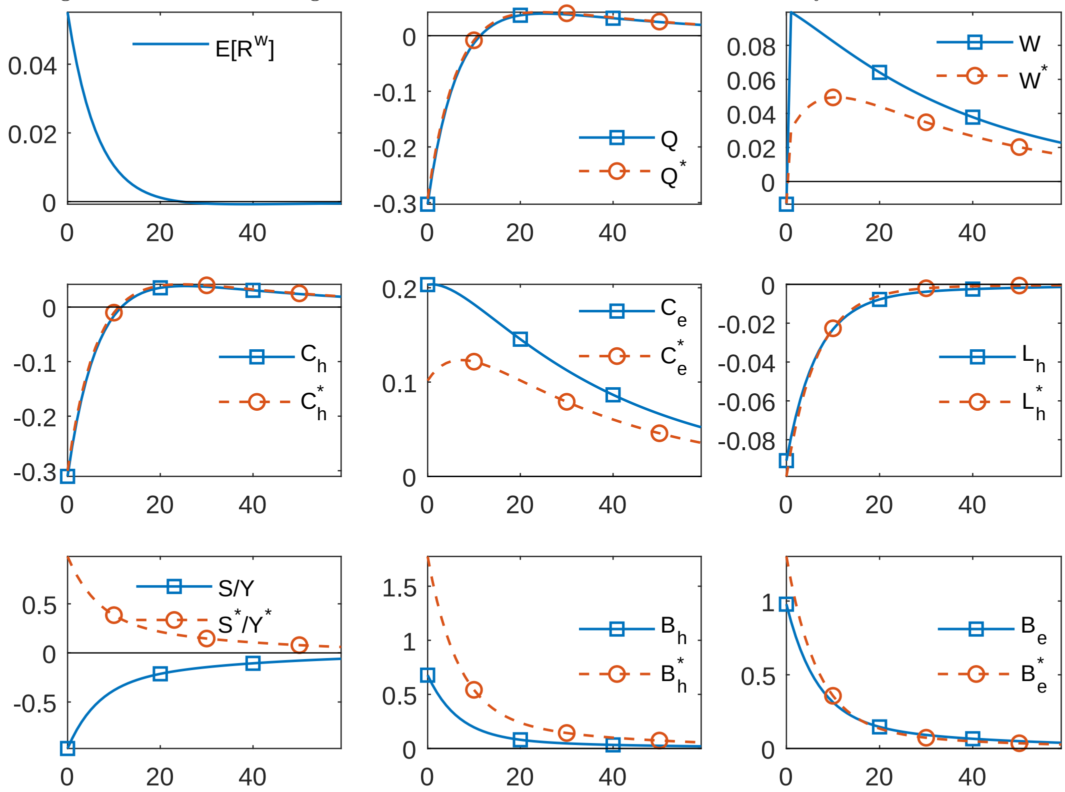


Figure 12: IRFs to a negative shock to the world interest rate – Asymmetric countries



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