

Domestic and Foreign Lenders and International Business Cycles*

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Abstract

We examine the international transmission of business cycles in a two-country model in which credit contracts are imperfectly enforceable. In our economy, foreign lenders differ from domestic lenders in their ability to recover value from borrowers' assets and, therefore, to protect themselves against contractual non-enforceability. The relative importance of domestic and foreign credit frictions changes over the cycle. This induces entrepreneurs to adjust their debt exposure and allocation of collateral between domestic and foreign lenders in response to exogenous productivity shocks. We show that such a model can explain the positive correlation of output fluctuations across countries. The model also appears consistent with econometric evidence on asset values and domestic and foreign debt exposure. (JEL classification: E44, F34, F41)

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1. Introduction

The importance of credit market imperfections in explaining business fluctuations has been the object of analysis of a large literature in the last two decades. More recently, a number of studies have analyzed open economy models with financial frictions, finding that these models can go in the right direction in explaining the international transmission of business cycles (e.g. Kehoe and Perri, 2002, Baxter and Crucini, 1995, and the papers cited below). One shortcoming of these studies is that they are silent on the different importance that credit imperfections can have according to the nature - domestic and foreign - of lenders. Since credit imperfections are thought to stem from lack of information of lenders on borrowers, it appears reasonable that these imperfections differ according to the origin of the lenders. In fact, foreign lenders are likely to have limited experience of local firms and laws, presumably because of a short history in lending to local firms.¹ More importantly, once we tie credit imperfections to the nature of the lenders, it is plausible that the *relative* importance of foreign versus domestic imperfections changes over the cycle. In fact, the absolute importance of credit imperfections depends on aggregate variables; and a change in aggregate variables is unlikely to leave unaffected the relative importance of credit imperfections.

In this paper we show how changes in the importance of foreign versus domestic credit imperfections and the resulting effects in the decision of domestic firms as to which lenders to choose (domestic or foreign) can explain important aspects of the international transmission of business cycles. In particular, we focus on the comovement of output across countries.² In the data, for instance, it is generally observed that following a positive shock to the productivity of a country,

¹Dell’Ariccia, Friedman and Marquez (1999) argue that banks that have been around longer may have a greater informational advantage if they have made loans to more borrowers than younger banks have.

²For extensive evidence on the nature of this comovement, see Canova and Marrinan (1998).

output in the country hit by the shock *and* abroad rise. Standard open economy RBC models (see e.g. Backus, Kehoe and Kydland, 1992) cannot replicate this pattern of the data: these models predict that when country F (foreign) is hit by a positive technology shock, output in country H (home) falls, especially as a result of a shift of resources towards the most productive economy.

We consider a two-country open economy model. In our model economy, entrepreneurs in both countries face restrictions in borrowing from domestic and foreign financiers, as in Gilchrist, Hairault and Kempf (2002) and Faia (2002). To this story, we add two new dimensions: *(i)* the relative importance of the credit frictions that entrepreneurs face in borrowing from domestic or foreign lenders changes endogenously over the cycle and *(ii)* entrepreneurs can adjust their relative debt exposure in order to maximize their borrowing capacity. In our model economy, entrepreneurs face a quantity borrowing constraint à-la Kiyotaki and Moore (1997), i.e. they cannot borrow more than the value of the hard assets (i.e., real estate) they can pledge as collateral. Lenders, on the other hand, face a transaction cost in liquidating the collateral of borrowers. This transaction cost can proxy for a cost in recovering collateral during bankruptcy procedures or in redeploying assets in the secondary market at the liquidation stage. The presence of this transaction cost prevents entrepreneurs from borrowing up to the full value of their hard assets. Crucially, the liquidation technologies of domestic and foreign lenders differ. Domestic lenders face a transaction cost that is proportional to the collateral value. Foreign lenders face diseconomies to scale in recovering and/or liquidating collateral: the fraction of collateral value they lose in liquidation increases as the collateral value increases. By assuming diseconomies to scale in their liquidation technology, we aim at capturing the idea that foreign lenders have probably less experience than domestic lenders in recovering borrowers' assets and less knowledge of their best alternative uses. Experience and knowledge, in other words, might represent a scarce local input such that, the higher is the value of the assets that foreign lenders recover and redeploy, the more their limited "liquidation ability"

becomes strained.³ In the paper, we elaborate on this feature of the model offering examples, providing empirical evidence and discussing related assumptions in the literature.

Our transmission mechanism works as follows. Suppose that, at some date t , the foreign economy experiences a favorable productivity shock: in the foreign and in the domestic economy the value of entrepreneurs' productive assets (including the collateralizable ones) rises.⁴ Consider next the domestic economy: the increase in the value of collateralizable assets increases the average transaction cost that foreign lenders are expected to face if they have to liquidate the collateral of domestic entrepreneurs. As a result, domestic entrepreneurs have the incentive to relocate their collateral from foreign towards domestic lenders as they try to maximize their debt capacity. In turn, the increase in the relative importance of domestic borrowing (increased autarky) is associated with the incentive to increase real estate demand. In fact, real estate has value as collateral especially vis-à-vis domestic lenders (since they can liquidate more efficiently, and more willing to supply credit for each unit of real estate pledged). This induces further pressure in the domestic asset market, leading to a further increase of asset prices. The increase in real estate holdings and prices spurs the average transaction cost faced by foreign lenders further, and so forth. Overall, since rises in asset prices and holdings of entrepreneurs relax their borrowing constraints, production in the domestic economy increases more in our model than in the traditional international RBC model.

A growing literature emphasizes the role of credit market imperfections in explaining some of the features of international business cycles that cannot be explained by frictionless RBC models. Backus, Kehoe and Kydland (1992), Baxter and Crucini (1995) and Heathcote and Perri (2002)

³Other local inputs that are limited for foreign lenders (e.g. personnel) can result into limited liquidation ability.

⁴The asset price comovement across countries derives directly from the propagation of the technological shock and indirectly from general equilibrium effects. This feature of the model is in common with other models on the financial accelerator in open economy (e.g. Gilchrist, Hairault and Kempf, 2002, and Faia, 2002).

make the extreme assumption of financial autarky, i.e. countries cannot trade financial assets. These papers find that restrictions in the type of financial assets that can be traded can account for the positive output correlation across countries by reducing international capital mobility. In the presence of financial autarky, when a positive productivity shock hits country F , resources cannot flow from country H to country F . Hence, the reduction in investment in country H is not as severe as the one that would occur with perfect capital markets. In these papers, credit frictions are exogenous, i.e. not tied to aggregate variables. Kehoe and Perri (2002) analyze a model in which the credit constraints that a country faces when borrowing from abroad are not given but change over the cycle. Building on the literature on sovereign debt imperfections (see Eaton and Gersovitz, 1981, for instance), they consider the case in which the debt capacity of a country is tied to the value that the country attributes to the access to international financial markets in the future. The credit constraint requires that, in each period, allocations have a higher discounted utility than would prevail if the country were excluded from all further intertemporal and international trade. When country F is hit by a positive shock, its output cannot increase too much otherwise the value of defaulting would become higher than the penalty of being excluded from international financial markets in the future. Hence, the flow of capital from country H to country F must be limited: this helps to sustain the output rise in country H . As Kehoe and Perri stress, they ‘abstract completely from the difficulties of enforcing contracts between agents within a country (page 908)’.⁵ Hence, there is no room for changes in the relative importance of foreign versus domestic credit imperfections. Gilchrist, Hairault and Kempf (2002) and Faia (2002) analyze models in which firms face a credit constraint in borrowing both home and abroad. The presence

⁵Note that a world economy in which agents face endogenous credit frictions abroad but not domestically cannot be considered as an extreme case of our economy. In such an economy agents borrow up to the limit allowed by foreign financiers but do not face a meaningful choice in allocating pledgeable net worth (collateral) between foreign and domestic financiers.

of generalized credit constraints amplifies the international transmission of shocks. They also allow for the degree of credit imperfections to differ across countries. However, there is no difference in credit imperfections according to the nature of lenders. Hence, only the *absolute* importance of credit frictions matters.

The paper is organized as follows: Section 2 describes the model and presents simulation results. Section 3 tests our assumption on the liquidation technology of the lenders. Section 4 concludes.

2. The model

In this section, we describe our model. The world consists of two symmetric, discrete-time economies. In each economy, entrepreneurs produce a unique final good (which is tradeable across countries) that is used for consumption. In each country, there is a fixed amount of a durable good (which is not tradeable across countries) that can be used either by entrepreneurs as input for production and collateral for loans or by households as a consumption good. We call this durable asset “real estate” to fix the ideas and to convey our message more effectively. This modeling structure allows for fluctuations in the price of the pledgeable, productive asset. It also allows for changes in entrepreneurial real estate holdings which have first-order effects on economic activity.

Each economy is populated by the same measure of infinitely lived agents, households and entrepreneurs.⁶ Households rent their labor input to entrepreneurs, and consume the final good and real estate; they also purchase non-contingent, one period bonds issued by domestic entrepreneurs, foreign entrepreneurs and foreign households. Entrepreneurs consume and use labor and real estate to produce final good; they can borrow (issue bonds) and choose whether to borrow from domestic or foreign households. In borrowing, entrepreneurs face credit constraints.⁷ We first describe the

⁶We use the terms household, lender and financier on the one hand, and entrepreneur, firm and borrower on the other, interchangeably.

⁷Households could face credit constraints, too. In the model we describe, given our assumption on the preferences,

borrowing constraints and how they relate to the nature (domestic versus foreign) of lenders. We then embed the credit constraints in the general equilibrium framework.

