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Financial Integration and International Business Cycle Co-Movement: The Role of Balance Sheets*

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Abstract

This paper investigates the effect of international financial integration on international business cycle co-movement. We first show with a reduced form empirical approach how capital market integration (equity) has a negative effect on business cycle co-movement while credit market integration (debt) has a positive effect. We then construct a model that can replicate these empirical results. In the model, capital market integration is modeled as cross-border equity ownership and involves wealth effects. Credit market integration is modeled as cross-border borrowing and lending between credit constrained entrepreneurs and banks, and thus involves balance sheet effects. The wealth effect tends to reduce cross-country output correlation, but balance sheet effects serve to increase correlation as a negative shock in one country causes loan losses on the balance sheets of foreign banks. In versions of the model with a financial accelerator and balance sheet effects, credit market integration has a positive effect on cyclical correlation. However, in versions of the model without the financial accelerator and balance sheet effects, credit market integration has a negligible effect on cyclical correlation.

JEL codes: E30, E44, F40, G15

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1 Introduction

The last few decades have seen a rapid increase in the degree of international financial integration. The stock of cross-country asset holdings has more than tripled as a percent of GDP since the mid-1980's (Lane and Milesi-Ferretti 2007). Therefore an interesting question, from both an academic and a policy perspective, is what effect this increased financial integration will have on the co-movement of business cycles across countries.

This seemingly simple question has received little attention in the literature.[1] This is partly due to the lack of available data, but it is also due to the lack of a clear intuitive explanation and the conflicting conclusions of many theoretical and empirical studies.

Using a cross-sectional regression framework, Imbs (2004 and 2006) and Kose, Prasad, and Terrones (2003) find that financial integration has a positive effect on cyclical co-movement. Kose, Otrock, and Prasad (2008) and Kose, Otrock, and Whitman (2008) find the same results with a dynamic latent factor model. Furthermore, by studying cases of international crisis and contagion, Kaminsky and Reinhart (2000) highlight the importance of international bank lending in the international spread of financial crises, Moto et al. (2007) find empirical evidence of a cross-country financial accelerator involved in the transmission of business cycles across borders, and Cetorelli and Goldberg (2010) use bilateral data on cross-border lending to show how cross-border financial integration led to the international transmission of the 2007-2009 crisis.[2]

However, the conclusion that cross-border financial integration should lead to greater international transmission and greater cross-country business cycle correlation is at odds with much of the theoretical literature. International real business cycle models in Baxter and Crucini (1995), Kehoe and Perri (2002), and Heathcote and Perri (2002, 2003, and 2004) and a model with sticky prices in Faia (2007) all find that increases in cross-border financial

[1] Relative to the attention paid to the effect of trade integration on cyclical co-movement.

[2] In contrast to these papers that argue that financial integration has a positive effect on cyclical co-movement, Kalemli-Ozcan, Papaioannou, and Peydró (2008) in a panel data study, find evidence that financial integration leads to less synchronized business cycles.

integration lead to a fall in cross-country business cycle correlation. Imbs (2006) goes so far as to say that the robust positive association between financial integration and cross-country co-movement in the data and the robust negative relationship in theory constitutes a puzzle.

While many of these models in the IRBC and new Keynesian tradition find that increased bilateral financial integration leads to less correlated business cycles, other models incorporating information asymmetry and financial frictions find the opposite. Allen and Gale (2000) show how international financial integration can lead to the spread of a financial panic and therefore has implications for real economic activity. Witnessing the international transmission of the recent financial crisis, a number of papers like Dedola and Lombardo (2009), Devereux and Yetman (2010), Ueda (2010), and Kollmann, Enders, and Müller (2011) have incorporated cross-border financial integration into a model with a financial accelerator and show how increased cross-border lending and financial flows have a positive effect on cross-country output correlation.

This paper shows that the reason for these conflicting empirical and theoretical results, and even the conflicting results between different theoretical models, is that different types of financial integration have different effects on cyclical co-movement. Specifically this paper shows that capital market integration (equity and FDI) has a negative effect on cyclical correlation, while credit market integration (debt) can have a positive effect.

First, we show this empirically. In a cross sectional regression similar to that in Imbs (2004 and 2006), we show that when a measure of aggregate bilateral financial integration is divided into separate measures of bilateral credit market integration and bilateral capital market integration, credit market integration has a positive effect on cyclical co-movement and capital market integration has a negative effect.

We then construct an international business cycle model with both cross-border equity ownership and cross-border bank lending that can replicate this empirical result. The key distinction is that cross-border equity ownership involves non-credit constrained parties, whereas cross-border borrowing and lending involves credit constrained entrepreneurs and banks.

Cross-border equity ownership involves wealth effects. As shown in Baxter and Crucini (1995), wealth effects will tend to reduce the degree of international transmission in an international business cycle model, as one country will take extra leisure while the other works when one country is hit by a shock and has a temporary absolute advantage. This tendency, described as the tendency to "make hay where the sun shines" by Backus, Kehoe, and Kydland (1995), is a feature of any international business cycle model with a high degree of cross-border equity integration and thus ex-ante risk sharing.

Cross-border debt holding involves balance-sheet effects. If domestic banks make loans to foreign entrepreneurs, then a negative shock in the foreign country which leads to a fall in foreign output and an increase in foreign bankruptcies will affect the balance sheets of domestic banks. If these banks face credit constraints, they will respond to the increased losses on their foreign loan portfolio by reducing the supply of credit to both domestic and foreign borrowers, leading to a drop in domestic output. The fact that international lending by leveraged intermediaries can lead to international transmission is referred to as the *international financial multiplier* in Krugman (2008) and is one leg of the "Unholy Trinity of Financial Contagion" in Kaminsky, Reinhart and Vegh (2003).[3]

Of course for balance sheets, particularly the balance sheets of financial intermediaries, to have an effect, the model needs to violate the assumptions necessary for the irrelevance of financial conditions implied by the Miller and Modigliani (1958) theorem. The model relies on the financial accelerator mechanism from Bernanke, Gertler, and Gilchrist (1999): borrowers pay an external finance premium that is a positive function of their level of indebtedness. However, in a deviation from the Bernanke, Gertler, and Gilchrist (1999) financial accelerator model, here we incorporate a financial intermediary sector and most importantly, financial frictions in the intermediary sector.[4]

[3] The different channels through which cross-border lending by leveraged intermediaries can serve as a transmission mechanism, some through solvency and some through liquidity, are summarized in Kollmann and Malherbe (2011).

[4] The model in this paper follows closely with the model presented in Davis (2010), but a number of other

The rest of this paper is organized as follows. In section 2 we provide robust empirical evidence that bilateral capital market integration leads to business cycle divergence while bilateral credit market integration leads to cyclical convergence. A model that can explain these empirical results is presented in sections 3 and 4. Section 5 presents the results from simulations of this model. In this section we show not only that the model can replicate our empirical findings, but that financial sector risk is the key mechanism driving the results related to credit market integration. Finally, section 6 concludes with some directions for further research.

2 Empirics

2.1 Regression model

To empirically study the effect of financial integration on business cycle co-movement we use a regression model that is common in empirical studies that examine the role of factors like international trade integration or industrial specialization on international business cycle co-movement.[5] Since both bilateral trade integration and industrial specialization can arise endogenously between two financially integrated economies, we need to control for both trade and specialization to isolate the effect of financial integration on cyclical co-movement. The cross-sectional regression equation we use is:

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papers also present models where balance sheets in the intermediaty sector can have macroeconomic effects (see e.g. Holstrom and Tirole 1997, Stein 1998, Chen 2001, and von Peter 2009)

Motivated by the recent crisis and the central role of the increase in interbank lending spreads (see Taylor and Williams 2009), a number of recent papers incorporate financial frictions *within* the intermediary sector in a quantitative business cycle model (see e.g. Aikman and Paustain 2006, Gertler and Karadi 2011, Gertler and Kiyotaki 2010, Gilchrist et al. 2009, Curdia and Woodford 2009, Hirakata, Sudo, and Ueda 2009, Dib 2010, and Meh and Moran 2010).

Van Den Heuvel (2009) writes specifically of the "bank capital channel" of monetary policy transmission (as opposed to the "bank lending channel") whereby monetary policy leads to changes in a bank's net worth and in the presence of financial frictions in the banking sector, this change in net worth affects the supply of lending from the intermediary sector.

[5] See Frankel and Rose (1998), Clark and van Wincoop (2001), Kalemli-Ozcan et al. (2001), and Imbs (2004 and 2006) among others.

$$\rho_{ij} = \alpha + \beta F_{ij} + \delta T_{ij} + \gamma S_{ij} + \varepsilon_{ij} \tag{1}$$

where ρ_{ij} is a measure of bilateral GDP correlation between countries i and j, F_{ij} is a measure of bilateral financial integration, T_{ij} is a measure of bilateral trade integration, and S_{ij} is a measure of bilateral industrial specialization.

In this model, β measures the effect of financial integration on cyclical co-movement. However, F_{ij} is a combination of both credit (debt) and capital (equity and FDI) market integration. If we include credit and capital market integration as separate terms then the regression model becomes:

$$\rho_{ij} = \alpha + \beta_1 C_{ij} + \beta_2 K_{ij} + \delta T_{ij} + \gamma S_{ij} + \varepsilon_{ij} \tag{2}$$

where C_{ij} is a measure of bilateral credit market integration between countries i and j and K_{ij} is a measure of credit market integration. Thus β_1 and β_2 measure the effect of greater credit and capital market integration, respectively, on cyclical co-movement.

2.2 Variables and data

2.2.1 Measures of credit and capital market integration

We use four different measures of financial integration. The first two are "volume based" measures. These actually measure the volume of financial flows between two countries. The last two measures are "effective" measures, which proxy the degree of financial integration by looking at the effects of this integration. These include the similarities in interest rates, or the extent of risk sharing.

The first measure of bilateral financial integration is based on the Coordinated Portfolio Investment Survey (CPIS) conducted by the IMF and featured in Imbs (2006). This survey includes data on portfolio assets, both debt and equity, issued by residents of country i and owned by residents of country j, c_{ij} and k_{ij}. The proxies for bilateral credit and capital market integration that we use in the disaggregated regression model in (2), C_{ij}^{cpis} and K_{ij}^{cpis}, is simply the total bilateral debt or equity flows normalized by the sum of the two countries' GDPs:

$$
\begin{aligned}
C_{ij}^{cpis} &= \frac{c_{ij} + c_{ji}}{GDP_i + GDP_j} \\
K_{ij}^{cpis} &= \frac{k_{ij} + k_{ji}}{GDP_i + GDP_j}
\end{aligned} \tag{3}
$$

Our second measure of financial integration is also volume based. Here we use data on external assets and liabilities for a wide range of countries compiled by Lane and Milesi-Ferretti (2007). This dataset divides external asset and liability positions into debt, as well as portfolio equity and FDI. Therefore our proxies for bilateral credit and capital market integration are given by:

$$
\begin{aligned}
C_{ij}^{nfa} &= \left| \frac{nfa_i^c}{GDP_i} - \frac{nfa_j^c}{GDP_j} \right| \\
K_{ij}^{nfa} &= \left| \frac{nfa_i^k}{GDP_i} - \frac{nfa_j^k}{GDP_j} \right|
\end{aligned} \tag{4}
$$

where nfa_i^c is equal to country i's external debt assets minus their external debt liabilities, and nfa_i^k is equal to the country's external portfolio equity and FDI assets minus their external portfolio equity and FDI liabilities.

This proxy for financial integration is introduced in Imbs (2004), and the reason it is a reasonable proxy for bilateral financial integration is as follows. If country i is a net creditor with a large and positive net foreign asset position and country j is a net debtor with a large and negative net foreign asset position, then it is likely that there are financial flows from country i to country j. In this case, C_{ij}^{nfa} and K_{ij}^{nfa} will be large. If on the other hand both countries are net creditors and have positive net foreign asset positions then it is less likely that there are financial flows between the two, and C_{ij}^{nfa} and K_{ij}^{nfa} is small. Similarly, even if one country is a net creditor and one is a net debtor, but their net foreign asset positions are relatively small then the financial flows between the two may be small; C_{ij}^{nfa} and K_{ij}^{nfa} is small to reflect this.

The effective measures of financial integration proxy integration by interest rate differentials and the degree of risk sharing. The first effective measure uses the mean absolute deviation of the real rates of return in countries i and j. The measure of credit market integration is the mean absolute deviation of bond returns, C_{ij}^{mad}, and the measure of capital market integration is the mean absolute deviation of stock returns, K_{ij}^{mad}.

$$\begin{aligned} C_{ij}^{mad} &= \frac{1}{T}\sum_{t=1}^{T}\left|r_{it}^{b}-r_{jt}^{b}\right| \\ K_{ij}^{mad} &= \frac{1}{T}\sum_{t=1}^{T}\left|r_{it}^{s}-r_{jt}^{s}\right| \end{aligned} \tag{5}$$

where r_{it}^{b} is the real rate of return on bonds in country j in period t, and r_{it}^{s} is the real rate of return on stocks. If country i and country j are integrated financially, then arbitrage conditions require that their real rates of return are equal. Thus C_{ij}^{mad} and K_{ij}^{mad} should be small for financially integrated economies.

The fourth measure of financial integration measures the extent of income and consumption risk sharing in countries i and j. This relies on a measure of risk sharing introduced by Asdrubali, Sorensen, and Yosha (1996) and is the primary measure of financial integration in Kalemli-Ozcan, Sorensen, and Yosha (2003). The measure of income risk sharing is the coefficient β_i^k, and the measure of consumption risk sharing is the coefficient β_i^c in the following panel data regressions:

$$\begin{aligned}\Delta\log(GDP_{it})-\Delta\log(GNP_{it}) &= \alpha_t^k+\beta_i^k\Delta\log(GDP_{it})+\varepsilon_{it}^k \\ \Delta\log(GNP_{it})-\Delta\log(C_{it}) &= \alpha_t^c+\beta_i^c\Delta\log(GDP_{it})+\varepsilon_{it}^c\end{aligned} \tag{6}$$

In the case of no income risk sharing , $\beta_i^k=0$, idiosyncratic fluctuations in GDP_{it} translate directly into fluctuations in GNP_{it} (up to some aggregate fluctuation, α_t^k, and some idiosyncratic error, ε_{it}^k). In the case of perfect income risk sharing, $\beta_i^k=1$, idiosyncratic fluctuations in GDP_{it} do not carry through into fluctuations in GNP_{it}, and GNP_{it} is a constant (again, up to some aggregate, and thus non-diversifiable, fluctuation, and some idiosyncratic error). International capital market integration leads to this income risk sharing. Thus if $K_{ij}^{rs}=\beta_i^k+\beta_j^k$ is high then countries i and j are well integrated in the international capital markets. This makes it likely that the degree of bilateral capital market integration between countries i and j is high.

The same logic can be used to show how $C_{ij}^{rs}=\beta_i^c+\beta_j^c$ is a measure of international credit market integration.

Some summary statistics for our four measures of credit market integration and our four measures of capital market integration are listed in table 1. Table 2 lists the unconditional correlation between these measures of credit and capital market integration.

Table 2 shows that in almost every case, C and K are highly correlated. Using the CPIS data, the correlation between C^{cpis} and K^{cpis} is over 70%, and it is over 50% and 60% using the net foreign asset data (C^{nfa} and K^{nfa}) and the mean absolute deviation of asset returns (C^{mad} and K^{mad}).

This fact highlights an important contribution of this paper. Given that C and K are highly correlated, any attempt to *pull apart* the effects of credit and capital market integration on cyclical co-movement would require many more degrees of freedom than are available in the previous empirical studies mentioned earlier. The data in this paper is specifically chosen to maximize the country coverage, and thus maximize the number of bilateral observations. We use 58 countries in this study, so there are a total of 1653 country pairs. These 58 countries produce 95% of world GDP. The full list of countries can be found in the appendix.

2.2.2 Measures of Co-movement, Trade integration, and Specialization

Our measure of bilateral business cycle correlation, ρ_{ij}, is the correlation of GDP fluctuations between countries i and j. Since GDP is non-stationary, we need to detrend the data before finding correlations. Our primary detrending method is the Hodrick-Prescott filter, but for robustness we repeat the estimation using log differences and linear detrending.

If instead of measuring the separate effects of credit and capital market integration we wish to find the effect of aggregate financial integration on cyclical co-movement, as in (1), the aggregate measure of financial integration, F_{ij}, is simply the sum of the measures of credit and capital market integration, $C_{ij} + K_{ij}$.

For data on bilateral trade flows we use the Trade, Production, and Protection database compiled by the World Bank and described in Nicita and Olarreaga (2006). This data set contains bilateral trade data, disaggregated into 28 manufacturing sectors corresponding to the 3 digit ISIC level of aggregation. It also contains country level production and tariff data with a similar level of disaggregation. The data set potentially covers 100 countries over the period $1976-2004$, but data availability is a problem for some countries, especially during the first half of the sample period. To maximize the number of countries in our sample, we use data for 58 countries from $1991-2004$.

To measure trade integration we use the measure of bilateral trade intensity from Frankel and Rose (1998). If the set $\mathcal{N}$ contains the 28 sectors in the Trade, Production, and Protection data base, then a measure of trade intensity is given by:

$$T_{ij} = \sum_{s \in \mathcal{N}} \frac{X_{ij}^s + M_{ij}^s}{GDP_i + GDP_j} \tag{7}$$

where X_{ij}^s represents the exports in sector s from country i to country j, and M_{ij}^s represents imports into sector s in country i from country j.

With the sectoral value added data in the Trade, Production, and Protection database, we can construct a measure of bilateral industrial specialization. This measure, from Clark and van Wincoop (2001) and Imbs (2004 and 2006), is defined as follows:

$$S_{ij} = \sum_{s \in \mathcal{N}} \left| \frac{VA_i^s}{GDP_i} - \frac{VA_j^s}{GDP_j} \right| \tag{8}$$

where VA_i^s represents value-added in sector s in country i.

Some statistics describing the four variables, ρ, F, T, and S can be found in table 3. The four different proxies for financial integration are listed separately in this table. Here it should be noted that the measure of financial integration based on the cross-country mean absolute deviation of asset returns in an inverse measure. Thus a low F^{mad} implies greater bilateral financial integration.

The unconditional correlations between these aggregate endogenous variables are found in table 4. Financial integration tends to be positively correlated with business cycle correlation, but this result is not robust across all four measures of financial integration. Furthermore, the high correlation between financial integration and trade or specialization implies that endogeneity may be an issue and that we must control for trade and specialization to find the effect of financial integration on cyclical correlation.

The table also shows that the four measures of financial integration are largely uncorrelated. The correlations between the different F's are generally positive, but small, and never more than 20%. This implies that these measures of financial integration are generally orthogonal and capture different aspects of bilateral financial integration.

2.2.3 Instruments

Reverse causality is a potential issue in the regression models in (1) and (2). This is especially true when finding the effect of financial integration on business cycle co-movement. Heathcote and Perri (2004) detail how bilateral business cycle correlation has a negative effect on bilateral financial integration. Bilateral business cycle correlation may potentially affect bilateral financial integration, trade integration, and industrial specialization. To correct for this, we estimate this model using both OLS and GMM.

In the GMM estimations, we use six instruments for bilateral financial integration. The first three are suggested by Portes and Rey (2005). They find that the gravity variables that are commonly used to describe bilateral trade integration are also useful in explaining bilateral financial integration. Therefore the first three instruments for bilateral financial integration between countries i and j are the physical distance between the capital of i and the capital of j, a dummy variable equal to one if countries i and j share the same language, and a dummy variable equal to one if the two countries share a border. The next three elements are from the law and finance literature, and are indices that describe the rule of law in a country, the strength of creditor rights, and the strength of shareholder rights. These indices were developed by La Porta et al. (1998), and this original paper supplies the data for most of the countries in this study. However we also refer to Pistor, Raiser, and Gelfer (2000) for similar indices for the Eastern European Transition Economies and Allen, Qian, and Qian (2005) for China. The actual instrument is simply the sum of the index value in countries i and j.

In the regression model in (2) when bilateral financial integration is dividend into credit and capital market integration, identification requires that each endogenous variable in the regression has at least one unique instrument. In the disaggregated regression model, distance, the language dummy, the border dummy, and the index describing the rule of law are instruments for both credit and capital market integration. However the index describing the strength of creditor rights is unique to the endogenous variable describing credit market integration, and the index describing shareholder rights is unique to capital market integration.

There are six instruments for bilateral trade integration. All are taken from the gravity literature. The first five instruments are the physical distance between the capitals of the two countries, a dummy variable equal to one if the two countries share the same language, a dummy variable equal to one if the countries share a border, the number of countries in the pair that are islands, and the number of countries in the pair that are landlocked. The sixth instrument is a sum of tariff rates in the two countries. The Trade, Production, and Protection data set contains information on country and sector specific tariff rates. t_i^s is the average tariff applied to imports from sector s into country i. The sixth instrument is simply the sum of these tariff rates across countries i and j and across sectors in $\mathcal{N}$, $t_{ij} = \sum_{s \in \mathcal{N}} \left(t_i^s + t_j^s\right)$.

There are three exogenous instruments for bilateral industrial specialization between countries i and j. The first two of these describe per capita income in countries i and j. Imbs and Wacziarg (2003) show that sectoral diversification is closely related to per capita income. At low levels of income, countries are specialized, then as income increases they diversify. They also find that the relationship between income and diversification is non-monotonic. At high levels of income, as income increases, countries again specialize. For this reason, in his list of exogenous variables that influence specialization, Imbs (2004) includes the sum of per capita GDP across i and j to account for the fact that as income increases countries diversify, and he also includes the difference in per capita GDP across i and j to account for the non-monotonic relationship between income and diversification.

To these two variables we add a measure of comparative advantage. The revealed comparative advantage of country i for production in sector s is defined by Balassa (1965) as:

$$b_i^s = \frac{X_i^s}{\sum_s X_i^s} / \sum_k \left(\frac{X_k^s}{\sum_s X_k^s} \right)$$

where X_i^s are exports from country i in sector s. The third instrument for bilateral industrial specialization between countries i and j is $b_{ij} = \sum_{s \in \mathcal{N}} \left| b_i^s - b_j^s \right|$.

2.3 Regression results

The results from the regression models in (1) and (2) are presented in table 5. The table contains the results from each of our four proxies of financial integration. The table also reports both the OLS and GMM estimation results. However, since endogeneity is an issue, especially when discussing the impact of financial integration on cyclical co-movement, we will only discuss the GMM results.

In accordance with other empirical studies, the results show that regardless of the proxy for financial integration, trade integration has a positive effect on cyclical correlation and industrial specialization has a negative effect.

The table shows that the effect of financial integration on cyclical correlation is not robust to different proxies of financial integration. The effect of finance on co-movement is either positive, negative, or insignificant depending on our particular proxy for aggregate financial integration.

However, when aggregate financial integration is divided into credit and capital market integration, credit market integration has a positive effect on cyclical correlation and capital market integration has a negative effect. This result is robust across the four measures of financial integration.[6]

3 Theoretical Model

In the previous section we found robust empirical evidence that credit market integration has a positive effect on cyclical co-movement but capital market integration has a negative effect. In this section, we will construct a model that can replicate these empirical results.

[6] Recall that with the proxy for financial integration based on the mean absolute deviation of asset returns, (5), more integration implies a lower C or K, so in the regression results, a negative coefficient on C implies that credit market integration has a positive effect on co-movement.

The model needs to have two forms of cross-border financial integration. Cross-border capital market integration takes the form of cross-border equity ownership, like in Heathcote and Perri (2004) and produces the typical IRBC result that financial integration has a negative effect on output co-movement. Cross-border credit market integration takes the form of cross-border bank lending, as in Ueda (2010) and Kollmann, Enders, and Müller (2011) and under certain conditions produces the result that financial integration has a positive effect on output co-movement.

The model that we use to explain why credit market integration and capital market integration have different effects on cyclical co-movement is an adaptation of the model presented in Davis (2010). In the model there are five types of agents: firms, entrepreneurs, capital builders, banks, and households. There is also a central bank that sets the risk free nominal rate of interest.

Firms use capital and labor inputs to produce tradeable output that is used for consumption and investment. Each firm produces a differentiated good and sets prices according to a Calvo (1983) style price setting framework, giving rise to nominal price rigidity.

Entrepreneurs own physical capital and rent it to firms. This physical capital is financed partially through debt and partially through equity. In every period, an individual entrepreneur faces an idiosyncratic shock to the value of their physical capital assets. While these shocks have no direct aggregate effects, they introduce heterogeneity among entrepreneurs. The shock is uninsurable, and a fraction of entrepreneurs may experience an abnormally large shock to the value of their physical capital stock and be pushed into bankruptcy, while most will not. The uncertainty over which entrepreneurs will be pushed into bankruptcy and which will not is a type of financial friction in the real sector. The ratio of debt to equity on an entrepreneur's balance sheet determines their ability to withstand an abnormally large shock to the value of their capital stock. Creditors use the entrepreneur's debt-equity ratio to determine the riskiness of lending to the entrepreneurial sector, giving rise to a default risk interest premium that depends on the debt-equity ratio.[7]

Capital builders purchase final goods from firms for physical capital investment. There are diminishing marginal returns to physical capital investment. In periods when investment is high, the marginal return of that investment in producing new physical capital is low, and vice versa. This gives rise to a procyclical relative value of physical capital.

Banks channel savings from households to firms in the form of working capital loans and to entrepreneurs in the form of physical capital loans. A bank finances its asset portfolio partially through equity and partially through debt, which is made up of deposits from domestic and foreign households.

Due to bankruptcies in the real sector, a portion of a bank's portfolio of physical capital loans will go into default in any given period. While these loan losses are not great enough to push the entire banking sector into insolvency, there is heterogeneity among banks with regards to their exposure to the set of non-performing loans. A few banks may be over-exposed to the set of bad loans, and they themselves may be pushed into insolvency. The uncertainty about which banks are over-exposed to the set of non-performing loans and which are not is a type of financial friction in the banking sector. The ratio of debt to equity on a bank's balance sheet determines their ability to absorb loan losses, so the debt-equity ratio determines the ex-ante riskiness of a particular bank. This gives rise to an environment where the spread between interbank lending rates and the risk free rate is increasing in the leverage ratio of the banking sector.