2.1. Borrowing constraints with endogenous liquidation costs

The setup. Consider the problem of the representative domestic entrepreneur who wants to borrow some amount for investment or consumption from either domestic or foreign financiers. Credit contracts are exposed to an enforceability problem. We follow the literature, especially Kiyotaki and Moore (1997), in specifying this enforceability problem. In its simplest formulation, we can think that the entrepreneur can always “walk away” with the funds borrowed. She will have no incentive to do so as long as the value of collateralized resources is at least equal to the funds borrowed. Alternatively, we can think that the entrepreneur’s human capital is specific to production and she cannot commit it at the contractual stage. This implies that ex-post, by threatening to withhold her human capital, the entrepreneur can trigger renegotiation of the contract and, if she has full bargaining power in the renegotiation, force the repayment down to the collateral value. Regardless of the preferred specification, as in Kiyotaki and Moore (1997), the entrepreneur cannot borrow more than the expected present value of her pledgeable resources (net of any recovery cost).⁸ We assume that the entrepreneur can use only her own real estate h_t as collateral for the loan. Denoting with E_t the expectation operator conditional on time t information, the expected time $t + 1$ price of real estate in terms of the final good is $E_t q_{t+1}$. The discount factor for the domestic financier is $1/R_t^H$, for the foreign financier is $1/R_t^F$.

We make the following assumptions: (i) the collateral is fully divisible; (ii) the collateral does not depreciate; (iii) each portion of the asset can be used for collateral only with one lender; (iv)

 these constraints would not be binding in equilibrium, so we rule them out ex ante.

⁸Notice that what matters is the expected present value of pledgeable resources. We are implicitly assuming that the opportunity to steal funds or to force renegotiation arises before any uncertainty on the value of collateral is resolved.

in case of debt repudiation, domestic and foreign financiers pay a transaction cost for disposing of the collateral (proxying for a bankruptcy or liquidation cost).

Lenders' Liquidation Technology and Credit Constraints. We now describe the liquidation technologies of domestic and foreign financiers. Below and throughout the paper, we extensively discuss our specification.

The domestic lender expects to pay a proportional transaction cost $(1 - m) E_t(q_{t+1}h_t)$ to dispose of the asset in case of debt repudiation. Hence, the value that the domestic lender can expect to recover from the sale of the asset is:

$$E_t(q_{t+1}h_t - (1 - m)q_{t+1}h_t) = E_t(mq_{t+1}h_t) \quad (2.1)$$

The foreign lender expects to pay a convex cost $(1 - z) E_t\left(\frac{1}{qh}(q_{t+1}h_t)^2\right)$ to dispose of the asset, i.e. her liquidation technology exhibits decreasing returns to scale.⁹ By assuming diseconomies to scale in their liquidation technology, we want to capture the idea that, unlike domestic lenders, foreign lenders are likely to have limited experience in recovering and liquidating the assets of the borrowers and limited knowledge of their best alternative uses. Experience and knowledge, in other words, might represent a scarce local input such that, the higher is the value of the assets that foreigners recover and redeploy, the more their limited "liquidation ability" is strained. The value that the foreign lender can expect to recover from the sale of the asset is therefore:

$$E_t\left(q_{t+1}h_t - \frac{1 - z}{qh}(q_{t+1}h_t)^2\right) \quad (2.2)$$

Let α_t be the share of own real estate h_t used by the entrepreneur as domestic collateral and $1 - \alpha_t$ the share used as international collateral. Let also b_t^H and b_t^F be the amount of borrowing from

⁹The value of qh in the denominator of the expression is just a normalization, which implies that in a steady state with constant q and h the per unit transaction cost is $1 - z$.

domestic and foreign lenders respectively. Given her choice of α_t , the entrepreneur will face the following two borrowing constraints:

$$R_t^H b_t^H \leq E_t(m\alpha_t q_{t+1} h_t) \quad (2.3)$$

$$R_t^F b_t^F \leq E_t \left(q_{t+1} (1 - \alpha_t) h_t \left(1 - \frac{1-z}{qh} (q_{t+1} (1 - \alpha_t) h_t) \right) \right) \quad (2.4)$$

It is clear that m and z can reflect the average efficiency of the liquidation technology of domestic and foreign lenders, respectively. Put differently, m and z can be thought of as average loan to value (LTV) ratios for domestic and foreign loans.

Discussion. The main assumption of the model is the decreasing marginal ability of foreign lenders to extract value from entrepreneurs' assets. With this assumption we want to capture the idea that foreign lenders have limited local experience and knowledge, which can be put under more pressure than that of domestic lenders as the value of assets to be liquidated increases. The limited ability of foreign lenders can materialize at the bankruptcy stage. Foreign lenders can have scarce knowledge of local insolvency practices, especially when bankruptcy laws are poorly drafted (see, for example, Rajan and Zingales, 1998).¹⁰ Their limited ability can also materialize at the redeployment stage. Consider, for example, an economy in which second-hand users have heterogenous efficiency in employing assets. The ability of a lender to identify efficient users is at least in part a by-product of the information gathered in previous credit relationships. Since foreign lenders have generally a shorter history in lending to local firms, they will likely have limited ability. Hence, as they liquidate additional assets, they could make "mistakes" and address sub-optimal users.¹¹ Another, related argument runs as follows. Lenders' liquidation ability allegedly stems

¹⁰Analyzing the reasons for the East Asian crisis, Rajan and Zingales (1998) argue that foreign lenders were particularly exposed to such a problem in East Asian countries, where accounting standards and disclosure and bankruptcy laws are poorly drafted and enforced.

¹¹Ramey and Shapiro (2001) stress the importance of search costs in the redeployment of assets. They argue that thin markets and costly search can complicate the process of finding buyers whose needs best match the capital's

from information acquisition (monitoring). It is reasonable that gathering additional information is more costly for foreign lenders than for domestic ones: that is, the monitoring technology of foreign lenders exhibits decreasing returns to scale. Indirectly, this would imply diseconomies to scale in their liquidation technology. In a similar vein, Hermalin and Rose (1999) argue that foreign lenders face higher marginal monitoring and debt recovery costs than domestic lenders so that their supply of funds is shifted inwards relative to the domestic one.

Indeed, our specification contains more information than the diseconomies to scale faced by foreign lenders. In fact, the liquidation technologies imply that, for small values of assets, foreign lenders have a lower average liquidation cost than domestic ones. Otherwise, foreign lenders would be dominated by domestic ones and would never be chosen in equilibrium. We believe that this feature is consistent with the pattern of international lending. As we better discuss in section 3, our analysis especially fits concentrated lenders, such as banks. For example, while concentrated lenders are directly involved in bankruptcy and liquidation procedures, dispersed financiers play a less active role, so that differences in their liquidation ability are likely to be less relevant. Internationally active financial institutions are on average larger¹² and probably count on better organized loan recovery offices than small ones. Domestic lenders consist instead of a mix of internationally active institutions and smaller ones. Therefore, we can think that in our economy, if their local experience and knowledge were as abundant as for domestic lenders, foreign lenders would have a linear liquidation technology with a lower average liquidation cost than the domestic. However, they suffer from diseconomies to scale. Hence, for sufficiently high values of collateral, the advantage due to their organized offices is offset by the disadvantage due to their limited local experience.

characteristics.

¹²For example, Tschoegl (2003) reports that the parent banks of foreign subsidiaries in the US are often the largest banks in their home country.

We are aware that several factors can affect lenders' liquidation technology and that the specification we propose might not necessarily reflect their liquidation ability. In section 3, we present empirical evidence in support of our specification. Since direct evidence on the liquidation technology faced by different categories of lenders is prohibitive to find, we provide indirect evidence, by testing the immediate implication that this technological assumption generates in the model.

2.2. General equilibrium

We now embed the features described above within a simple dynamic general equilibrium model. We then assess the dynamic properties of the model and its implications for international business cycles. As the two countries are symmetric, without loss of generality, we only describe the decisions in the domestic economy.

Domestic entrepreneurs. Entrepreneurs derive utility from consumption of final good; they produce the final good using labor and real estate as inputs. As mentioned, real estate is non-tradeable, is in fixed supply within the country and can either serve as an input for entrepreneurial activity or provide utility services to households. Real estate holdings shifts have therefore first-order effects on economic activity.

Entrepreneurs can borrow from domestic and foreign households, with their borrowing capacity being determined by the expected value of the assets (real estate) they pledge respectively to domestic and foreign households as in 2.3 and 2.4.

The production function is Cobb-Douglas in domestically located labor l_t (remunerated at the wage rate w_t) and real estate owned by entrepreneurs:

$$Y_t = A_t h_{t-1}^\nu l_t^{1-\nu} \tag{2.5}$$

where productivity follows an exogenous AR(1) process in logs. Entrepreneurs maximize their lifetime utility from the consumption flow c_t . Denoting with γ their discount factor, entrepreneurs

solve the following problem:

$$\max_{b_t^H, b_t^F, h_t, l_t, \alpha_t} E_0 \sum_{t=0}^{\infty} \gamma^t \ln c_t$$

subject to the flow of funds:

$$A_t h_{t-1}^\nu l_t^{1-\nu} + b_t^H + b_t^F = c_t + q_t (h_t - h_{t-1}) + R_{t-1}^H b_{t-1}^H + R_{t-1}^F b_{t-1}^F + w_t l_t$$

and to the domestic and foreign borrowing constraints (equations 2.3 and 2.4). Entrepreneurs choose labor demand, real estate holdings, domestic borrowing, foreign borrowing and the allocation of real estate (collateral) between domestic and foreign financiers (α). Define λ_t^H and λ_t^F the time t shadow values of the domestic and foreign borrowing constraint respectively. The first-order conditions for an optimum are the consumption Euler equations (2.6 and 2.7), real estate demand (2.8), choice of α_t (2.9), and labor demand (2.10):

$$\frac{1}{c_t} = E_t \left(\frac{\gamma R_t^H}{c_{t+1}} \right) + \lambda_t^H R_t^H \quad (2.6)$$

$$\frac{1}{c_t} = E_t \left(\frac{\gamma R_t^F}{c_{t+1}} \right) + \lambda_t^F R_t^F \quad (2.7)$$

$$\frac{q_t}{c_t} = E_t \left(\frac{\gamma}{c_{t+1}} \left(\nu \frac{y_{t+1}}{h_t} + q_{t+1} \right) + \lambda_t^H m \alpha_t q_{t+1} + \lambda_t^F (1 - \alpha_t) q_{t+1} \left(1 - \frac{2(1-z)(1-\alpha_t)q_{t+1}h_t}{qh} \right) \right) \quad (2.8)$$

$$1 = \frac{1}{m} \frac{\lambda_t^F}{\lambda_t^H} E_t \left(1 - \frac{2(1-z)(1-\alpha_t)q_{t+1}h_t}{qh} \right) \quad (2.9)$$

$$w_t = (1 - \mu - \nu) y_t / l_t \quad (2.10)$$

The consumption Euler equations differ from the usual formulations because of the presence of λ , the Lagrange multiplier on the borrowing constraint. In a neighborhood of the steady state equilibrium, the multiplier will be positive, so long as the entrepreneurial discount rate γ is lower than the households' discount rate (β), which in turn prices bonds.