Households supply labor to firms and consume final output. Furthermore they supply a differentiated type of labor and set wages according to a Calvo-style wage setting process, giving rise to nominal wage rigidity.

Finally, the central bank tries to stabilize output and prices by controlling the risk free nominal rate of interest.

The remainder of this section presents the actual details of the model. In what follows,

[7] The fact that this idiosyncratic shock is uninsurable provides the necessary violation of the complete markets assumption necessary to overcome the implications of the Miller and Modigliani theorem.

all variables are written in per capita terms and foreign variables are distinguished by an asterisk (*). The two countries are symmetric, so foreign equations have been omitted for brevity except where absolutely necessary.

3.1 Firms

In the home country, intermediate goods producing firms, indexed $i \in \left[0\ \frac{1}{2}\right]$, combine capital and labor, $k_t(i)$ and $h_t(i)$ to produce a unique intermediate good $Y_t(i)$. The firm's production function is:

$$Y_t(i) = A_t h_t(i)^{1-\alpha} k_t(i)^{\alpha} - \phi \tag{9}$$

where A_t is an exogenous country specific stochastic TFP parameter that is common to all firms and ϕ is a fixed cost parameter that is calibrated to ensure that firms earn zero profit in the steady state.

The output from firm i can be sold to the domestic market or sold as imports in the foreign market:

$$Y_t(i) = y_t^d(i) + y_t^{m*}(i)$$

where $y_t^d(i)$ is output from firm i that is sold domestically and $y_t^{m*}(i)$ is the output that is imported into the foreign country.

Intermediate goods from domestic and foreign firms are then combined into one aggregate final good. Domestically supplied and imported intermediate goods are aggregated by the following:

$$y_t = \left[\int_0^{\frac{1}{2}} y_t^d(i)^{\frac{\sigma-1}{\sigma}} di + \int_{\frac{1}{2}}^{1} y_t^m(i)^{\frac{\sigma-1}{\sigma}} di\right]^{\frac{\sigma}{\sigma-1}} \tag{10}$$

where σ is the elasticity of substitution between varieties from different firms.

From this aggregator function the demand in the home country for the intermediate good from domestic firm i, where $i \in \left[0\ \frac{1}{2}\right]$, as a function of aggregate demand is:

$$y_t^d(i) = \left(\frac{P_t^d(i)}{P_t}\right)^{-\sigma} y_t \tag{11}$$

Similarly, the demand in the home country for the intermediate good from foreign firm i, where $i \in \left(\frac{1}{2}\ 1\right]$, as a function of aggregate demand is:

$$y_t^m(i) = \left(\frac{P_t^m(i)}{P_t}\right)^{-\sigma} y_t \tag{12}$$

where $P_t = \left[\int_0^{\frac{1}{2}} P_t^d(i)^{1-\sigma}\, di + \int_{\frac{1}{2}}^{1} P_t^m(i)^{1-\sigma}\, di\right]^{\frac{1}{1-\sigma}}$.

Firm i can discriminate when setting prices for the domestic or foreign market. Thus they can set separate prices for the domestic and export markets. In period t, the firm will be able to change its price in the domestic market with probability $1-\xi_p$. If the firm cannot change prices then they are reset automatically according to $P_t^d(i) = \pi_{t-1} P_{t-1}^d(i)$, where $\pi_{t-1} = \frac{P_{t-1}}{P_{t-2}}$.

Thus if allowed to change their domestic price in period t, the firm will set a price to maximize:

$$\max_{P_t^d(i)} E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} \left\{\Pi_{t,t+\tau} P_t^d(i)\, y_{t+\tau}^d(i) - MC_{t+\tau} y_{t+\tau}^d(i)\right\}$$

where λ_t is the marginal utility of income in period t. As discussed in this paper's technical appendix, the firm that is able to change its domestic price in period t will set its price to:

$$P_t^d(i) = \frac{\sigma}{\sigma-1} \frac{E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} MC_{t+\tau} \left(\frac{\Pi_{t,t+\tau}}{P_{t+\tau}}\right)^{-\sigma} y_{t+\tau}}{E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} \Pi_{t,t+\tau} \left(\frac{\Pi_{t,t+\tau}}{P_{t+\tau}}\right)^{-\sigma} y_{t+\tau}}$$

If prices are flexible, and thus $\xi_p = 0$, then this expression reduces to:

$$P_t^d(i) = \frac{\sigma}{\sigma-1} MC_t$$

which says that the firm will set a price equal to a constant mark-up over marginal cost.

Write the domestic price set by the firm that can reset prices in period t as $\tilde{P}_t^d(i)$ to denote that it is an optimal price. Firms that can reset prices in period t will all reset to the same level, so $\tilde{P}_t^d(i) = \tilde{P}_t^d$. Substitute this optimal price into the price index $P_t^d = \left(2\int_0^{\frac{1}{2}} \left(P_t^d(i)\right)^{1-\sigma} di\right)^{\frac{1}{1-\sigma}}$. Since a firm has a probability of $1-\xi_p$ of being able to change their price, then by the law of large numbers in any period $1-\xi_p$ percent of firms will reoptimize prices, and the prices of ξ_p percent of firms will be automatically reset using the previous periods inflation rate. Thus the domestic price index, P_t^d, can be written as:

$$P_t^d = \left(\xi_p \left(\Pi_{t-1,t} P_{t-1}^d\right)^{1-\sigma} + \left(1-\xi_p\right)\left(\tilde{P}_t^d\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

The full details of this derivation as well as the derivation for prices set for the foreign market is located in the appendix.

The firm hires labor and capital inputs, where W_t is the wage rate paid for labor input and R_t is the capital rental rate, both of which the firm takes as given. Furthermore the firm must pay their wage bill in advance. To do so they borrow $b_t^{wc}(i) = W_t h_t(i)$. The firm's income after paying for capital and labor inputs is:

$$d_t^f(i) = P_t^d(i)\, y_t^d(i) + P_t^x(i)\, y_t^x(i) - W_t h_t(i) - R_t k_t(i) - r_t^{wc} b_t^{wc}(i) \tag{13}$$

where $P_t^x(i)$ is the export price for the intermediate good from firm i, and r_t^{wc} is the interest rate on working capital loans. Since there is no default risk from lending working capital to firms, competition in the banking sector forces the rate on working capital loans down to the bank's own cost of capital, $r_t^{wc} = r_t^b$.

The aggregate income from all firms is returned to households as a lump sum payment, $d_t^f = \int_0^n d_t^f(i)\, di$.

The firm will choose $h_t(i)$ and $k_t(i)$ to maximize profit in (13) subject to the production function in (9). The working capital requirement implies that the cost of the labor input is

$W_t\left(1+r_t^{wc}\right)$ and the cost of the capital input is R_t. Given these prices, the firm's demand for labor and capital inputs are:

$$\begin{aligned} h_t(i) &= (1-\alpha)\frac{MC_t}{W_t\left(1+r_t^{wc}\right)}Y_t(i) \\ k_t(i) &= \alpha\frac{MC_t}{R_t}Y_t(i) \end{aligned} \tag{14}$$

where $MC_t = \frac{1}{A_t}\left(\frac{W_t\left(1+r_t^{wc}\right)}{1-\alpha}\right)^{1-\alpha}\left(\frac{R_t}{\alpha}\right)^{\alpha}$.

3.2 Entrepreneurs

Entrepreneurs, indexed $j \in \left[0\ \frac{1}{2}\right]$, buy capital from capital builders and rent it to firms. At the beginning of period t, entrepreneur j has a stock of capital, $K_t(j)$, that he will rent to firms in period t at a rental rate R_t. In equilibrium, the aggregate stock of capital supplied by all domestic entrepreneurs j is equal to the aggregate stock of capital demanded by all domestic firms i, $\int_0^{\frac{1}{2}} K_t(j)\,dj = \int_0^{\frac{1}{2}} k_t(i)\,di$.

Entrepreneurs finance this stock of capital partially through debt. The entrepreneur borrows $b_t^e(j)$ from domestic banks and $b_t^{ef}(j)$ from foreign banks to finance their capital stock $K_t(j)$. Thus the market value of the assets and liabilities for entrepreneur j at the beginning of period t are:

$$\begin{aligned} \text{Assets:} &\quad P_t^K K_t(j) \\ \text{Liabilities:} &\quad b_t^e(j) + b_t^{ef}(j) \end{aligned} \tag{15}$$

where P_t^K is the price of existing capital.

The end of period the value of the non-depreciated capital stock for the average entrepreneur is $P_t^K(1-\delta)K_t$. However during the period, the individual entrepreneur j receives an idiosyncratic draw that affects the relative price of their existing capital, so for entrepreneur j the end of period value of their non-depreciated capital stock is:

$$\omega_t^e(j) P_t^K (1-\delta) K_t(j)$$

where $\omega_t^e(j)$ is a i.i.d. draw from a lognormal distribution on the interval $[0,\infty)$ with mean 1 and variance σ_e^2.

Since this draw has a mean 1, it has no effect on the aggregate capital stock. It simply introduces heterogeneity among entrepreneurs, and in any given period a fraction of entrepreneurs receive a draw that has a large adverse effect on the value of their existing capital (a small $\omega_t^e(j)$) and thus at the end of the period, the value of their liabilities exceeds the value of their assets.

During the period the entrepreneur rents his capital stock to firms for a rental rate of R_t. The entrepreneur pays a net interest rate of r_t^e on loans from domestic banks and r_t^{ef} on loans from foreign banks. Thus at the end of the period, after the realization of $\omega_t^e(j)$, the nominal market value of entrepreneur j's assets is $\omega_t^e(j) P_t^K (1-\delta) K_t(j) + R_t K_t(j)$. At the end of the period the nominal value of the entrepreneur's liabilities is $(1+r_t^e) b_t^e(j) + \left(1+r_t^{ef}\right) b_t^{ef}(j)$.

Thus, after the realization of $\omega_t^e(j)$, entrepreneur j is bankrupt if:

$$\omega_t^e(j) P_t^K (1-\delta) K_t(j) + R_t K_t(j) < (1+r_t^e) b_t^e(j) + \left(1+r_t^{ef}\right) b_t^{ef}(j) \tag{16}$$

Thus the threshold value of $\omega_t^e(j)$ below which the entrepreneur goes bankrupt in period t and above which they continue operations is:

$$\bar{\omega}_t^e = \frac{\left[1+(1-\chi) r_t^e + \chi r_t^{ef}\right] \frac{b_t^e(j)+b_t^{ef}(j)}{K_t(j)} - R_t}{P_t^K (1-\delta)} \tag{17}$$

where $\chi = \frac{b_t^{ef}(j)}{b_t^e(j)+b_t^{ef}(j)}$ and $DA_t^e(j) = \frac{b_t^e(j)+b_t^{ef}(j)}{K_t(j)}$ is the ratio of the book value of debt to the book value of assets on an entrepreneur's balance sheet. The history of individual entrepreneur j will determine the level of $b_t^e(j)$, $b_t^{ef}(j)$ and $K_t(j)$, but the ratio $DA_t^e(j) = \frac{b_t^e(j)+b_t^{ef}(j)}{K_t(j)}$ is equal across all entrepreneurs. This is a key result for aggregation, for it implies that the bankruptcy cutoff value $\bar{\omega}_t^e$ does not depend on an entrepreneur's history. More intuition behind this result is presented at the end of this section and a formal proof is presented in the appendix.

When deciding how much to lend to entrepreneurs going into next period and at what rate, banks factor in the fact that if entrepreneur j does not default in period $t+1$, domestic creditors receive a return of r_{t+1}^{e} and foreign creditors receive r_{t+1}^{ef}. If the entrepreneur defaults, creditors receive a share of the entrepreneur's remaining assets, less the bankruptcy cost μ^{e}. The threshold value $\bar{\omega}_{t+1}^{e}$ in equation (17) determines whether or not an entrepreneur goes into default next period. Thus the payoff to domestic and foreign creditors conditional of the realization of the shock $\omega_{t+1}^{e}(j)$ is:

$$
\begin{array}{ll}
\text{Payoff to domestic creditors:} & \\
\left(1+r_{t+1}^{e}\right)\left(b_{t+1}^{e}(j)\right) & \text{if } \omega_{t+1}^{e}(j) \geq \bar{\omega}_{t+1}^{e} \\
(1-\chi)(1-\mu^{e})\left[\omega_{t+1}^{e}(j)(1-\delta)P_{t+1}^{K}K_{t+1}(j)+R_{t+1}K_{t+1}(j)\right] & \text{if } \omega_{t+1}^{e}(j) < \bar{\omega}_{t+1}^{e} \\
\text{Payoff to foreign creditors:} & \\
\left(1+r_{t+1}^{ef}\right)\left(b_{t+1}^{ef}(j)\right) & \text{if } \omega_{t+1}^{e}(j) \geq \bar{\omega}_{t+1}^{e} \\
\chi(1-\mu^{e})\left[\omega_{t+1}^{e}(j)(1-\delta)P_{t+1}^{K}K_{t+1}(j)+R_{t+1}K_{t+1}(j)\right] & \text{if } \omega_{t+1}^{e}(j) < \bar{\omega}_{t+1}^{e}
\end{array}
\tag{18}
$$

Perfect competition in the banking sector implies that the bank's expected profit is zero. So the interest rate the (home or foreign) bank charges on physical capital loans, r_{t+1}^{e} or r_{t+1}^{ef}, is set such that the expected return, after factoring in the cost of bankruptcy, is equal to the (home or foreign) bank's cost of capital, r_{t+1}^{b} or r_{t+1}^{b*}:

$$
\begin{aligned}
\text{For domestic creditors} &: \\
\left(1+r^{b}_{t+1}\right) b^{e}_{t+1}(j) &= \int_{0}^{\bar{\omega}^{e}_{t+1}} (1-\chi)(1-\mu^{e}) \left(\begin{array}{c} \omega^{e}_{t+1}(j)(1-\delta) P^{K}_{t+1} K_{t+1}(j) \\ +R_{t+1} K_{t+1}(j) \end{array} \right) dF\left(\omega^{e}_{t+1}\right) \\
&+ \int_{\bar{\omega}^{e}_{t+1}}^{\infty} \left(1+r^{e}_{t+1}\right) b^{e}_{t+1}(j)\, dF\left(\omega^{e}_{t+1}\right) \\
\text{For foreign creditors} &: \\
\left(1+r^{b*}_{t+1}\right) b^{ef}_{t+1}(j) &= \int_{0}^{\bar{\omega}^{e}_{t+1}} \chi (1-\mu^{e}) \left(\begin{array}{c} \omega^{e}_{t+1}(j)(1-\delta) P^{K}_{t+1} K_{t+1}(j) \\ +R_{t+1} K_{t+1}(j) \end{array} \right) dF\left(\omega^{e}_{t+1}\right) \\
&+ \int_{\bar{\omega}^{e}_{t+1}}^{\infty} \left(1+r^{ef}_{t+1}\right) b^{ef}_{t+1}(j)\, dF\left(\omega^{e}_{t+1}\right)
\end{aligned}
$$

where $F\left(\omega^{e}_{t+1}\right)$ is the c.d.f. of the lognormal distribution of ω^{e}_{t+1}.

Thus the interest rate charged by banks for physical capital loans is:

$$
\begin{aligned}
1+r^{e}_{t+1} &= \frac{\left(1+r^{b}_{t+1}\right)}{1-F\left(\bar{\omega}^{e}_{t+1}\right)} - \frac{(1-\mu^{e})\left[R_{t+1}F\left(\bar{\omega}^{e}_{t+1}\right) + (1-\delta) P^{K}_{t+1} \int_{0}^{\bar{\omega}^{e}_{t+1}} \omega^{e}_{t+1} dF\left(\omega^{e}_{t+1}\right)\right]}{\left(1-F\left(\bar{\omega}^{e}_{t+1}\right)\right) \frac{b^{e}_{t+1}(j)+b^{ef}_{t+1}(j)}{K_{t+1}(j)}} \\
1+r^{ef}_{t+1} &= \frac{\left(1+r^{b*}_{t+1}\right)}{1-F\left(\bar{\omega}^{e}_{t+1}\right)} - \frac{(1-\mu^{e})\left[R_{t+1}F\left(\bar{\omega}^{e}_{t+1}\right) + (1-\delta) P^{K}_{t+1} \int_{0}^{\bar{\omega}^{e}_{t+1}} \omega^{e}_{t+1} dF\left(\omega^{e}_{t+1}\right)\right]}{\left(1-F\left(\bar{\omega}^{e}_{t+1}\right)\right) \frac{b^{e}_{t+1}(j)+b^{ef}_{t+1}(j)}{K_{t+1}(j)}}
\end{aligned}
$$

where $F\left(\bar{\omega}^{e}_{t+1}\right)$ is the percent of manufacturing firms that declare bankruptcy.

Holding all else equal, these interest rates, r^{e}_{t+1} and r^{ef}_{t+1}, are increasing in $F\left(\bar{\omega}^{e}_{t+1}\right)$. If there are financial frictions in the entrepreneurial sector, $F\left(\bar{\omega}^{e}_{t+1}\right)$ is increasing in $\bar{\omega}^{e}_{t+1}$. $\bar{\omega}^{e}_{t+1}$ is increasing in the manufacturing firm's debt-asset ratio. Thus when there are financial frictions in the entrepreneurial sector, the interest rate on physical capital loans is increasing in the level of debt on an entrepreneur's balance sheet.

The cutoff value of $\omega^{e}_{t+1}(j)$ in equation (17) combined with the above equilibrium interest rates demonstrates the feedback loop associated with financial frictions in the entrepreneurial sector. When the price of existing capital, P_{t+1}^{K} falls, the cutoff value $\bar{\omega}_{t+1}^{e}$ rises. This implies that more firms will receive draws of $\omega_{t+1}^{e}(j)$ below this cutoff value and be forced into bankruptcy. When more firms go into bankruptcy, $F\left(\bar{\omega}_{t+1}^{e}\right)$ increases, and r_{t+1}^{e} and r_{t+1}^{ef} increase as banks now demand a higher interest rate to compensate for the increased bankruptcy risk. Higher r_{t+1}^{e} and r_{t+1}^{ef} means higher interest expenses and lower profit for the entrepreneur, which leads to a further increase in the cutoff value $\bar{\omega}_{t+1}^{e}$.

The end of period net worth for the firm that survives is the firm's profit in time t plus the value of their non-depreciated capital stock:

$$\tilde{N}_t^e(j) = r_t^k K_t(j) - (1 + r_t^e) b_t^e(j) - \left(1 + r_t^{ef}\right) b_t^{ef}(j) + \omega_t^e(j) P_t^K (1 - \delta) K_t(j)$$

The firm will pay a dividend to shareholders of $d_t^e(j)$ and begin the next period with net worth $N_{t+1}^e(j) = \tilde{N}_t^e(j) - d_t^e(j)$. For simplicity, and keeping with the convention from Bernanke, Gertler, and Gilchrist (1999), we assume that $d_t^e(j) = \varphi \tilde{N}_t^e(j)$, where $\varphi < 1$.[8] Firms that declare bankruptcy in period t pay no dividend and drop out of the market, they are replaced with new firms, which are endowed with start up capital of $\bar{N}^e$. Thus the net worth of the entrepreneurial sector at the beginning of next period is:

$$\begin{aligned} N_{t+1}^e &= \int_0^{\bar{\omega}_t^e} N_{t+1}^e(j)\, dF(\bar{\omega}_t^e) + \int_{\bar{\omega}_t^e}^{\infty} N_{t+1}^e(j)\, dF(\bar{\omega}_t^e) \\ &= \bar{N}^e F(\bar{\omega}_t^e) + (1-\varphi)\left(r_t^k K_t - (1 + r_t^e) b_t^e - \left(1 + r_t^{ef}\right) b_t^{ef}\right)(1 - F(\bar{\omega}_t^e)) \\ &\quad + (1-\varphi) P_t^K (1-\delta) K_t \int_{\bar{\omega}_t^e}^{\infty} \omega_t^e\, dF(\bar{\omega}_t^e) \end{aligned} \tag{19}$$

[8] Much of the financial accelerator literature, including Bernanke, Gertler, and Gilchrist (1999) assume a separate entrepreneurial consumption, although adopt the simplifying assumption that entrepreneurs do not actually choose their consumption level, it is simply a fixed portion of their end of period net worth. However, in this model, cross border dividend flows are an important part of capital market integration, so we instead adopt the simplifying assumption that a portion of the entrepreneur's end of period net worth is rebated to share holders in the form of lump sum dividends, and following the convention from the literature, we simply assume that this portion is fixed.

The entrepreneur will acquire capital up to the point where the interest rate on bank loans is equal to the expected return to holding a unit of capital:

$$(1-\chi)\, r^{e}_{t+1} + \chi r^{ef}_{t+1} = E_t \left(\frac{R_{t+1} + \omega^{e}_{t+1}(j)\,(1-\delta)\, P^{K}_{t+1}}{P^{K}_{t}} \right)$$

Since $\omega^{e}_{t+1}(j)$ is i.i.d. and $E_t\left(\omega^{e}_{t+1}(j)\right) = 1$, the right hand side of the above expression is the same across all entrepreneurs j, which implies that $(1-\chi)\, r^{e}_{t+1} + \chi r^{ef}_{t+1}$ is the same across all entrepreneurs.

3.3 Capital Builders

The representative capital builder converts final goods, given by equation (10), into the physical capital purchased by entrepreneurs. At the end of period t, the non depreciated physical capital stock is $(1-\delta)\, K_t$, and the physical capital stock at the beginning of the next period is K_{t+1}. The evolution of the physical capital stock is given by:

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

where $\phi' > 0$ and $\phi'' < 0$ implying that there are diminishing marginal returns to physical capital investment. Capital builders purchase final goods for investment at a price P_t and sell existing capital to entrepreneurs at a price P^{K}_{t}. Thus the profits of the representative capital builder are given by:

$$d^{c}_{t} = P^{K}_{t}\left(K_{t+1} - (1-\delta)\, K_t\right) - P_t I_t$$

In a competitive capital building sector, profit maximization implies that the relative price of existing capital is:

$$\frac{P^{K}_{t}}{P_t} = \left[\phi'\left(\frac{I_t}{K_t}\right)\right]^{-1}$$

Since $\phi'' < 0$, when $\frac{I_t}{K_t}$ is high, $\phi'\left(\frac{I_t}{K_t}\right)$ is low, so $\frac{P_t^K}{P_t}$ is high. This implies that during times of high physical capital investment, when the ratio of investment to the existing capital stock is high, the relative price of existing capital is high. Since investment is highly procyclical, capital adjustment costs imply that the relative price of capital is highly procyclical as well.

3.4 Banks

Banks, indexed $k \in \left[0\ \frac{1}{2}\right]$ make physical capital loans to domestic and foreign entrepreneurs. They finance this loan portfolio partially with equity and partially with borrowing from domestic and foreign households.

At the beginning of period t, the value of the bank's loans to domestic entrepreneurs is $B_t^e(k)$ and its loans to foreign entrepreneurs is $B_t^{ef}(k)$. The value of the bank's liabilities is $b_t^s(k) + b_t^{sf}(k)$, where $b_t^s(k)$ are the deposits of domestic households and $b_t^{sf}(k)$ are the deposits of foreign households.[9]

The bank also makes working capital loans to firms in order to finance the firm's wage bill. This however is not listed as a beginning of period asset for the bank. By assumption this loan is made after the beginning of the period and repaid before the end of the period.

Bankruptcy in the entrepreneurial sector in period t means the bank's assets are worth less at the end of the period. The value of the average bank's assets at the end of the period is $(1-\zeta_t^e)(1+r_t^e)B_t^e + (1-\zeta_t^{e*})\left(1+r_t^{ef}\right)B_t^{ef}$, where ζ_t^e is the share of the average bank's domestic loan portfolio that is lost to bankruptcy and liquidation costs, and ζ_t^{e*} is the share of the average bank's foreign loan portfolio that is lost to bankruptcy and liquidation. The

[9] The same stock of bonds that is a liability to one party is an asset to another. Throughout this paper, when a stock of bonds is an asset, it is written with a capital B, when the stock of bonds is a liability it is written with a lower case b.

Thus market clearing in the bond market requires that the sum across all home banks of physical capital loans to domestic entrepreneurs equals the sum of borrowing by home entrepreurs from domestic banks, $\int_0^{\frac{1}{2}} B_t^e(k)\,dk = \int_0^{\frac{1}{2}} b_t^e(j)\,dj$, and the sum across all home banks of physical capital loans to foreign entrepreneurs equals the sum of borrowing by foreign entrepreurs from banks in the home country, $\int_0^{\frac{1}{2}} B_t^{ef}(k)\,dk = \int_{\frac{1}{2}}^1 b_t^{ef}(j)\,dj$.

asset side of the bank's balance sheet can be rewritten as:

$$\left(1-\bar{\zeta}_t^e\right)\left(1+\bar{r}_t^e\right)\left(B_t^e\left(k\right)+B_t^{ef}\left(k\right)\right)$$

where $\bar{B}_t^e\left(k\right) = B_t^e\left(k\right) + B_t^{ef}\left(k\right)$, $\bar{r}_t^e = \frac{B_t^e(k)}{B_t^e(k)+B_t^{ef}(k)} r_t^e + \frac{B_t^{ef}(k)}{B_t^e(k)+B_t^{ef}(k)} r_t^{ef}$, and $1-\bar{\zeta}_t^e = \frac{(1-\zeta_t^e)(1+r_t^e)B_t^e(k)+(1-\zeta_t^{e*})\left(1+r_t^{ef}\right)B_t^{ef}(k)}{(1+r_t^e)B_t^e(k)+\left(1+r_t^{ef}\right)B_t^{ef}(k)}$.