Domestic households. The household sector (denoted with a prime) is conventional. In each period, households enter with real estate holdings h'_{t-1} (priced at q_t) and bonds coming to maturity.

They derive utility from consumption of the final good c'_t and from real estate services proportional to their current real estate holdings h'_t . They rent labor l_t to domestic entrepreneurs at a wage w_t (labor is immobile across countries), lend b_t^H to domestic firms, b_t^{F*} to foreign firms and lend b_t (or borrow $-b_t$) to (from) foreign households, while receiving back the amount lent in the previous period times the agreed gross interest rates, respectively R^H , R^{F*} and R .

Formally, households solve:

$$\max_{b_t^H, b_t^{F*}, h'_t, b_t, l_t} E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln c'_t + j \ln h'_t - \frac{\tau}{\eta} l_t^\eta \right)$$

where β is the discount factor. We assume that $\beta > \gamma$, where γ is the entrepreneurial discount rate. This ensures that entrepreneurs' borrowing constraints will hold with equality in a small neighborhood of the steady state.

The flow of funds for the household is:

$$c'_t + q_t (h'_t - h'_{t-1}) + b_t^H + b_t^{F*} + b_t = R_{t-1}^H b_{t-1}^H + R_{t-1}^{F*} b_{t-1}^{F*} + R_{t-1} b_{t-1} + w_t l_t \quad (2.11)$$

The solution to this problem yields standard first order conditions: the no-arbitrage opportunities will yield a single world interest rate in equilibrium. The remaining equations are the labor supply schedule and the real estate residual demand schedule. We show these conditions in the appendix.

Equilibrium. In equilibrium, domestic and foreign households demand the same return on bonds issued domestically and abroad. Hence, at each date a unique interest rate holds for all bonds:

$$R_t = R_t^H = R_t^F = R_t^{H*} = R_t^{F*} \quad (2.12)$$

For given levels of bond holdings $(b_{t-1}^H, b_{t-1}^F, b_{t-1}^{H*}, b_{t-1}^{F*}, b_{t-1})$, interest rate (R_{t-1}) , domestic real estate holdings (h_{t-1}, h'_{t-1}) , foreign real estate holdings (h_{t-1}^*, h'_{t-1}^*) , and technology (A_t, A_t^*) , a recursive competitive equilibrium is characterized by a path of asset prices (q_t, q_t^*) , interest rate R_t , wages (w_t, w_t^*) , consumption $(c_t, c'_t, c_t^*, c'_t^*)$, real estate holdings $(h_t, h'_t, h_t^*, h'_t^*)$, bond holdings

$(b_t^H, b_t^F, b_t^{H*}, b_t^{F*}, b_t)$, labor supply (l_t, l_t^*) , output (y_t, y_t^*) , share of domestic collateral (α_t, α_t^*) , multiplier on entrepreneurs' credit constraint (λ_t, λ_t^*) , such that entrepreneurs and households maximize their utility and the bond markets, the labor markets, the real estate markets and the world's good market clear.

In the symmetric steady state, the equality of discount rates between domestic and foreign households implies that the net foreign asset position b of domestic households vis-à-vis foreign is indeterminate and cannot be uniquely pinned down. To rule out any asymmetry between the two countries, we set it arbitrarily close to zero. We present the steady state and the complete linearized model in the appendix of the paper.¹³

The optimal value of α : a graphical analysis. Before turning to analyze the impact of an exogenous productivity shock, we provide an intuitive analysis of entrepreneurs' choice of their relative debt exposure to domestic and foreign lenders. Using 2.9 and the no arbitrage condition 2.12, we can solve for the optimal α_t as a function of the value of real estate held by entrepreneurs:

$$\alpha_t = 1 - \frac{1 - m}{2(1 - z)} \frac{qh}{E_t(q_{t+1}h_t)} \quad (2.13)$$

The optimal value of α , the share of domestic collateral, is positively related to the average domestic loan-to-value ratio (m) and inversely related to the average foreign loan-to-value ratio (z). In addition, in a neighborhood of the steady state, α is a positive function of real estate

¹³In a steady state with constant household consumption, $R = 1/\beta$. Combining this result with the steady state entrepreneurial Euler equation for consumption yields: $\lambda = (\beta - \gamma)/c$. If $\beta > \gamma$, $\lambda > 0$ and the borrowing constraint will always hold with the equality sign in a neighborhood of the steady state.

A word of caution is needed here. If the variance of the shocks becomes very large or if γ becomes very close to β , entrepreneurs might not borrow up to the limit after a sufficiently long series of productivity shocks and might decide instead to keep a buffer stock of resources to use in bad times so to avoid the possibility of running into the borrowing constraint. By assuming that the variance of the shocks is small and that γ is well below β , among other things, we can minimize the probability that the credit constraint becomes non-binding in some states of the world.

prices and holdings. That is, increases in the value of the real estate held by entrepreneurs will be associated with a switch from foreign towards domestic lenders.

Figure C.1 provides a useful summary of the determination of the optimal α in and out of the steady state. On the horizontal axis in the left panel, for a given level of the asset value qh , the supply of domestic credit is measured from the left, and is increasing and linear in α (see equation 2.3). The supply of foreign credit is measured from the right, and is an increasing and concave function of $1 - \alpha$ (see 2.4). That is, as entrepreneurs' demand for foreign loans rises, marginal transaction costs become higher for the foreign lender, who in turn becomes less willing to supply additional funds. The optimal amount of α is the one that maximizes total debt capacity, i.e. the vertical sum of the two solid lines. The interior solution of α is such that the slopes of the two solid lines are equal and is reported in the right panel.

A temporary increase in the expected value of real estate ($q_{t+1}h_t$) - coming from, say, a positive technology shock that increases real estate productivity - shifts both lines up: however, since out-of-the-steady-state transaction costs become relatively higher *at the margin* for the foreign lender, the amount of entrepreneurs' foreign borrowing rises less than the amount of domestic borrowing (α temporarily increases).

Allowing for variable capital. In the model presented above, although real estate changes hands between households and entrepreneurs, aggregate investment is zero because the total supply of the productive asset is fixed. It is straightforward to extend the model to allow for aggregate investment. Such an extension is valuable when we consider the cyclical properties of the model, because it allows a more direct comparison of the model with the traditional two-country stochastic general equilibrium model à-la Backus-Kehoe-Kydland (1992).

To allow for aggregate investment, we assume that entrepreneurs own and accumulate another asset, k , that can be reproduced from the final good at no cost but cannot be used as collateral (for

instance, because it has no resale value or because it can be easily absconded in case of default). The technology for the production of final output is described by:

$$Y_t = A_t k_{t-1}^\mu h_{t-1}^\nu L_t^{1-\mu-\nu}$$

and entrepreneurs own the entire variable capital stock which depreciates at rate δ over time. The entrepreneurial flow of funds becomes:

$$A_t h_{t-1}^\nu l_t^{1-\nu} + b_t^H + b_t^F = c_t + i_t + q_t (h_t - h_{t-1}) + R_{t-1}^H b_{t-1}^H + R_{t-1}^F b_{t-1}^F + w_t l_t$$

where $i_t = k_t - (1 - \delta) k_{t-1}$.

The capital demand equation for this problem is standard (see equation A.25 in the appendix). The other first order conditions are unchanged.

2.3. Calibration

To show the basic workings of our model, we set variable capital aside for the moment. Likewise, we assume that shocks to productivity are purely temporary and do not spillover across countries. Later, when we consider the second moment properties of the model in more detail, we will allow for richer interactions between domestic and foreign shocks taking the parameters describing the evolution of the technology from Backus, Kehoe and Kydland (1992), who model productivity as highly persistent and allow for spillovers across countries.

Our time period is set to be a quarter, and the two economies are perfectly symmetric. We set β equal to 0.99, implying a steady state real interest rate of 4 percent on an annual basis. We set $\gamma = 0.98$, implying a steady state in which the return on entrepreneurial investment is twice as large as the market interest rate. We set labor supply elasticity to 0.05, in the ballpark of several microeconomic studies¹⁴: this way, the response of output to shocks depends almost entirely

¹⁴See e.g. Browning, Hansen and Heckman, 1999.

on the behavior of technology and on changes in entrepreneurs' real estate holdings. We set the elasticity of output to labor to 0.9 and the elasticity of output to real estate (ν) to 0.1. In the household utility function, we set the weight j on housing demand equal to 0.1. These parameter choices imply that real estate is about equally split between households and entrepreneurs.

We set the parameters describing the average liquidation ability (the loan to value ratios) equal to $m = 0.9$ and $z = 0.8$. Given our liquidation technology, the steady state level of α , the share of domestic collateral, is equal to 75 percent, whereas entrepreneurs' domestic debt and foreign debt are respectively 150 and 50 percent of annual output.¹⁵ As for the household bond holdings b , they cannot be uniquely determined from the steady state. In order to rule out any steady state asymmetries across countries, we set them arbitrarily close to zero. Entrepreneurial real estate ends up being worth about 2 times annual output.

In the steady state of the basic model, entrepreneurs end up being highly levered and consume 3 percent of total output, whereas households consume the remaining 97 percent.