$\bar{\zeta}_t^e$ represents the share of the *average* bank's portfolio of home and foreign loans that is lost to bankruptcy and liquidation costs, however banks don't hold fully diversified loan portfolios. Some banks may be overexposed to the set of non-performing loans to the entrepreneurial sector. This overexposure may be due to a regional bias in the bank's portfolio, or it may be because a bank has a certain core competency and is therefore overexposed to a certain sector of the economy.[10]

The percent of the bank k's loan portfolio that is lost to bankruptcy or liquidation costs is $\omega_t^b\left(k\right)\bar{\zeta}_t^e$, where $\omega_t^b\left(k\right)$ is an i.i.d. draw from a lognormal distribution on the interval $\left[0\ \frac{1}{\bar{\zeta}_t^e}\right]$ with mean 1 and variance σ_b^2.

If bank k receives a large draw $\omega_t^b\left(k\right)$, it implies that the bank is overexposed to the set of non-performing loans and may itself face insolvency. The bank is insolvent if the end of period value of its assets is less than the end of period value of its liabilities:

$$\left(1-\omega_t^b\left(k\right)\bar{\zeta}_t^e\right)\left(1+\bar{r}_t^e\right)\left(B_t^e\left(k\right)+B_t^{ef}\left(k\right)\right) < \left(1+r_t^b\left(k\right)\right)\left(b_t^s\left(k\right)+b_t^{sf}\left(k\right)\right)$$

The threshold value of $\omega_t^b\left(k\right)$ above which bank k is forced to declare bankruptcy and below which the bank will continue operations is:

$$\bar{\omega}_t^b = \frac{\left(1+\bar{r}_t^e\right)-\left(1+r_t^b\left(k\right)\right)\frac{b_t^s(k)+b_t^{sf}(k)}{B_t^e(k)+B_t^{ef}(k)}}{\bar{\zeta}_t^e\left(1+\bar{r}_t^e\right)} \tag{20}$$

[10] Like the banks, many of which are now bankrupt or were acquired by healthier rivals, who were overexposed to the subprime sector of the mortgage market during the recent financial crisis.

As of early September 2008, the ratio of net subprime assets to total market cap for the four major U.S. investment banks was: Goldman Sachs-4%, Morgan Stanley-29%, Merrill Lynch-30%, Lehman Brothers-277%. (Potter 2008)

Bank k's history of idiosyncratic draws, $\omega_t^b(k)$, thus its history of exposure to non-preforming sectors of the economy, will determine the levels of $B_t^e(k)$, $B_t^{ef}(k)$, $b_t^s(k)$, and $b_t^{sf}(k)$. However, at the beginning of the period, all banks will have the same ratio of total debt to total assets, $DA_t^b(k) = \frac{b_t^s(k)+b_t^{sf}(k)}{B_t^e(k)+B_t^{ef}(k)}$ and will have the same cost of capital, $r_t^b(k)$. This result is key for the aggregation of balance sheet variables across a continuum of individual banks, for this implies that the cutoff value $\bar{\omega}_t^b$ is common across all banks. The formal proof of this claim is presented in the appendix.

When deciding how much to lend to bank k in the next period and at what rate, the bank's creditors factor in the fact that if the bank does not default, they receive a gross interest rate $1 + r_{t+1}^b(k)$. If bank k defaults, creditors receive nothing.[11] Thus the expected payoff to a bank's creditors conditional on the bank's exposure to the set of non-preforming loans is:

$$\begin{array}{cc} \left(1 + r_{t+1}^b(k)\right)\left(b_{t+1}^s(k) + b_{t+1}^{sf}(k)\right) & \text{if } \omega_{t+1}^b(k) < \bar{\omega}_{t+1}^b \\ 0 & \text{if } \omega_{t+1}^b(k) \geq \bar{\omega}_{t+1}^b \end{array} \tag{21}$$

Domestic and foreign depositors will extend bank k credit up to the point where the expected return, after factoring in the probability of default is equal to the risk free rate:

$$(1 + i_{t+1})\left(b_{t+1}^b(k) + b_{t+1}^{bf}(k)\right) = \int_0^{\bar{\omega}_{t+1}^b} \left(1 + r_{t+1}^b(k)\right)\left(b_{t+1}^b(k) + b_{t+1}^{bf}(k)\right) dG\left(\omega_{t+1}^b\right)$$

This condition can be used to solve for the interest rate on lending to bank k:

$$1 + r_{t+1}^b(k) = \frac{1 + i_{t+1}}{G\left(\bar{\omega}_{t+1}^b\right)} \tag{22}$$

where $G\left(\bar{\omega}_{t+1}^b\right)$ is the c.d.f. of the lognormal distribution of $\bar{\omega}_{t+1}^b$, and thus measures the

[11] The assumption that creditors receive nothing in the case of bank default is because the model is later calibrated such that the spread between the interbank rate, r^b, and the risk free rate, i, in the steady state of the model is equal to the historical average of the spread between the 3-month Libor and the 3-month T-bill. The Libor is an interbank index rate that is based on the interest rate for unsecured lending to banks.

proportion of banks that do not go bankrupt in period $t+1$. Since $DA_{t+1}^{b}(k) = \frac{b_{t+1}^{s}(k)+b_{t+1}^{sf}(k)}{B_{t}^{e}(k)+B_{t}^{ef}(k)}$ is constant across all banks, the interbank lending rate, and thus banks' cost of capital, is constant across all banks.

The expressions for the cutoff value $\bar{\omega}_{t+1}^{b}$ in (20) and the interbank interest rate in (22) show how when there are financial frictions in the banking sector, cross border financial integration, in the form of increased cross border lending, can have a positive effect on cross-country business cycle correlation.

The share of the average domestic bank's portfolio of home and foreign loans that is lost to bankruptcy and liquidation costs is $\bar{\zeta}_{t}^{e}$, where $\bar{\zeta}_{t}^{e}$ is simply a weighted average of the bankruptcy costs on domestic and foreign loans, ζ_{t}^{e} and ζ_{t}^{e*}, where the weight on the foreign bankruptcy variable, ζ_{t}^{e*} is approximately the share of the foreign loans in the bank's loan portfolio.

An adverse foreign shock that leads to a fall in foreign output also leads to an increase in foreign entrepreneurial sector bankruptcies. If home country banks make a significant number of their loans to foreign entrepreneurs, then loan losses for the average home bank, $\bar{\zeta}_{t}^{e}$, increase as well.

A higher proportion of losses for the average home bank lowers the cutoff value, $\bar{\omega}_{t}^{b}$. When the cutoff value falls, more home banks will find themselves over-exposed to the set of bad loans and be forced into insolvency. This higher riskiness in the banking sector will cause the home interbank lending spread to increase. Banks pass on this higher cost of capital to their borrowers, and thus domestic entrepreneurs find their borrowing rates increase, and they are forced to cut investment and production, because of an adverse shock in the foreign country. The greater the degree of cross-country borrowing and lending, the greater the effect of an increase in ζ_{t}^{e*} on home interbank lending spreads, and thus the treater the degree of international transmission of the country specific productivity shock.

The end of period t net worth of the bank that is not over-exposed to the set of non-preforming loans and is able to continue operations is:

$$\tilde{N}_t^b(k) = \left(1 - \omega_t^b(k)\bar{\zeta}_t^e\right)(1 + \bar{r}_t^e)\left(B_t^e(k) + B_t^{ef}(k)\right) - \left(1 + r_t^b\right)\left(b_t^s(k) + b_t^{sf}(k)\right)$$

The bank will pay a dividend to shareholders and begin the next period with a net worth $N_{t+1}^b(k) = \tilde{N}_t^b(k) - d_t^b(k)$. As in the case of entrepreneurial sector dividend payouts, we assume that surviving banks simply pay out dividends equal to a fixed portion of their end of period net worth, $d_t^b(k) = \varphi \tilde{N}_t^b(k)$. Banks that were overexposed to the set of non-preforming loans and thus were forced into bankruptcy end the period with no net worth and drop out of the market. They are replaced with new banks that are endowed with start up capital $\bar{N}^b$. Thus the net worth of the entire banking sector at the beginning of next period is:

$$N_{t+1}^b = \int_{\bar{\omega}_t^b}^{\infty} \bar{N}^b dG\left(\omega_t^b\right) + \int_0^{\bar{\omega}_t^b} \tilde{N}_t^b(k)\, dG\left(\omega_t^b\right)$$

3.5 Households

Households, indexed $l \in \left[0\ \frac{1}{2}\right]$, supply heterogeneous labor to firms and consume from their labor income, interest on savings, and profit income from domestic and foreign firms, entrepreneurs, capital builders, and banks.

The household maximizes their utility function:

$$\max \sum_{t=0}^{\infty} \beta^t \left[\ln\left(C_t(l)\right) - \psi\left(H_t(l)\right)^{\frac{1+\sigma_H}{\sigma_H}}\right] \tag{23}$$

Since we assume complete markets at the national level, we can assume that households maximize utility subject to one nationwide budget constraint:

$$\int_0^{\frac{1}{2}} P_t C_t(l)\, dl + B^s_{t+1} + S_t B^{sf*}_{t+1} \tag{24}$$
$$= \int_0^{\frac{1}{2}} W_t(l)\, H_t(l)\, dl + \gamma \left(d^f_t + d^e_t + d^c_t + d^b_t - F(\bar{\omega}^e_t)\, \bar{N}^e - \left(1 - G\left(\bar{\omega}^b_t\right)\right) \bar{N}^b \right)$$
$$+ (1-\gamma) \left(d^{f*}_t + d^{e*}_t + d^{c*}_t + d^{b*}_t - F(\bar{\omega}^{e*}_t)\, \bar{N}^{e*} - \left(1 - G\left(\bar{\omega}^{b*}_t\right)\right) \bar{N}^{b*} \right)$$
$$+ \left(1 - \zeta^b_t\right)\left(1 + r^b_t\right) B^s_t + \left(1 - \zeta^{b*}_t\right)\left(1 + r^{b*}_t\right) S_t B^{sf*}_t + \zeta^e_t + \zeta^b_t - \frac{\chi^b}{2}\left(S_t B^{sf*}_t\right)^2$$

where $C_t(l)$ is consumption by household l in period t, $H_t(l)$ is the household's labor effort in the period, B^s_t is the stock of deposits with domestic banks at the beginning of the period, B^{sf*}_t is the stock of deposits with foreign banks, $W_t(l)$ is the wage paid for the household's heterogenous labor supply, ζ^b_t (ζ^{b*}_t) represents the small share of deposits to the home (foreign) banking sector that are lost to bankruptcy and liquidation costs, and d^f_t, d^e_t, d^c_t and d^b_t are period t dividends from firms, entrepreneurs, capital builders and banks, respectively.[12]

There is a small quadratic transactions cost to holding deposits with foreign banks, $\frac{\chi^b}{2}\left(S_t B^{sf*}_t\right)^2$.

Households in the home country receive a share γ or the proceeds (dividends minus any cost of capitalizing new entrepreneurs and banks) from home country firms, entrepreneurs, capital builders, and banks and $1-\gamma$ of the proceeds from foreign country firms, entrepreneurs, capital builders, and banks.

Each household supplies a differentiated type of labor. The function to aggregate the labor supplied by each household into the aggregate stock of labor employed by domestic firms is:

[12]Market clearing in the market for deposits requires that the sum of deposits with domestic banks across all domestic households equals the sum of borrowing from domestic households across all domestic banks, $\int_0^{\frac{1}{2}} B^s_t(l)\, dl = \int_0^{\frac{1}{2}} b^s_t(k)\, dk$, and that the sum of deposits with foreign banks across all domestic households equals the sum of borrowing from domestic households across all foreign banks, $\int_0^{\frac{1}{2}} B^{sf*}_t(l)\, dl = \int_{\frac{1}{2}}^1 b^{sf*}_t(k)\, dk$.

$$H_t = \left(\int_0^{\frac{1}{2}} H_t(l)^{\frac{\theta-1}{\theta}} dl \right)^{\frac{\theta}{\theta-1}} \tag{25}$$

where $H_t = \int_0^n h_t(i)\, di$. Since the household supplies a differentiated type of labor, it faces a downward sloping labor demand function:

$$H_t(l) = \left(\frac{W_t(l)}{W_t} \right)^{-\theta} H_t$$

In any given period, household l faces a probability of $1 - \xi_w$ of being able to reset their wage, otherwise it is reset automatically according to $W_t(l) = \pi_{t-1} W_{t-1}(l)$.

If household l is allowed to reset their wages in period t they will set a wage to maximize the expected present value of utility from consumption minus the disutility of labor.

$$E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \left\{ \lambda_{t+\tau} \Pi_{t,t+\tau} W_t(l) H_{t+\tau}(l) - \psi \left(H_{t+\tau}(l) \right)^{\frac{1+\sigma_H}{\sigma_H}} \right\}$$

Thus after technical details which are located in the appendix, the household that can reset wages in period t will choose a wage:

$$W_t(l)^{\frac{\theta}{\sigma_H}+1} = \frac{\theta}{\theta-1} \frac{1+\sigma_H}{\sigma_H} \psi (W_t)^{\frac{\theta}{\sigma_H}} \frac{E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \left(\frac{W_{t+\tau}}{\Pi_{t,t+\tau} W_t} \right)^{\frac{\theta}{\sigma_H}+\theta} (H_{t+\tau})^{\frac{1+\sigma_H}{\sigma_H}}}{E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \lambda_{t+\tau} \Pi_{t,t+\tau} \left(\frac{W_{t+\tau}}{\Pi_{t,t+\tau} W_t} \right)^{\theta} H_{t+\tau}}$$

If wages are flexible, and thus $\xi_w = 0$, this expression reduces to:

$$W_t(l) = \frac{\theta}{\theta-1} \frac{\frac{1+\sigma_H}{\sigma_H} \psi (H_t)^{\frac{1}{\sigma_H}}}{\lambda_t}$$

Thus when wages are flexible the wage rate is equal to a mark-up, $\frac{\theta}{\theta-1}$, multiplied by the marginal disutility of labor, $\frac{1+\sigma_H}{\sigma_H} \psi (H_t)^{\frac{1}{\sigma_H}}$, divided by the marginal utility of consumption, λ_t.

Write the wage rate for the household that can reset wages in period t, $W_t(l)$, as $\tilde{W}_t(l)$

to denote it as an optimal wage. Also note that all households that can reset wages in period t will reset to the same wage rate, so $\tilde{W}_t(l) = \tilde{W}_t$.

All households face a probability of $(1-\xi_w)$ of being able to reset their wages in a given period, so by the law of large numbers $(1-\xi_w)$ of households can reset their wages in a given period. The wages of the other ξ_w will automatically reset by the previous period's inflation rate.

Substitute $\tilde{W}_t$ into the expression for the average wage rate $W_t = \left(\int_0^n W_t(l)^{1-\theta} dl\right)^{\frac{1}{1-\theta}}$, to derive an expression for the evolution of the average wage:

$$W_t = \left(\xi_w \left(\Pi_{t-1,t} W_{t-1}\right)^{1-\theta} + (1-\xi_w)\left(\tilde{W}_t\right)^{1-\theta}\right)^{\frac{1}{1-\theta}}$$

3.6 Monetary Policy

The monetary policy instrument is the short term risk free rate, i_t, which is determined by the central bank's Taylor rule function:

$$i_t = i^{ss} + \theta_i \left(i_{t-1} - i^{ss}\right) + (1-\theta_i)\,\theta_p \pi_t + m_t \tag{26}$$

where $\pi_t = \frac{P_t}{P_{t-4}}$, and m_t is an exogenous shock to the nominal interest rate.

4 Parameter Values

The model in the previous section is solved with a first-order approximation and the results are found from simulations of the calibrated model. This section will begin by presenting the basic parameter values used in this calibration. Then we will describe the various types of exogenous shocks that will drive the simulations of the model and the estimation of these different shock processes.

The full list of the model's parameters and their values is found in table 6.

The first seven parameters; the discount factor, the capital depreciation rate, capital's share of income, the bond adjustment cost parameter, the labor supply elasticity, the elasticity of substitution between goods from different firms, and the elasticity of substitution between labor from different households are all set to values that are commonly found in the literature.

The capital adjustment cost parameter, κ, describes the curvature of the capital adjustment function $\phi\left(\frac{I_t}{K_t}\right)$. It is the elasticity of the relative price of capital with respect to changes in the investment-capital ratio. This parameter performs the important functions of lowering the relative volatility of investment and ensuring the procyclicality of the price of capital. Empirical estimates of this parameter vary, but the value of 0.25 is in the middle of the range of empirical estimates and ensures that the relative volatility of investment in the model is near what we see in the data.

The next two parameters in the table are the Calvo price and wage stickiness parameters. The wage stickiness parameter is chosen such that on average a household adjusts their wages once a year. The price stickiness parameter implies that prices are a little more flexible than wages and is taken from the DSGE estimation literature (see e.g. Christiano et al. 2005).

The next set of parameters describe exponents in the central bank's Taylor rule function. The interest rate smoothing parameter and the weight on inflation are all set to values that are commonly found in the literature.

The next two parameters, ϕ and ψ are the fixed cost in the production of intermediate goods and the weight on the disutility from labor in the household's utility function, respectively. These are set to ensure that in the steady state, intermediate goods firms earn zero economic profit and the household's labor supply is unity.

The parameter φ measures the fixed portion of a surviving entrepreneur or bank's net worth that is rebated to share holders in the form of lump sum dividends. This parameter is necessary to ensure stationarity in entrepreneur or bank net worth, and thus ensure that borrowers do not get to the point where they can fully finance their asset portfolio with their own net worth. This parameter is simply set to 0.0272 in accordance with the financial accelerator model in Bernanke, Gertler, and Gilchrist (1999).

Finally the last three parameters in the table relate to the risk of bankruptcy and liquidation costs in either the banking or entrepreneurial sectors. The parameter σ^b measures the steady state level of uncertainty in the financial sector. This parameter is determined to ensure that in the steady state of the model, when banks have a debt-asset ratio of about 0.9, there is a 13 basis point spread between interbank rates and the risk free rate, the average spread between the 3-month Libor and the 3-month T-bill from 1984 to 2007.

The cost of liquidation and the idiosyncratic bankruptcy risk in the entrepreneurial sector, μ^e and σ_e are jointly determined. These parameters ensure that in the steady state of the model, when firms in the entrepreneurial sector have a debt-asset ratio of 0.5, an entrepreneur faces a 2% probability of bankruptcy and the steady state spread between the interest rate on physical capital loans and the bank's cost of capital is approximately 70 basis points.[13]

4.1 Exogenous Shock Processes

In this model there are two types of shocks, country specific shocks to total factor productivity (TFP) in (9) and country specific monetary policy shocks that appear in the central bank's Taylor rule function in (26).

Shocks to TFP are given by:

$$\hat{A}_t = \hat{Y}_t - (1-\alpha)\,\hat{N}_t - \alpha\hat{K}_t$$

where $\hat{Y}_t$, $\hat{N}_t$, and $\hat{K}_t$, are country-specific time series of deviations of GDP, employment, and the capital stocks, from an HP filtered trend. The series for home and foreign TFP fluctuations are then used to estimate a VAR(1) process:

[13] The calibration that entrepreneurs have a steady state debt-asset ratio of about 0.5 and banks have a steady state debt-asset ratio of about 0.9 is based on the historical average debt-asset ratios for U.S. non-financial and financial firms as reported in the Federal Reserve's Flow of Funds Accounts.

$$\begin{bmatrix} \hat{A}_{t+1} \\ \hat{A}^*_{t+1} \end{bmatrix} = \boldsymbol{\rho}^A \begin{bmatrix} \hat{A}_t \\ \hat{A}^*_t \end{bmatrix} + \begin{bmatrix} \hat{\varepsilon}^a_t \\ \hat{\varepsilon}^{a*}_t \end{bmatrix}$$

where $\boldsymbol{\Omega}^A = \begin{bmatrix} \hat{\varepsilon}^a_t \\ \hat{\varepsilon}^{a*}_t \end{bmatrix} \begin{bmatrix} \hat{\varepsilon}^a_t \\ \hat{\varepsilon}^{a*}_t \end{bmatrix}'$ is the covariance matrix of the innovations, $\hat{\varepsilon}^a_t$ and $\hat{\varepsilon}^{a*}_t$.

Alternatively we can consider shocks to the risk free interest rate in the central bank's Taylor rule function:

$$(i_t - i_{ss}) = \theta_i (i_{t-1} - i_{ss}) + (1 - \theta_i)(\theta_p \pi_t) + m_t$$

where i_t and π_t are country specific time series of the overnight interest rate and the inflation rate. Apply the benchmark parameterization, $\theta_i = 0.9$ and $\theta_p = 1.5$ to calculate the residual term m_t, which is a time series of country specific monetary policy shocks.

The series for home and foreign monetary policy shocks are then used to estimate a VAR(1) process:

$$\begin{bmatrix} m_{t+1} \\ m^*_{t+1} \end{bmatrix} = \boldsymbol{\rho}^M \begin{bmatrix} m_t \\ m^*_t \end{bmatrix} + \begin{bmatrix} \hat{\varepsilon}^m_t \\ \hat{\varepsilon}^{m*}_t \end{bmatrix}$$

where $\boldsymbol{\Omega}^M = \begin{bmatrix} \hat{\varepsilon}^m_t \\ \hat{\varepsilon}^{m*}_t \end{bmatrix} \begin{bmatrix} \hat{\varepsilon}^m_t \\ \hat{\varepsilon}^{m*}_t \end{bmatrix}'$ is the covariance matrix of the innovations, $\hat{\varepsilon}^m_t$ and $\hat{\varepsilon}^{m*}_t$.

The shock processes are estimated from data for the U.S. and the Eurozone from 1995:1 to 2007:2. The processes for the TFP and monetary policy shocks are presented in table 7.

5 Theoretical Results

In this section we present the results from simulations of the quantitative model. However it is first necessary to establish benchmark levels of credit and capital market integration.

Lane and Milesi-Ferretti (2007) provide data on external asset and liability positions for a large number of countries. This data is used to construct the C^{nfa} and K^{nfa} measures of financial integration in section 2. Lane and Milesi-Ferretti report that around the year 2000, the ratio of external capital market liabilities to GDP among industrialized countries was about 50%. This ratio is reproduced in the model when foreign equities make up about 11% of the household's equity portfolio.[14]

The ratio of external credit market liabilities to GDP among industrialized countries is about 1. This ratio can be reproduced in the model when approximately 24% of a bank's loan portfolio is in loans to foreign entrepreneurs.[15]

We simulate the model under the shock processes described earlier. From the simulated model we calculate the theoretical correlation between home and foreign GDP. First we simulate the model to find the correlation under the benchmark levels of capital and credit market integration. Then the correlation is found under the benchmark level of capital market integration and twice the benchmark level of credit market integration. The difference between the correlation from the second simulation and that from the first simulation is the effect of increases in credit market integration on cyclical co-movement and is directly comparable to the coefficient of C in the empirical results in table 5.

Repeating this process but double the level of capital market integration while holding fixed the level of credit market integration gives the effect of capital market integration of co-movement and is directly comparable to the coefficient on K in table 5.[16]

The results from simulations of the model are found in table 8. The first row of the table reports the bilateral output correlation for the model simulated under monetary policy shocks. The first column of the table reports the results from the benchmark parameterization, the second column reports the results when the level of credit market integration is doubled, and the third column reports the results when the level of capital market integration

[14] In terms of the household's budget constraint in (24), $\gamma = .11$.

[15] In the steady state, $\frac{b^{ef}}{b^e + b^{ef}} = .24$.

[16] The theoretical simulations specifically measure the effect of a change in the stock of extrenal credit or capital market assets on co-movement. Therefore the theoretical results are most comparable to the results from the volume based measures of financial integration, *cpis* and nfa, in the top half of table 5.

is doubled.

In the model, doubling the level of credit market integration leads to a 9 percentage point *increase* in cross-country output correlation and doubling the level of capital market integration leads to a 9 percentage point *decrease*. Qualitatively, this is exactly what we see in the data, and quantitatively, the model can only match about two-thirds of the impact of financial integration that we see in the data.

The second row of the table reports the results from simulations of the model under monetary policy shocks, but where the financial accelerator mechanism in the model has been "turned off". Here the cost of capital for both banks and entrepreneurs is not a function of debt-asset ratios. In the second row, where balance sheets of both entrepreneurs and banks are again irrelevant for macroeconomic outcomes, doubling the level of capital market integration again has a negative effect on bilateral correlation (although smaller than before). Doubling the level of credit market integration also has a positive effect, but it is much smaller and close to zero. Thus the empirical results where credit market integration has a positive effect on bilateral correlation only holds in the model with financial accelerator effects.

The third and fourth rows of the table presents the results from simulations of the model where business cycles are driven by country-specific TFP shocks. Qualitatively, the model is still able to match the data. Quantitatively, the results are weaker. In the third row, when the financial accelerator is "turned on", doubling the level of credit market integration leads to about a 1 percentage point increase in bilateral correlation, and doubling the level of capital market integration leads to about a 2 percentage point decrease.

Table 9 presents the results from various robustness checks. The first panel in the table presents the results from simulations of the model where wages are perfectly flexible, and thus only intermediate goods prices are sticky. When only prices are sticky, the effect of doubling the level of financial integration is marginally higher, when wages were also sticky, doubling the level of credit market integration led to a 9 percentage point increase in GDP correlation, now the increase is slightly greater than 10 percentage points. Similarly doubling the level of capital market integration caused GDP correlation to fall by 9 percentage points when wages were sticky, now correlation falls by about 10 percentage points under flexible wages.

The table also presents the results from versions of the model where wages are sticky but goods prices are flexible, where firms must pay their wage bill in advance (working capital channel), where debt contracts are indexed (and thus surprise inflation does not erode the real value of debt), and the version of the model that is an international real business cycle model. These variations have a marginal effect on the impact of doubling the level of credit or capital market integration on cross-country GDP co-movement, but the masin result that the model with financial frictions can reproduce the positive effect of credit market integration and the negative effect of capital market integration is unchanged.