In the extended model, we set the elasticity μ of output to variable capital to 0.25 (so that, with $\nu = 0.1$, the labor share is 65%) and its quarterly depreciation rate to 3%. This way, steady state investment to output becomes equal to 15%, households consume 73% of output, and entrepreneurs consume 12%. The steady state ratios of domestic and foreign entrepreneurial debt and asset prices to output are independent of μ (see appendix), and are the same as in the basic

¹⁵As of 2002, the total amount of liabilities of Nonfarm Nonfinancial Corporate Business and Nonfarm Noncorporate Business in the US was 13.21 trillion dollars, that is 126% of GDP. Including Households and Nonprofit Organizations debt (8.78 trillion dollars), the total ratio private debt over GDP rises to 210% (source: Federal Reserve, Flows of Funds of the United States). Moving to the foreign sector, the total amount of US-owned assets abroad is 6.47 trillion dollars (62% of GDP), which is split roughly equally between foreign direct investment, securities, and loans. The total amount of foreign-owned assets in the US is 9.08 trillion dollars, or 87% of GDP (source: BEA, Survey of Current Business, 2003). Although our model does not differentiate between the various liabilities, our values of 150% for domestic and 50% for foreign entrepreneurial debt are roughly consistent with the data.

model.

In Table C.1 we report our calibrated parameters.

2.4. Results

Impulse responses Our transmission mechanism has two distinct aspects: on the one hand, the effect of changes in asset values on entrepreneurs' debt capacity and asset demand (à-la Kiyotaki and Moore, 1997); on the other, the effect of changes in asset values on the relative efficiency of domestic and foreign lenders. We highlight the importance and the relative contribution of each channel by considering for simplicity the impact of a serially uncorrelated shock to A_t^* , the productivity in the foreign country.

To better disentangle the contribution played by the asymmetry between domestic and foreign lenders, we compare the impulse responses with those obtaining when there is no difference (equal average and marginal liquidation costs) between domestic and foreign borrowing, so that the allocation of collateral between domestic and foreign lenders becomes de facto exogenous. That is, we consider an economy (exogenous- α economy, dashed lines) where the initial levels of domestic and foreign entrepreneurial debt are the same as in our preferred model, but they increase in an equal proportion when the value of real estate holdings rises.¹⁶ This version can be thought of as an extension of the Kiyotaki and Moore setup to an international environment.¹⁷

The solid lines of Figure C.2 show the responses of output, asset holdings of entrepreneurs, asset prices and domestic and foreign borrowing in the domestic and in the foreign economy.

In both countries, the shock to productivity elicits: (i) an increase in production; (ii) a rise

¹⁶For comparison purposes, we choose the same α that obtains in the “endogenous- α economy”, and assume that the loan to value ratios are both equal to $m' = z' = (m + z) / 2 = 0.85$.

¹⁷Paasche (2001) extends the Kiyotaki and Moore framework to a model of contagion for two small economies that trade with a large economy but not with each other. In this model, propagation relies on terms of trade effects which are amplified by a collateral constraint.

in real estate prices; *(iii)* an increase in the relative importance of domestic versus foreign entrepreneurial borrowing. The results show that the positive impact of the shock is transmitted to the domestic economy generating a positive comovement of production in the two economies. Unsurprisingly, in period 0 output does not move at home while A^* has a direct effect on foreign output. However, the response of entrepreneurs' real estate holdings (second row) is similar in both countries, and is quite persistent despite the fact that the productivity shock only lasts one period. From period 1 on the countries experience deviations of output from steady state which are similar, and roughly proportional to ν .

In the exogenous- α economy (dashed lines), the international transmission of the shock operates through the effect of asset values on credit constraints but not through changes in the relative debt exposure of entrepreneurs to foreign and domestic lenders. There is propagation of the shock to the domestic economy, but the effect is limited. Analogously, the rise in real estate prices and entrepreneurs' real estate holdings (which are proportional to output) is smaller.

How does the endogenous- α economy generate a stronger comovement of output? Our view is the following. After the positive technology shock in the foreign country, asset prices rise abroad and domestically. Without technology spillovers, a temporary foreign shock pushes domestic asset prices higher initially because of general equilibrium effects (mainly, the drop in the world interest rate drives up asset demand and prices both home and abroad).¹⁸ In the model with technology spillovers, the increase in the productivity of domestic real estate will exert a direct pressure on domestic asset prices.¹⁹ The rise in domestic real estate prices modifies the incentive for domestic

¹⁸The drop in the interest rate also signals households to gradually consume the increase in production over time, starting from a high level of consumption today, and slowly returning to the baseline. For these standard effects see, for example, King and Rebelo (1999).

¹⁹The comovement of asset prices across countries is a common feature of the models of international business cycles based on the financial accelerator (see for instance Gilchrist, Hairault, and Kempf, 2002, and Faia, 2002). Several empirical studies find a positive international correlation of asset prices. For example, analyzing commercial property

firms to borrow from domestic versus foreign households. In fact, because of the increase in the value of real estate, the average liquidation cost faced by foreign lenders increases, while that of domestic lenders stays constant: the liquidation ability of foreign lenders becomes strained as the value of collateral rises. As domestic borrowing rises relative to foreign, entrepreneurs have a higher incentive to invest in real estate. In fact, real estate has a higher marginal value as collateral whenever the entrepreneur borrows from a more efficient marginal liquidator. Put differently, as entrepreneurs switch to domestic lenders, their real estate demand increases more, because they know that each additional unit of real estate will relax their credit constraints by more.²⁰ This induces further pressure in the domestic real estate market, leading to a further increase of real estate prices. The increase in real estate holdings and prices spurs the average liquidation cost faced by foreign lenders further, and so forth. Overall, since increases in the entrepreneurs' real estate holdings and prices relax entrepreneurial credit constraints, the output of the domestic economy increases more than in the exogenous- α economy.

Cyclical properties. The results of the previous section are qualitatively similar when we allow for variable capital and elastic labor supply as well as for persistent technological shocks which spill over across countries. In this subsection, we try to obtain a more precise measure of the interaction between endogenous choice of lenders, asset prices, net foreign assets and output. We borrow the description of the technology properties from Backus, Kehoe and Kydland (1992), as reported in

 values in 21 countries over the period 1987-1997, Case, Goetzmann and Rouwenhorst (2000) find correlations within property types across countries that range between 0.33 and 0.44. The comovement of asset prices between the two economies is crucial for the mechanism of international transmission of cycles we describe, though it is not the main focus of the paper.

²⁰Remember that in our economy entrepreneurs demand real estate both for its services as an input and as collateral. Moreover, the (marginal) usefulness of real estate as collateral depends on the (marginal) liquidation ability of the lender.

the last column of Table C.1.

Table C.2 shows the cyclical properties of our preferred economy in the second column, reporting the contemporaneous correlations with home output of domestic and foreign entrepreneurial debt, asset prices and consumption. The table also shows the international output, consumption and asset price correlations. We compare the cyclical properties of our preferred economy with those of the exogenous- α economy (third column) and with the data (last column). To render our results more directly comparable with related literature, we also report the corresponding statistics in Backus, Kehoe and Kydland (open economy RBC model with time-to-build structure). We report statistics for their benchmark economy (fourth column). We also report statistics for their economy augmented with a transportation cost (fifth column) and for their model with financial autarky and no international borrowing (sixth column).

While our model cannot offer (even allowing for spillovers and for persistence in the productivity processes) a complete explanation of the full range of effects that are at stake, it is successful in turning the international output correlation from negative to positive. The exogenous- α model predicts a positive correlation between y and y^* of 16%. The asymmetry between domestic and foreign lenders increases international output correlation to 27%.

We now turn to the model predictions regarding the second moments of debt, asset prices and consumption. Both the endogenous and the exogenous- α economy predict positive correlations of domestic asset prices with domestic output and foreign asset prices. These features are not surprising and are consistent with the data. However, interestingly, only our preferred economy captures the strongly procyclical pattern of the ratio domestic/foreign business debt observed in the data.²¹ We provide a structural test for the predicted behavior of this ratio in the econometric

²¹For evidence on the international correlation of asset (property) prices see also Case, Goetzmann and Rouwenhorst (2000). For evidence on the procyclical pattern of the ratio domestic/foreign bank debt exposure see Dages, Goldberg and Kinney (2000) and Goldberg (2002).

analysis. Domestic and foreign consumption are instead more highly correlated in the model than in the data. This finding is neither new nor surprising. Households, who do *not* face financing constraints in the model economy, do most of the consumption in steady state. As found by Backus, Kehoe and Kydland (1992), in a context without frictions, the operation of the permanent income hypothesis generates an international correlation of consumption much higher than in the data. It would be worth exploring modifications to our modelling structure that preserve our key mechanism and can help to get around the differences between the theory and the data: we leave this for future research.

3. Empirical Evidence

Having shown that the business cycle properties of the model are in line with what predicted by US data, we now provide evidence on the main working assumption of the model, i.e. the increasing disadvantage that foreign lenders experience in recovering value from borrowers' assets.

Circumstantial evidence. Direct evidence on the liquidation technology, especially differentiated according to the nature of the financiers, is prohibitive to find since it requires micro-level data on the debt recovery ratios of different categories of lenders. To obtain at least a direct feeling of the realism of our assumption, we sent a survey questionnaire to the loan administration offices of the 25 largest foreign banks in the United States, ranked by total assets in US commercial bank offices.²² Twelve banks returned the questionnaire: six banks gave answers consistent with the assumption of an increasing marginal disadvantage relative to US banks in recovering business loans; three banks declared that their liquidation ability does not differ from the liquidation ability of US

²²The rankings were published by the magazine *American Banker* in 1998. The assets of the largest 25 banks make up for about 85% of the total assets of foreign banks in the US; the total assets of the foreign banks make up for about 20% of the assets of all banks in the US. More details are available from the authors on request.

banks substantially; finally, three banks were either unable to answer or uncertain.²³ We take this evidence as encouraging, while acknowledging the difficulty of obtaining direct evidence from the bankers on their liquidation ability. For this reason, in the next section we take a less direct (but perhaps more conventional) approach, testing the immediate implication of the increasing marginal liquidation cost for the foreign lenders.