6 Summary and Conclusion

This paper shows how international financial integration that involves trade in equity and ownership shares leads to less international business cycle co-movement. This paper also shows how financial integration that involves trade in debt may lead to greater cyclical co-movement. The negative effect of capital market integration is a common feature of many international real business cycle models and comes from the wealth effect. The positive effect of credit market integration is entirely due to balance sheet effects and requires a financial accelerator.

This paper explains why different types of financial integration seem to have had different effects on cross-country business cycle co-movement. Years of international financial integration in the form of equity market integration and cross-border FDI flows seem to have resulted in less co-movement and a "decoupling" of the U.S. business cycle from the rest of the world (Heathcote and Perri 2003), but this "decoupling" trend reversed sharply in the

Fall of 2008. A housing bubble and a subprime crisis in the United States and a handful of other countries quickly spread around the world as banks in countries without a housing bubble still found themselves exposed to declining house prices and defaults in the United States.

Relatively little attention has been paid to the effect of financial integration on international business cycle co-movement (relative to the amount of attention paid to the effect of trade on co-movement). This is partly because the data is better for trade flows than for financial flows, but partly because there seemed to be little consistency in the results. On one hand financial integration seemed to be leading to increased ex-ante risk sharing and thus made possible the "decoupling" of production cycles, but on the other hand financial integration brought the possibility of financial contagion and the international spread of financial panic. This paper shows that when we think of financial integration not as one homogenous set of financial flows, but rather as a heterogenous set, some involving credit constrained parties and some involving non-credit constrained parties, these seemingly inexplicable results can be explained.

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A Appendix

This appendix will present some of the more technical derivations in the paper related to the nominal rigidities and financial frictions present in the model. First, section A.1 presents the list of countries that are used in the empirical regressions. Then, section A.2 presents the derivations involved with the Calvo style wage and price equations. Finally, section A.3 presents the proofs necessary for aggregation in the presence of financial frictions.

A.1 Countries in the estimations

Argentina; Australia; Austria; Belgium-Luxembourg; Brazil; Bulgaria; Canada; Chile; China; Colombia; Czech Rep.; Denmark; Ecuador; Egypt; Finland; France; Germany; Greece; Hong Kong; Hungary; India; Indonesia; Ireland; Israel; Italy; Japan; Jordan; Kenya; Korea; Latvia; Malaysia; Mexico; Netherlands; New Zealand; Nigeria; Norway; Pakistan; Peru; Philippines; Poland; Portugal; Romania; Russia; Singapore; Slovakia; Slovenia; South Africa; Spain; Sri Lanka; Sweden; Switzerland; Taiwan; Thailand; Turkey; UK; Uruguay; USA; Venezuela

A.2 Nominal Rigidities

A.2.1 Sticky Wages

In any given period, household j faces a probability of $1-\xi_w$ of being able to reset their wage, otherwise it is reset automatically according to $W_t(l) = \pi_{t-1} W_{t-1}(l)$, where $\pi_{t-1} = \frac{P_{t-1}}{P_{t-2}}$.

If household j is allowed to reset their wages in period t they will set a wage to maximize the expected present value of utility from consumption minus the disutility of labor.

$$E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \left\{ \lambda_{t+\tau} \Pi_{t,t+\tau} W_t(l) H_{t+\tau}(l) - \psi (H_{t+\tau}(l))^{\frac{1+\sigma_H}{\sigma_H}} \right\} \tag{27}$$

where $\lambda_{t+\tau}$ is the marginal utility of consumption in period $t+\tau$.[17]

[17] We assume complete contingent claims markets among households within a country. This implies that

$$\Pi_{t,t+\tau} = \begin{cases} 1 & \text{if } \tau = 0 \\ \pi_{t+\tau-1}\Pi_{t,t+\tau-1} & \text{if } \tau > 0 \end{cases}$$

The imperfect combination of labor from different households is described in (25). Use this function to derive the demand function for labor from a specific household:

$$H_t(l) = \left(\frac{W_t(l)}{W_t}\right)^{-\theta} H_t \tag{28}$$

where $W_t = \left(\int_0^n W_t(l)^{1-\theta} dl\right)^{\frac{1}{1-\theta}}$ is the average wage across households, and H_t is aggregate labor supplied by all households.

Substitute the labor demand function into the maximization problem to express the maximization problem as a function of one choice variable, the wage rate, $W_t(l)$:

$$E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \left\{ \lambda_{t+\tau}\Pi_{t,t+\tau}W_t(l) \left(\frac{\Pi_{t,t+\tau}W_t(l)}{W_{t+\tau}}\right)^{-\theta} H_{t+\tau} - \psi \left(\left(\frac{\Pi_{t,t+\tau}W_t(l)}{W_{t+\tau}}\right)^{-\theta} H_{t+\tau} \right)^{\frac{1+\sigma_H}{\sigma_H}} \right\}$$

After some rearranging, the first order condition of this problem is:

$$W_t(l)^{\frac{\theta}{\sigma_N}+1} = \frac{\theta}{\theta-1}\frac{1+\sigma_H}{\sigma_H}\psi(W_t)^{\frac{\theta}{\sigma_H}} \frac{E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \left(\frac{W_{t+\tau}}{\Pi_{t,t+\tau}W_t}\right)^{\frac{\theta}{\sigma_H}+\theta} \left(H_{t+\tau}\right)^{\frac{1+\sigma_H}{\sigma_H}}}{E_t \sum_{\tau=0}^{\infty} \beta^{\tau} (\xi_w)^{\tau} \lambda_{t+\tau}\Pi_{t,t+\tau} \left(\frac{W_{t+\tau}}{\Pi_{t,t+\tau}W_t}\right)^{\theta} H_{t+\tau}}$$

If wages are flexible, and thus $\xi_w = 0$, this expression reduces to:

$$W_t(l) = \frac{\theta}{\theta-1}\frac{\frac{1+\sigma_H}{\sigma_H}\psi(H_t)^{\frac{1}{\sigma_H}}}{\lambda_t}$$

Thus when wages are flexible the wage rate is equal to a mark-up, $\frac{\theta}{(\theta-1)}$, multiplied by the

the marginal utility of consumption is the same across all households within a country, regardless of their income. Therefore the total utility from the consumption of labor income in any period is simply the country specific marginal utility of comsumption, λ_t, multiplied by the household's labor income, $W_t(l) N_t(l)$.

marginal disutility of labor, $\frac{1+\sigma_H}{\sigma_H}\psi(H_t)^{\frac{1}{\sigma_H}}$, divided by the marginal utility of consumption, λ_t.

Write the wage rate for the household that can reset wages in period t, $W_t(l)$, as $\tilde{W}_t(l)$ to denote it as an optimal wage. Also note that all households that can reset wages in period t will reset to the same wage rate, so $\tilde{W}_t(l) = \tilde{W}_t$.

All households face a probability of $(1-\xi_w)$ of being able to reset their wages in a given period, so by the law of large numbers $(1-\xi_w)$ of households can reset their wages in a given period. The wages of the other ξ_w will automatically reset by the previous periods inflation rate.

So substitute $\tilde{W}_t$ into the expression for the average wage rate $W_t = \left(\int_0^n W_t(l)^{1-\theta} dl\right)^{\frac{1}{1-\theta}}$, to derive an expression for the evolution of the average wage:

$$W_t = \left(\xi_w(\Pi_{t-1,t}W_{t-1})^{1-\theta} + (1-\xi_w)\left(\tilde{W}_t\right)^{1-\theta}\right)^{\frac{1}{1-\theta}}$$

A.2.2 Sticky Output Prices

Domestic Prices In the model, intermediate goods prices are sticky. Intermediate goods firms can set separate domestic and export prices.

In period t, the firm will be able to change it's price in the domestic market with probability $1-\xi_p$. If the firm cannot change prices then they are reset automatically according to $P_t^d(i) = \pi_{t-1}P_{t-1}^d(i)$.

The firm that can reset prices in period t will choose $P_t^d(i)$ to maximize discounted future profits:

$$\max_{P_t^d(i)} E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} \left\{\Pi_{t,t+\tau}P_t^d(i)\, y_{t+\tau}^d(i) - MC_{t+\tau}y_{t+\tau}^d(i)\right\}$$

where $MC_{t+\tau}$ is marginal cost of production in period $t+\tau$.

The firm's domestic demand is given in (11). Substitute this demand function into the maximization problem to express this problem as a function of one choice variable, $P_t(i)$:

$$\max_{P_t^d(i)} E_t \sum_{\tau=0}^{\infty} \beta^{\tau} \left(\xi_p\right)^{\tau} \lambda_{t+\tau} \left\{ \begin{array}{c} \Pi_{t,t+\tau} P_t^d(i) \gamma(n)^{\frac{1-\rho}{1-\sigma}-1} \left(\frac{\Pi_{t,t+\tau} P_t^d(i)}{P_{t+\tau}^d}\right)^{-\sigma} \left(\frac{P_{t+\tau}^d}{P_{t+\tau}}\right)^{-\rho} y_{t+\tau} \\ -MC_{t+\tau} \gamma(n)^{\frac{1-\rho}{1-\sigma}-1} \left(\frac{\Pi_{t,t+\tau} P_t^d(i)}{P_{t+\tau}^d}\right)^{-\sigma} \left(\frac{P_{t+\tau}^d}{P_{t+\tau}}\right)^{-\rho} y_{t+\tau} \end{array} \right\}$$

After some rearranging, the first order condition with respect to $P_t^d(i)$ is:

$$P_t^d(i) = \frac{\sigma}{\sigma-1} \frac{E_t \sum_{\tau=0}^{\infty} \beta^{\tau} \left(\xi_p\right)^{\tau} \lambda_{t+\tau} MC_{t+\tau} \left(\frac{\Pi_{t,t+\tau}}{P_{t+\tau}^d}\right)^{-\sigma} \left(\frac{P_{t+\tau}^d}{P_{t+\tau}}\right)^{-\rho} y_{t+\tau}}{E_t \sum_{\tau=0}^{\infty} \beta^{\tau} \left(\xi_p\right)^{\tau} \lambda_{t+\tau} \Pi_{t,t+\tau} \left(\frac{\Pi_{t,t+\tau}}{P_{t+\tau}^d}\right)^{-\sigma} \left(\frac{P_{t+\tau}^d}{P_{t+\tau}}\right)^{-\rho} y_{t+\tau}}$$

If prices are flexible, and thus $\xi_p = 0$, then this expression reduces to:

$$P_t^d(i) = \frac{\sigma}{\sigma-1} MC_t$$

which says that the firm will set a price equal to a constant mark-up over marginal cost.

Write the domestic price set by the firm that can reset prices in period t as $\tilde{P}_t^d(i)$ to denote that it is an optimal price. Firms that can reset prices in period t will all reset to the same level, so $\tilde{P}_t^d(i) = \tilde{P}_t^d$. Substitute this optimal price into the price index $P_t^d = \left(\frac{1}{n}\int_0^n \left(P_t^d(i)\right)^{1-\sigma} di\right)^{\frac{1}{1-\sigma}}$ and use the fact that in any period $1-\xi_p$ percent of firms will reoptimize prices, and the prices of ξ_p percent of firms will be automatically reset using the previous periods inflation rate, to derive an expression for the domestic price index, P_t^d:

$$P_t^d = \left(\xi_p \left(\Pi_{t-1,t} P_{t-1}^d\right)^{1-\sigma} + \left(1-\xi_p\right) \left(\tilde{P}_t^d\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

Export Prices Domestic firm i, where $i \in [0, n]$, will set a price $P_t^{m*}(i)$ for its intermediate input in the foreign market.

The demand for the intermediate good from domestic firm i in the rest of the world is given by:

$$y_t^{m*}(i) = (n)^{\frac{1-\rho}{1-\sigma}-1} \left(\frac{P_t^{m*}(i)}{P_t^{m*}}\right)^{-\sigma} \left(\frac{P_t^{m*}}{P_t^*}\right)^{-\rho} y_t^*$$

In period t, the firm will be able to change it's export price with probability $1-\xi_p$. If the firm cannot change its price in the foreign market then it is reset automatically according to $P_t^{m*}(i) = \pi_{t-1}^* P_{t-1}^{m*}(i)$, where $\pi_{t-1}^* = \frac{P_{t-1}^*}{P_{t-2}^*}$.

If domestic firm i was last able to change their export price in period t, the demand for the intermediate good from firm i in the rest of the world in period $t+\tau$ is:

$$y_{t+\tau}^{m*}(i) = \gamma^{f*}(n)^{\frac{1-\rho}{1-\sigma}-1} \left(\frac{\Pi_{t,t+\tau}^* P_t^{m*}(i)}{P_{t+\tau}^{m*}} \right)^{-\sigma} \left(\frac{P_{t+\tau}^{m*}}{P_{t+\tau}^*} \right)^{-\rho} y_{t+\tau}^*$$

The firm that can reset prices in period t will choose $P_t^{m*}(i)$ to maximize discounted future profits:

$$\max_{P_t^{m*}(i)} E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} \left\{ \Pi_{t,t+\tau}^* \frac{P_t^{m*}(i)}{S_{t+\tau}} y_{t+\tau}^{m*}(i) - MC_{t+\tau} y_{t+\tau}^{m*}(i) \right\}$$

where S_t is the nominal exchange rate denoted in units of the foreign currency per units of the home currency.