A test of the main assumption. Combining the log-linearized versions of 2.3, 2.4, 2.9 for the entrepreneurs and 2.12 for the households yields (indicating with a hat the percentage deviations of the variables from their steady state levels):

$$\widehat{b}_t^H - \widehat{b}_t^F = \theta E_t \left(\widehat{q}_{t+1} + \widehat{h}_t \right) \quad (3.1)$$

where $\theta = 1/\alpha > 0$. This equation predicts that the log-difference between domestic and foreign business loans should positively depend on the expected value of firms' pledgeable assets.

We test 3.1 using time-series data for the US (we describe the data in the appendix). We take the growth rate of commercial and industrial loans of domestic banks over commercial and industrial loans of foreign banks as our dependent variable.²⁴ There are two reasons to consider a measure of bank (domestic and foreign) credit rather than of the economy-wide (domestic and foreign) debt exposure. First, our theory appears particularly suitable for describing differences in the liquidation ability of domestic and foreign concentrated lenders, such as banks. Unlike dispersed financiers, these lenders are directly involved in bankruptcy and liquidation procedures so that differences in their liquidation ability are likely to be especially relevant. Hence, including forms of dispersed

²³The survey consisted of two questions: "(1) According to your experience, do you believe that Your bank experiences a disadvantage relative to US banks in recovering debt from its loans to firms in the US ? (2) If the answer to question 1 is affirmative, do you believe that the disadvantage relative to US banks is more severe if the total amount of debt to be recovered is bigger or smaller?"

²⁴The results that we report here were robust to different filtering methods used for the data.

finance in our dependent variable would weaken the power of the tests. Second, the nature of the contracts we assume in the model is close to collateralized debt. Since bank finance mostly consists of collateralized debt, our choice enables us to be consistent also with this feature of the model. It is worth stressing that the focus on the ratio between loans of domestic banks and loans of foreign banks renders our empirical analysis of independent interest. In fact, the econometric literature is substantially silent on the cyclical behavior of this ratio.²⁵

Our sample runs from 1983Q1 to 2002Q2. The start date reflects the structural break that occurred with the introduction of The Depository Institutions Deregulation and Monetary Control Act (DIDMCA) in 1980, which extended domestic services and privileges to foreign banks located in the United States, and a reasonable adjustment period after that. As explanatory variables, we include the sum of the changes in real estate prices and non-residential fixed investment, as suggested by equation 3.1. We also estimated our specifications using the *stock* of non-residential real estate instead of investment: the results we obtained were very similar to those reported here, and are available from the authors upon request.²⁶

The h of our model is a proxy for all the productive assets within a firm that can be used as collateral. In accordance with our theoretical framework, we use non-residential fixed investment, thus excluding investment in inventories from our measure of h . It is argued (Myers and Rajan, 1998) that inventories can be easily absconded and continuously transformed into potentially softer assets.

²⁵Dages, Goldberg and Kinney (2000) is an exception, although in a different context: focussing on Argentina and Mexico, they compare the behavior of foreign banks with that of domestic banks over the 1990s. They find that foreign banks in these countries show less volatile loan growth than domestic banks.

²⁶In particular, we used several measures of the stock of nonfarm nonfinancial corporate business tangible assets (real estate or equipment & software) taken from the balance sheet tables of the Flows of Funds Accounts. The coefficient estimates for ψ_2 and ψ_3 that we obtained in these specifications were somewhat larger in absolute value (perhaps unsurprisingly, since using a flow variable rather than its stock proxy perhaps overstates the variation in the regressor), but most of the results were qualitatively and quantitatively similar.

Fixed assets are therefore likely to be better collateral insofar as they limit the transformation risk without limiting the entrepreneur's flexibility or incurring high monitoring costs.

Moreover, since our theory rests on the presence of bankruptcy costs, we expect the feedback from expected asset values to relative loans to be stronger when expected bankruptcy costs are higher. Therefore, the aim of our empirical tests is two-fold: (i) we want to assess whether expected real estate values positively affect the ratio domestic debt over foreign debt; (ii) if this is true, we want to verify whether this effect is stronger as expected bankruptcy costs rise. To test for this, we include an interactive term constructed as the product between real estate values and an aggregate measure of leverage for US corporate businesses. Leverage is generally considered a good predictor of the probability of firms' distress and, therefore, of their expected bankruptcy costs. In particular, highly levered firms are allegedly more exposed to the risk of bankruptcy.²⁷ Figure C.3 plots the series.

Finally, we control for other factors that could affect the ratio between domestic and foreign bank loans and that our stylized model does not explicitly capture. To begin with, we include the lagged dependent variable to take into account inertia in the adjustment of the ratio towards its optimal level. We include foreign direct investment (as a share of GDP) to control for changes in the relative demand for bank loans due to changes in the volume of activity of foreign firms in the US: it is frequently argued, in fact, that multinationals mainly borrow from banks with which they have established relationships domestically. Finally, we include measures of the relative capitalization of US banks versus Japanese banks to control for supply side effects due to bank capital changes.

²⁷In our model, a proportional rise in m and z would yield an increase in domestic and foreign corporate leverage (as measured by the ratio borrowing over market value of assets) but would not affect the optimal value of α , whose inverse multiplies the coefficient on expected asset values in equation 3.1 (see equation A.6 in the appendix). Therefore, our empirical prediction on leverage cannot be derived from the linearized model, but appears plausible if one posits that the probability of default is increasing in leverage.

Japanese banks have the strongest presence among foreign banks in the United States and a number of studies have found that changes in their capitalization affect their lending to US firms (e.g. Peek and Rosengren, 1997 and 2000). We measure relative capitalization as the difference between total capital and reserves of US commercial banks versus large Japanese commercial banks (as a percent of banks' total balance sheet).²⁸ This is at best a rough proxy: during the sample period, a number of changes have occurred in the way bank capital adequacy is measured (such as the introduction of the Basel requirements) that prevent us from using a more specific measure of banks' capitalization. In addition, following Peek and Rosengren (1997), we include Japanese land prices. Japanese banks have allegedly been slow in making provisions for loan losses and many of their non-performing loans have been concentrated in the real estate sector.²⁹ Including a measure of land prices can help to capture Japanese banks' incentive to change their lending due to fluctuations in the amount of non-performing loans not yet reserved for.

Specification and Results. To summarize, our augmented version of equation 3.1 becomes:

$$\begin{aligned} \widehat{b}_t^H - \widehat{b}_t^F &= \psi_0 + \psi_1 \left(\widehat{b}_{t-1}^H - \widehat{b}_{t-1}^F \right) + \psi_2 E_t \left(\widehat{q}_{t+1} + \widehat{h}_t \right) + \psi_3 \cdot \text{leverage} \cdot E_t \left(\widehat{q}_{t+1} + \widehat{h}_t \right) + (3.2) \\ &+ \psi_4 \widehat{q}_t^* + \psi_5 \text{FDI/GDP}_t + \psi_6 \left(\widehat{CR}_t - \widehat{CR}_t^* \right) + \varepsilon_t \end{aligned}$$

The model predicts that both real estate prices and quantities affect the ratio domestic/foreign entrepreneurial debt, that feeds back on them by modifying firms' incentive to borrow from domestic or foreign lenders. Hence, a problem of endogeneity of the regressors arises. More in general, we can expect all the regressors to be exposed to a problem of endogeneity. To control for this, we instrument our variables. The note to Table C.3 reports the chosen instruments. We estimate our parameters via GMM methods. Table C.3 presents the results from four different specifications.

²⁸We focus on large commercial banks. As argued in 2.1., among commercial banks, they are the most active internationally.

²⁹We obtained similar results including the Nikkei 225 share price index.

In the specification (1), we include only commercial property prices and fixed investment as explanatory variables. Since the model predicts that the total value (price times quantity) of pledgeable assets affects the ratio domestic/foreign debt, we impose the restriction that the coefficients on property prices and fixed investment are equal: the results show a significant, positive coefficient.³⁰ However, such a specification shows serial correlation in the error term: in (2) we therefore include the lagged dependent variable. This enters the regression with a positive sign (thus suggesting that relative loans adjust sluggishly towards their optimal level) and is significant; the results for commercial prices and fixed investment are unaltered, showing a smaller short-run but a bigger long-run elasticity of relative loans to asset values. The results also show no autocorrelation in the residuals, as evidenced by the high p -values for the test for serial correlation in the residuals. In the specification (3), we include the interactive variable constructed using firms' leverage. This variable (leverage minus its sample mean times expected asset values) has the expected positive sign and is significant. This implies that when leverage is higher, the effect of collateral values on the ratio domestic over foreign debt is stronger, as suggested by the model. In (4), we enrich the specification with additional controls. We include the change in the ratio foreign direct investment over GDP. This enters the regression with the expected negative sign and is significant. Finally, the coefficient on the Japanese urban land price index has the expected negative sign and is significant, while the relative capitalization of US banks enters with the expected positive sign but is not significant.³¹

Summarizing, the results appear to support the main assumption of the model, showing that real estate values positively affect the importance of domestic versus foreign business loans, and that

³⁰As a robustness check, we also estimated the equation without imposing the coefficient restrictions. The results were qualitatively similar: however, only the coefficient on asset prices was significantly different from zero.

³¹We also tried other specifications which included: (1) domestic and foreign interest rates, (2) the leverage term, (3) an exchange rate index. None of these variables was significant.

this effect is stronger when firms' expected bankruptcy costs are higher. The latter effect appears sizeable. At the beginning of the sample period, our measure of leverage is about 10 percent lower than its sample average for the period 1983-2002: the long-run elasticity of relative lending shares to expected asset values is $\frac{\psi_2 - 10\% \times \psi_3}{1 - \psi_1} = -0.22$, that is, slightly negative. For most of the 1990's until the end of the sample period, leverage is about 10 percent higher than its sample average, as shown in the bottom right panel of Figure C.3): the same elasticity becomes $\frac{\psi_2 + 10\% \times \psi_3}{1 - \psi_1} = 1.16$, that is positive and above one, as predicted by the model, which predicts a value of $1/\alpha$ ³².

4. Conclusions

We have presented a two-country general equilibrium model in which the relative importance of credit frictions that entrepreneurs face vis-à-vis domestic and foreign lenders changes over the cycle. As a result, entrepreneurs endogenously adjust their allocation of collateral between domestic and foreign lenders in order to minimize the total cost of credit frictions. The endogenous interaction between relative credit frictions, domestic and foreign debt exposure and collateral values acts as a powerful international transmission mechanism of technology shocks, allowing us to explain business cycle comovements across countries.

We have also tested the main empirical implication of the cyclical movements in the relative importance of domestic versus foreign credit frictions. In accordance with the model predictions, the econometric results provide strong and robust evidence that domestic loans are strongly responsive to domestic asset prices and holdings, more so than foreign loans.

³²In the theoretical model, we calibrate the domestic and foreign loan-to-value ratios, m and z , so that the steady state value of $1/\alpha$ is $1/0.75 = 1.33$. Our estimate of 1.16 for the second half of the sample period is therefore slightly lower than what our calibration implies but well inside the ballpark.

References

- [1] Backus, D. K., P.J. Kehoe, and F.E. Kydland, (1992), “International Real Business Cycles,” *Journal of Political Economy*, 100, 745-775.
- [2] Baxter, M., and M.J. Crucini, (1995), “Business Cycles and the Asset Structure of Foreign Trade,” *International Economic Review*, 36, 821-854.
- [3] Browning, M., L.P. Hansen and J.J. Heckman (1999), “Micro Data and General Equilibrium Models,” Chapter 8 in J.B. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics*, North-Holland.
- [4] Canova, F. and J. Marrinan (1998), “Sources and Propagation of International Output Cycles: Common Shocks or Transmission?,” *Journal of International Economics*, 46, 133–166.
- [5] Case, B., W. Goetzmann, and K. G. Rouwenhorst (2000), “Global real estate markets: cycles and fundamentals,” NBER Working Paper 7566
- [6] Dages, B., L. Goldberg, and D. Kinney (2000), “Foreign and Domestic Bank Participation in Emerging Markets: Lessons from Mexico and Argentina”, *Federal Reserve Bank of New York Economic Policy Review*, September, 17-36.
- [7] Dell’Ariccia, G., E. Friedman, and R. Marquez (1999) “Adverse selection as a barrier to entry in the banking industry,” *Rand Journal of Economics*, 30, 3, 515-534.
- [8] Eaton, J., and M. Gersovitz, (1981), “Debt with Potential Repudiation: Theoretical and Empirical Analysis,” *Review of Economic Studies*, 48, 289-309.
- [9] Faia, E., (2002), “Monetary Policy in a World with Different Financial Systems,” *European Central Bank w.p. No. 183*

- [10] Gilchrist, S., J.O. Hairault, and H. Kempf, (2002), "Monetary policy and the financial accelerator in a monetary union," European Central Bank w.p. No. 175
- [11] Goldberg, L., (2002), "When is US bank lending to emerging markets volatile," in Sebastian Edwards and Jeffrey Frankel, eds.: Preventing currency crises in emerging markets (NBER and Chicago University Press).
- [12] Heathcote, J., and F. Perri, (2002), "Financial Autarky and International Business Cycles," *Journal of Monetary Economics*, 49, 3, 601-627
- [13] Hermalin, B. E., and A. K. Rose, (1999) "Risks to lenders and borrowers in international capital markets," in Martin Feldstein, ed.: "International capital flows", Chicago University Press
- [14] Kehoe, P. J., and F. Perri, (2002), "International Business Cycles with Endogenous Incomplete Markets," *Econometrica*, 70, 3, 907-928
- [15] King, R. G. and S. T. Rebelo (1999), "Resuscitating Real Business Cycles," in *Handbook of Macroeconomics* edited by John Taylor and Michael Woodford, North Holland, 927-1007.
- [16] Kiyotaki, N., and J. Moore (1997), "Credit Cycles," *Journal of Political Economy*, 105, 2, 211-248.
- [17] Myers, S.C., and R. G. Rajan (1998), "The Paradox of Liquidity," *Quarterly Journal of Economics*, 113, 3, 733-771.
- [18] Paasche, B. (2001), "Credit constraints and international financial crises," *Journal of Monetary Economics*, 48, 3, 623-650.
- [19] Peek, J., and E. Rosengren (1997), "The International Transmission of Financial Shocks: The Case of Japan," *American Economic Review*, 87, 4, 495-505.

- [20] Peek, J., and E. Rosengren. (2000) "Collateral damage: effects of the Japanese bank crisis on real activity in the United States," *American Economic Review*, 90, 1, 30-45.
- [21] Rajan, R. G., and L. Zingales (1998) "Which capitalism? Lessons from the East Asian Crisis," *Journal of Applied Corporate Finance*, 11, 3, 40-48
- [22] Ramey V. A., and M. D. Shapiro (2001), "Displaced Capital: a Study of Aerospace Plant Closings," *Journal of Political Economy*, 109, 5, 958-992.
- [23] Tschoegl, A. E. (2003) "Who owns the major US subsidiaries of foreign banks? A note" Working Paper 03-11, Wharton Financial Institutions Center

A. The complete model setup

A.1. The household problem

The first-order conditions for the household problem are:

$$\frac{1}{c'_t} = \beta E_t \left(\frac{R_t^H}{c'_{t+1}} \right) \quad (\text{A.1})$$

$$R_t^H = R_t^F \quad (\text{A.2})$$

$$R_t^H = R_t \quad (\text{A.3})$$

$$w_t = \tau c'_t l_t^{\eta-1} \quad (\text{A.4})$$

$$\frac{q_t}{c'_t} = \frac{j}{h'_t} + \beta E_t \left(\frac{q_{t+1}}{c'_{t+1}} \right) \quad (\text{A.5})$$

A.2. The steady state

We consider the general case in which capital is variable (for $\mu = 0$ the model boils down to its basic version). The net foreign asset position b of domestic households vis-à-vis foreign households is indeterminate and cannot be uniquely pinned down. To rule out any asymmetries between the two countries, we set it arbitrarily close to zero ($b/b^H = 0.00001$). Therefore, $y = y^*$, $c = c^*$ and so on. In steady state $R^H = R^F = R^{H*} = R^{F*} = R = 1/\beta$. Define $\phi = (1 - m)\gamma + m\beta$ the “average” entrepreneurial discount rate and $H = 1$ the total physical supply of real estate in each country. In steady state, α will equal:

$$\alpha^* = 1 - \frac{1}{2} \frac{1 - m}{1 - z} \quad (\text{A.6})$$

We can plug back the optimal value of α^* into the remaining equations to find that in steady state:

$$k = \frac{\gamma\mu}{1 - \gamma(1 - \delta)} y \quad (\text{A.7})$$

$$c' = (R - 1) (b^H + b^{F*} [+b]) + (1 - \mu - \nu) y \quad (\text{A.8})$$

$$c = (\mu + \nu) y - \delta k - (R - 1) (b^H + b^F) \quad (\text{A.9})$$

$$\frac{h}{1 - h} = \frac{\gamma\nu(1 - \beta)}{j[\gamma\nu(1 - \beta)m + (1 - \nu)(1 - \phi)]} \quad (\text{A.10})$$

$$\frac{q}{c} = \frac{j}{(1 - \beta)(1 - h)} \quad (\text{A.11})$$

$$q = \frac{\gamma\nu}{1 - \phi} \frac{y}{h} \quad (\text{A.12})$$

$$Rb^H = mqh \left(1 - \frac{1}{2} \frac{1 - m}{1 - z} \right) \quad (\text{A.13})$$

$$Rb^F = \frac{qh}{4} \frac{1 - m^2}{1 - z} \quad (\text{A.14})$$

$$y^{1 - \frac{1 - \nu - \mu}{\eta}} = A \left(\frac{1 - \nu}{\tau} \frac{1}{c'} \right)^{\frac{1 - \nu - \mu}{\eta}} h^\nu k^\mu \quad (\text{A.15})$$

The corresponding equations for the foreign economy are similar. Goods market clearing yields:

$$1 - \left(\frac{c}{y} + \frac{c'}{y} + \frac{\delta k}{y} \right) = \left(\frac{c^*}{y^*} + \frac{c'^*}{y^*} + \frac{\delta k^*}{y^*} - 1 \right) \frac{y^*}{y} \quad (\text{A.16})$$

A.3. Log-linear equilibrium

Here we present our complete log-linearized model, allowing for variable capital. All the variables with a time subscript are in percentage deviations from their steady state levels (indicated without subscripts). To save on notation, we drop the expectation operator before $t + 1$ variables, which must be intended in expected value.

The equations for the domestic economy are:

$$\frac{c'}{y}c'_t + \frac{b^H}{y}b_t^H + \frac{b^{F*}}{y}b_t^{F*} + \frac{b}{y}b_t = \frac{R(b^H + b^{F*} + b)}{y}R_{-1} + \frac{Rb}{y}b_{-1} + \frac{Rb^H}{y}b_{-1}^H + \frac{Rb^{F*}}{y}b_{-1}^{F*} + (1 - \mu - \nu)y_t + \frac{qh}{y}\Delta h_t \quad (\text{A.17})$$

$$(\mu + \nu)y_t + \frac{b^H}{y}b_t^H + \frac{b^F}{y}b_t^F = \frac{R(b^H + b^F)}{y}R_{-1} + \frac{Rb^H}{y}b_{-1}^H + \frac{Rb^F}{y}b_{-1}^F + \frac{qh}{y}\Delta h_t + \frac{c}{y}c_t + \frac{k}{y}(k_t - (1 - \delta)k_{-1}) \quad (\text{A.18})$$

$$c'_{t+1} = c'_t + R_t \quad (\text{A.19})$$

$$q_t = \beta q_{t+1} + \frac{(1 - \beta)h}{1 - h}h_t + c'_t - \beta c'_{t+1} \quad (\text{A.20})$$

$$(1 - (1 - \nu - \mu)/\eta)y_t = A_t + \nu h_{t-1} + \mu k_{t-1} - ((1 - \nu - \mu)/\eta)c'_t \quad (\text{A.21})$$

$$R_t + b_t^H = (1/\alpha)(q_{t+1} + h_t) \quad (\text{A.22})$$

$$R_t + b_t^F = 0 \quad (\text{A.23})$$

$$q_t - \phi q_{t+1} = (1 - m\beta)(c_t - c_{t+1}) + (1 - \phi)(y_{t+1} - h_t) - m\beta R_t \quad (\text{A.24})$$

$$0 = c_t - c_{t+1} + (1 - \gamma(1 - \delta))(y_{t+1} - k_t) \quad (\text{A.25})$$

The equations for the foreign economy are:

$$\frac{c^{*'}}{y^*}c^{*'}_t + \frac{b^{H*}}{y^*}b_t^{H*} + \frac{b^F}{y^*}b_t^F - \frac{b}{y^*}b_t = \frac{R(b^{H*} + b^F - b)}{y^*}R_{-1} - \frac{Rb}{y^*}b_{-1} + \frac{Rb^{H*}}{y^*}b_{-1}^{H*} + \frac{Rb^F}{y^*}b_{-1}^F + (1 - \mu - \nu)y_t^* + \frac{q^*h^*}{y^*}\Delta h_t^* \quad (\text{A.26})$$

$$(\mu + \nu)y_t^* + \frac{b^{H*}}{y^*}b_t^{H*} + \frac{b^{F*}}{y^*}b_t^{F*} = \frac{R(b^{H*} + b^{F*})}{y^*}R_{-1} + \frac{Rb^{H*}}{y^*}b_{-1}^{H*} + \frac{Rb^{F*}}{y^*}b_{-1}^{F*} + \frac{q^*h^*}{y^*}\Delta h_t^* + \frac{c^*}{y^*}c_t^* + \frac{k^*}{y^*}(k_t^* - (1 - \delta)k_{-1}^*) \quad (\text{A.27})$$

$$c^{*'}_{t+1} = c^{*'}_t + R_t \quad (\text{A.28})$$

$$q_t^* = \beta q_{t+1}^* + \frac{(1 - \beta)h^*}{1 - h^*}h_t^* + c_t^* - \beta c_{t+1}^* \quad (\text{A.29})$$

$$(1 - (1 - \nu - \mu)/\eta)y_t^* = A_t^* + \nu h_{t-1}^* + \mu k_{t-1}^* - ((1 - \nu - \mu)/\eta)c_t^* \quad (\text{A.30})$$

$$R_t + b_t^{H*} = (1/\alpha^*)(q_{t+1}^* + h_t^*) \quad (\text{A.31})$$

$$R_t + b_t^{F*} = 0 \quad (\text{A.32})$$

$$q_t^* - \phi^* q_{t+1}^* = (1 - m^*\beta)(c_t^* - c_{t+1}^*) + (1 - \phi^*)(y_{t+1}^* - h_t^*) - m^*\beta R_t \quad (\text{A.33})$$

$$0 = c_t^* - c_{t+1}^* + (1 - \gamma(1 - \delta))(y_{t+1}^* - k_t^*) \quad (\text{A.34})$$

In the exogenous- α economy, the linearized borrowing constraints (equations A.22, A.23, A.31 and A.32) become:

$$R_t + b_t^H = q_{t+1} + h_t \quad (\text{A.35})$$

$$R_t + b_t^F = q_{t+1} + h_t \quad (\text{A.36})$$

$$R_t + b_t^{H*} = q_{t+1}^* + h_t^* \quad (\text{A.37})$$

$$R_t + b_t^{F*} = q_{t+1}^* + h_t^* \quad (\text{A.38})$$

B. Data issues, sources and description

Here we report the exact variable names, sources and definitions for the variables used in the empirical section of the paper.

Variable name: Domestic Loans

Source: Federal Reserve Board.

Definition: Commercial and Industrial Loans of Domestically Chartered Banks in the United States (Quarter Average)

.

Variable name: Foreign Loans

Source: Federal Reserve Board

Definition: Commercial and Industrial Loans of Foreign Related Institutions in the United States, Seasonally Adjusted (Quarter Average)

.

Variable name: Commercial Property Prices

Source: NCREIF (National Council of Real Estate Investment Fiduciaries)

Definition: Commercial Property Price Index (Quarter Average, Deflated with the GDP deflator, quarter on quarter percent change)

.

Variable name: Real Private Non-Residential Fixed Investment

Source: BEA

Definition: Log change in the real private Non-Residential Fixed Investment

.

Variable name: Leverage

Source: Flows of Funds of United States, Federal Reserve Board, Release Z1, Table B.102 Balance Sheet of Nonfarm Noncorporate Business, Line 35.

Definition: Non-Farm Non-Financial Businesses Leverage (Credit Market Liabilities divided by Market value of Net Worth)

Unit: *Demeaned*

.

Variable name: Japan Land Price Index

Source: Japan Real Estate Institute

Definition: All urban land price index (Deflated with the Japan Consumer Price Index, percent change)

Notes: The original series is semi-annual. A quarterly one was obtained via interpolation with a cubic spline

.

Variable name: Foreign Direct Investment

Definition: Net FDI in the US

Source: BEA

Notes: The series is available on a quarterly basis from 1994Q1. Until 1993, there is only an annual series available (a quarterly one was obtained via interpolation with a cubic spline)

.

Variable name: Capital Ratios

Definition: Capital and reserves of commercial banks (all banks for US, large commercial banks for Japan) as a percent of year-end total balance sheet

Source: OECD, Bank profitability, Financial Statements of Banks, Statistical Supplement, Various Years (Commercial Banks)

Notes: The original series were annual, and were converted with a linear trend. The series were available only until 2000. We obtained the values for 2001 and 2002 extrapolating the series with an AR(1) procedure.

C. Tables and Figures

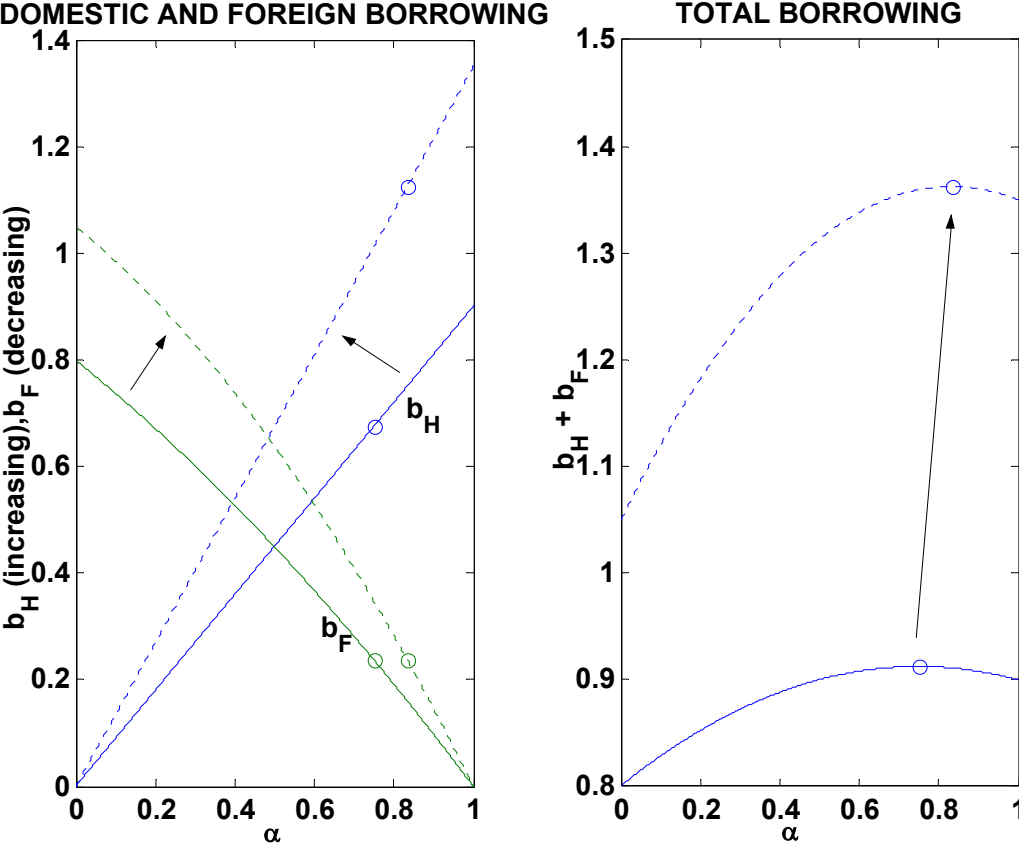


Figure C.1: Optimal choice of α , the share of domestic borrowing

Description	Parameter	Model	
		Basic	Extended
households discount	β	.99	.99
entrepreneurs discount	γ	.98	.98
domestic LTV	m	.9	.9
foreign LTV	z	.8	.8
housing services utility	j	.1	.1
real estate share	ν	.1	.1
labor wage elasticity	$\frac{1}{\eta-1}$.05	.05
variable capital share	μ	—	0.25
variable capital deprec.	δ	—	0.03
Autocorrelation and variance covariance of shocks			
$\begin{bmatrix} \widehat{A}_{t+1} \\ \widehat{A}_{t+1}^* \end{bmatrix} = \Gamma \begin{bmatrix} \widehat{A}_t \\ \widehat{A}_t^* \end{bmatrix} + \varepsilon_t$		$\Gamma = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$	$\Gamma = \begin{bmatrix} .9 & .09 \\ .09 & .9 \end{bmatrix}$
$E\varepsilon\varepsilon' = \Xi$		$\begin{bmatrix} .726 & 0 \\ 0 & .726 \end{bmatrix}$	$\begin{bmatrix} .726 & .187 \\ .187 & .726 \end{bmatrix}$

Table C.1: Calibrated Parameter Values

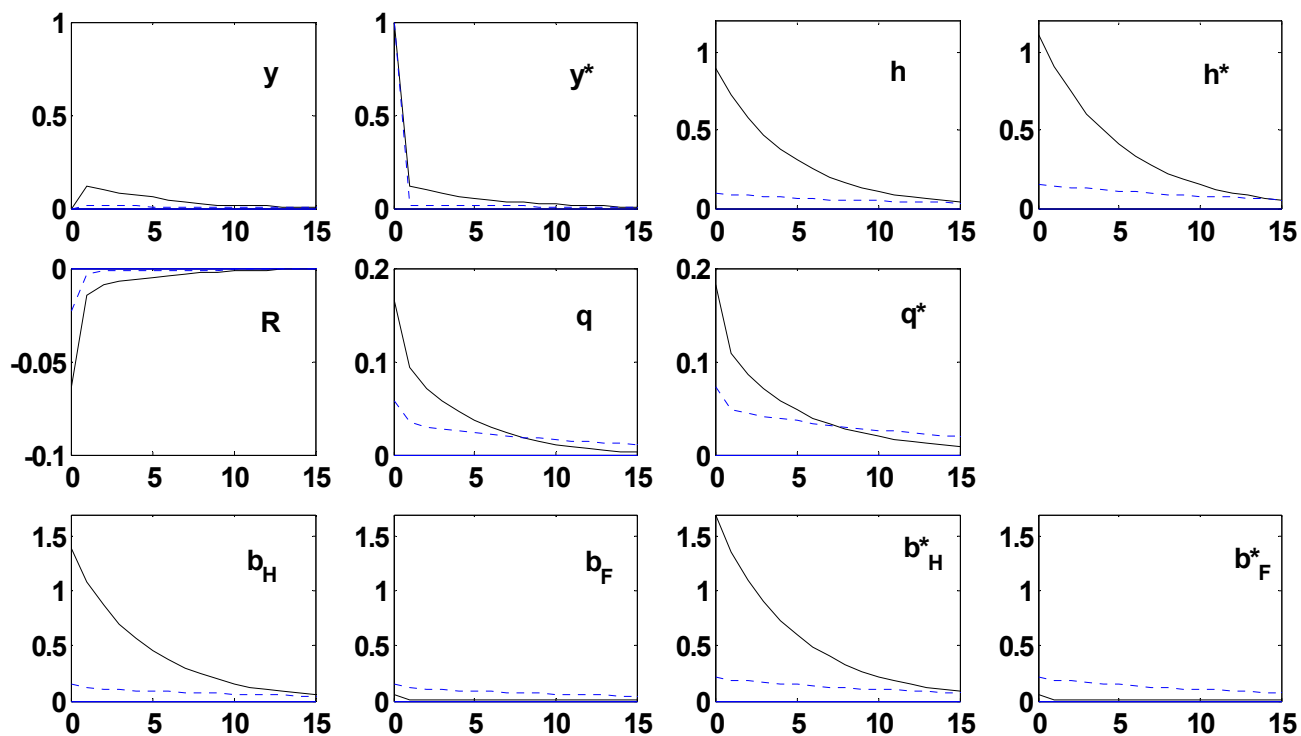


Figure C.2: Impulse responses to a purely temporary foreign productivity shock at time 0, model without variable capital. Solid lines: model with asymmetry between domestic and foreign lenders (endogenous α). Dashed lines: model with symmetric lenders (exogenous α). *Ordinate*: Time Horizon in Quarters. *Coordinate*: % deviation from the baseline.

	Model					
	<i>Endo. α</i>	<i>Exo. α</i>	<i>BKK Benchmark</i>	<i>BKK Transport</i>	<i>BKK Autarky</i>	<i>US data</i>
Correlations with y						
b^H	0.77	0.81	na	na	na	0.52
b^F	-0.65	0.81	na	na	na	-0.14
q	0.67	0.45	na	na	na	0.58
C	0.84	0.77	0.79	0.82	0.91	0.87
world correlations						
y and y^*	0.27	0.16	-0.18	0.02	0.11	0.51
C and C^*	0.95	0.95	0.88	0.91	0.73	0.32
q and q^*	0.95	0.95	na	na	na	0.50

Table C.2: Business Cycle Properties: Predicted Correlations

Business cycle properties of the model with variable capital. All series are detrended using the HP filter. The correlations in column 4 are from Backus, Kehoe and Kydland (1992) benchmark two-country international RBC model with a time-to-build structure. The correlations in column 5 are from Backus, Kehoe and Kydland (1992) model augmented with a cost for shipping goods across the border. The correlations in column 6 are from Backus, Kehoe and Kydland (1992) autarky model with no physical trade and no international borrowing. In the last column, the international correlations for y , y^* , C and C^* are calculated from US variables and an aggregate of 15 European countries and are from Kehoe and Perri (2002). Those of y with b^H , b^F , q and C and the international correlation of q with q^* are calculated using data on domestic loans, foreign loans, commercial real estate and Japan real estate (land) prices (all in real terms) as described in the appendix and in the next section.

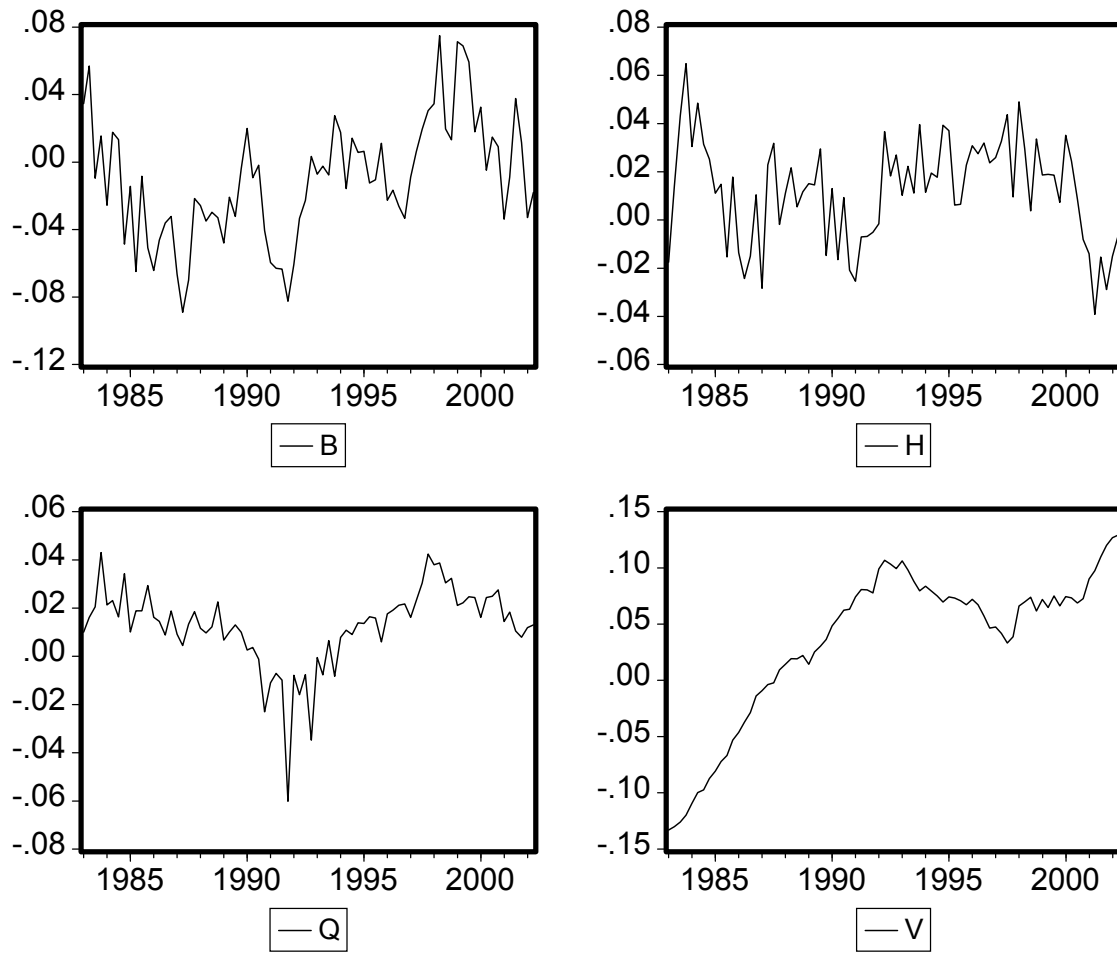


Figure C.3: Plot of growth rate of domestic over foreign loans (B), growth rate of non-residential fixed investment (H), growth rate of commercial real property prices (Q), leverage minus its sample average (V)

Dependent variable: $\Delta \ln$ (domestic loans \div foreign loans)					
		(1)	(2)	(3)	(4)
Intercept	ψ_0	-0.030 (.006)	-0.008 (.003)	-0.012 (.003)	-0.012 (.002)
Lagged Dependent Variable	ψ_1		0.645 (.052)	0.668 (.059)	0.687 (.068)
$\Delta \ln$ (Expected Comm.Prop + Fixed Investment)	ψ_2	0.600 (.175)	0.251 (.085)	0.161 (.080)	0.148 (.069)
Leverage \times $\Delta \ln$ (Exp. Comm.Prop + Fixed Inv.)	ψ_3			3.031 (.616)	2.162 (.588)
$\Delta \ln$ Japan Real Land Price Index	ψ_4				-0.348 (.129)
Δ (Foreign Direct Investment \div GDP)	ψ_5				-0.464 (.074)
Δ (US – Japanese banks capital ratios)	ψ_6				0.012 (.015)
Adjusted R^2		0.117	0.497	0.464	0.418
j -statistic		0.047	0.076	0.077	0.123

Table C.3: Regression Results, GMM estimates

The table reports GMM estimates of various versions of Eq. 3.1. Estimates are based on quarterly data over the period 1983:1 - 2002:2. Δ denotes the first difference operator. The set of instruments includes in each regression four lags of the explanatory variables and the long-short interest rate spread. Robust standard errors are reported in parentheses. The last row reports the p-value associated with Hansen's j -test of the model's overidentifying restrictions.