After some rearranging, the first order condition with respect to $P_t^{m*}(i)$ is:

$$P_t^{m*}(i) = \frac{\sigma}{\sigma-1} \frac{E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} MC_{t+\tau} \left(\frac{\Pi_{t,t+\tau}^*}{P_{t+\tau}^{m*}} \right)^{-\sigma} \left(\frac{P_{t+\tau}^{m*}}{P_{t+\tau}^*} \right)^{-\rho} y_{t+\tau}^*}{E_t \sum_{\tau=0}^{\infty} \beta^\tau \left(\xi_p\right)^\tau \lambda_{t+\tau} \frac{\Pi_{t,t+\tau}^*}{S_{t+\tau}} \left(\frac{\Pi_{t,t+\tau}^*}{P_{t+\tau}^{m*}} \right)^{-\sigma} \left(\frac{P_{t+\tau}^{m*}}{P_{t+\tau}^*} \right)^{-\rho} y_{t+\tau}^*}$$

If prices are flexible, and thus $\xi_p = 0$, then this expression reduces to:

$$P_t^{m*}(i) = \frac{\sigma}{\sigma-1} S_t MC_t$$

Denote $\tilde{P}_t^{m*}(i)$ as the optimal price for the foreign market set by a firm that was able to change their prices in period t. Firms that can reset prices in period t will all reset to the same level, so $\tilde{P}_t^{m*}(i) = \tilde{P}_t^{m*}$. Substitute this optimal price into the price index $P_t^{m*} = \left(\frac{1}{n} \int_0^n \left(P_t^{m*}(i)\right)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$ and use the fact that in any period $1-\xi_p$ percent of firms will reoptimize prices, and the prices of ξ_p percent of firms will be automatically reset using the previous periods inflation rate, to derive an expression for the import price index, P_t^{m*}:

$$P_t^{m*} = \left(\xi_p \left(\Pi_{t-1,t}^{*} P_{t-1}^{m*}\right)^{1-\sigma} + \left(1-\xi_p\right)\left(\tilde{P}_t^{m*}\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$$

A.3 Financial Frictions

The derivation of the various interest rates in the model, r_t^e, r_t^b, r_t^{wc} is presented in the text. However in the text, aggregation was only possible because at the beginning of the period, entrepreneur j's debt-asset ratio, $DA_t^e(j) = \frac{b_t^e(j)}{K_t(j)}$, was equal across all entrepreneurs, and bank k's debt-asset ratio, $DA_t^b(k) = \frac{b_t^s(k)+b_t^{sf}(k)}{B_t^e(k)}$, was equal across all banks. This section of the appendix will present the formal proof to both of these claims.

A.3.1 Entrepreneurial sector

Prove: $DA_{t+1}^e(i) = DA_{t+1}^e(j)$:

Entrepreneur i will purchase capital up to the point where:

$$1 + r_{t+1}^e(i) = E_t\left(\frac{R_{t+1} + \omega_{t+1}^e(i) P_{t+1}^K (1-\delta) K_{t+1}}{P_t^K}\right)$$

Since $E_t\left(\omega_{t+1}^e(i)\right) = 1$ and $cov\left(\omega_{t+1}^e(i), P_{t+1}^K(1-\delta)K_{t+1}\right) = 0$, $E_t\left(\frac{R_{t+1}+\omega_{t+1}^e(i)P_{t+1}^K(1-\delta)K_{t+1}}{P_t^K}\right) = E_t\left(\frac{R_{t+1}+P_{t+1}^K(1-\delta)K_{t+1}}{P_t^K}\right)$

Since $E_t\left(\frac{R_{t+1}+P_{t+1}^K(1-\delta)K_{t+1}}{P_t^K}\right)$ does not depend on any characteristics that are specific to entrepreneur i, in equilibrium $r_{t+1}^e(i) = r_{t+1}^e(j)$ for any two entrepreneurs i and j.

Proof by contradiction:

Suppose $DA_{t+1}^e(i) < DA_{t+1}^e(j)$

From the bank's optimal loan supply schedule:

$$1+r_{t+1}^{e}\left(j\right)=\frac{\left(1+r_{t+1}^{b}\right)}{1-F\left(\bar{\omega}_{t+1}^{e}\left(j\right)\right)}-\frac{\left(1-\mu^{e}\right)\left[R_{t+1}F\left(\bar{\omega}_{t+1}^{e}\left(j\right)\right)+\left(1-\delta\right)P_{t}^{K}\int_{0}^{\bar{\omega}_{t+1}^{e}\left(j\right)}\omega_{t+1}^{e}dF\left(\omega_{t+1}^{e}\right)\right]}{\left(1-F\left(\bar{\omega}_{t+1}^{e}\left(j\right)\right)\right)\frac{b_{t+1}^{e}\left(j\right)}{K_{t+1}\left(j\right)}}$$

where

$$\bar{\omega}_{t+1}^{e}\left(j\right)=\frac{\left(1+r_{t+1}^{e}\right)\frac{b_{t+1}^{e}\left(j\right)}{K_{t+1}\left(j\right)}-R_{t+1}}{P_{t+1}^{K}\left(1-\delta\right)}$$

If $DA_{t+1}^{e}\left(i\right)<DA_{t+1}^{e}\left(j\right)$, then $\frac{b_{t}^{e}\left(i\right)}{K_{t}\left(i\right)}<\frac{b_{t}^{e}\left(j\right)}{K_{t}\left(j\right)}$, so $\bar{\omega}_{t}^{e}\left(i\right)<\bar{\omega}_{t}^{e}\left(j\right)$ and $r_{t}^{e}\left(i\right)<r_{t}^{e}\left(j\right)$.

This contradicts with the earlier equilibrium condition that $r_{t+1}^{e}\left(i\right)=r_{t+1}^{e}\left(j\right)$, thus $DA_{t+1}^{e}\left(i\right)\not<DA_{t+1}^{e}\left(j\right)$ and since the choice of i and j where arbitrary the only possible equilibrium is one where $DA_{t+1}^{e}\left(i\right)=DA_{t+1}^{e}\left(j\right)$.

A.3.2 Banking sector

Prove $DA_{t+1}^{b}\left(i\right)=DA_{t+1}^{b}\left(j\right)$:

Bank i will make loans up to the point where:

$$1+r_{t+1}^{b}\left(i\right)=E_{t}\left(\left(1-\omega_{t+1}^{b}\left(k\right)\zeta_{t+1}^{e}\right)\left(1+r_{t+1}^{e}\right)B_{t+1}^{e}\left(i\right)\right)$$

Since $\omega_{t+1}^{b}\left(i\right)$ is i.i.d. and $E_{t}\left(\omega_{t+1}^{b}\left(i\right)\right)=1$, $E_{t}\left(\left(1-\omega_{t+1}^{b}\left(k\right)\zeta_{t+1}^{e}\right)\left(1+r_{t+1}^{e}\right)B_{t+1}^{e}\left(i\right)\right)=E_{t}\left(\left(1-\zeta_{t+1}^{e}\right)\left(1+r_{t+1}^{e}\right)B_{t+1}^{e}\left(i\right)\right)$

Thus $r_{t+1}^{b}\left(i\right)=r_{t+1}^{b}\left(j\right)$ for any two banks i and j.

Proof by contradiction:

Suppose $DA_{t+1}^{b}\left(i\right)<DA_{t+1}^{b}\left(j\right)$

From the equilibrium condition that determines how much credit is extended to a bank:

$$1 + r^b_{t+1}(i) = \frac{1 + i_{t+1}}{G\left(\bar{\omega}^b_t\right)}$$

where

$$\bar{\omega}^b_{t+1}(i) = \frac{\left(1 + r^e_{t+1}\right) - \left(1 + r^b_{t+1}(i)\right)\frac{b^s_{t+1}(i) + b^{sf}_{t+1}(i)}{B^e_{t+1}(i)}}{\zeta^e_{t+1}\left(1 + r^e_{t+1}\right)}$$

If $DA^b_{t+1}(i) < DA^b_{t+1}(j)$ then $\frac{b^s_{t+1}(i)+b^{sf}_{t+1}(i)}{B^e_{t+1}(i)} < \frac{b^s_{t+1}(j)+b^{sf}_{t+1}(j)}{B^e_{t+1}(j)}$, so $\bar{\omega}^b_{t+1}(i) > \bar{\omega}^b_{t+1}(j)$, so $r^b_{t+1}(i) < r^b_{t+1}(j)$.

This contradicts with the earlier equilibrium condition that $r^b_{t+1}(i) = r^b_{t+1}(j)$, thus $DA^b_{t+1}(i) \nless DA^b_{t+1}(j)$ and since the choice of i and j where arbitrary the only possible equilibrium is one where $DA^b_{t+1}(i) = DA^b_{t+1}(j)$.

Table 1: Some descriptive statistics for the various measures of credit and capital market integration

Variable	Mean	St. Dev.	Minimum	Maximum
C^{cpis}	3.18×10^{-3}	9.87×10^{-3}	9.63×10^{-10} (ESP-IND)	0.100 (IRL-GBR)
K^{cpis}	1.79×10^{-3}	5.58×10^{-3}	2.27×10^{-10} (JPN-ROM)	0.060 (USA-GBR)
C^{nfa}	0.381	0.416	3.36×10^{-5} (NLD-ESP)	2.158 (IRL-JOR)
K^{nfa}	0.245	0.268	3.46×10^{-4} (RUS-IDN)	1.841 (IRL-SWE)
C^{mad}	0.076	0.048	3.86×10^{-3} (DEU-PRT)	0.348 (TUR-JPN)
K^{mad}	0.071	0.022	0.022 (NLD-FRA)	0.150 (TUR-IDN)
C^{rs}	0.086	0.093	4.53×10^{-5} (ESP-HUN)	0.689 (IDN-NGA)
K^{rs}	0.037	0.026	5.90×10^{-5} (SVN-PAK)	0.135 (PER-EGY)

Table 2: Unconditional correlations between the various measures of credit and capital market integration

	C^{cpis}	K^{cpis}	C^{nfa}	K^{nfa}	C^{mad}	K^{mad}	C^{rs}	K^{rs}
C^{cpis}	1							
K^{cpis}	0.721	1						
C^{nfa}	0.127	0.131	1					
K^{nfa}	0.187	0.187	0.537	1				
C^{mad}	−0.146	−0.093	0.036	0.007	1			
K^{mad}	−0.144	−0.130	−0.005	0.059	0.626	1		
C^{rs}	0.006	0.033	0.031	−0.047	−0.118	−0.202	1	
K^{rs}	−0.112	−0.054	0.007	−0.077	−0.014	−0.022	0.052	1

Table 3: Some descriptive statistics for the aggregate endogenous variables in the regression model

Variable	Mean	St. Dev.	Minimum	Maximum
ρ	0.1343	0.4501	−0.9448 (ESP-CHN)	0.9784 (IRL-PRT)
F^{cpis}	4.9×10^{-3}	0.0143	1.9×10^{-9} (NZL-MEX)	0.1543 (IRL-GBR)
F^{nfa}	0.6260	0.6034	0.0061 (SVN-URY)	3.7122 (IRL-SWE)
F^{mad}	0.1474	0.0643	0.0294 (NLD-FRA)	0.4904 (JPN-TUR)
F^{rs}	0.1235	0.0985	6.9×10^{-4} (FRA-SVN)	0.8192 (IDN-NGA)
T	2.1×10^{-3}	7.8×10^{-3}	1.2×10^{-7} (SGP-IDN)	0.2268 (SGP-MYS)
S	0.1567	0.0741	0.0363 (USA-GBR)	0.4211 (SGP-LKA)

Table 4: Unconditional correlations between the aggregate endogenous variables in the regression model

	ρ	F^{cpis}	F^{nfa}	F^{mad}	F^{rs}	T	S
ρ	1						
F^{cpis}	0.221	1					
F^{nfa}	−0.056	0.183	1				
F^{mad}	−0.090	−0.147	0.027	1			
F^{rs}	0.072	−0.010	−0.007	−0.157	1		
T	0.178	0.363	0.065	0.016	−0.006	1	
S	−0.078	0.006	0.472	0.083	−0.002	0.057	1

Table 5: Results from the cross-sectional regression of business cycle correlation on financial integration, trade integration and industrial specialization.

	CPIS OLS	CPIS OLS	CPIS GMM	CPIS GMM		NFA OLS	NFA OLS	NFA GMM	NFA GMM
F	-0.039^{**}		0.073		F	0.000		-0.020^{**}	
	(0.014)		(0.064)			(0.005)		(0.009)	
C		-0.003		0.136^{**}	C		0.004		0.159^{**}
		(0.009)		(0.047)			(0.005)		(0.026)
K		-0.032^{**}		-0.284^{**}	K		-0.005		-0.144^{**}
		(0.009)		(0.046)			(0.005)		(0.022)
T	0.051^{**}	0.052^{**}	0.002	0.096^{**}	T	0.064^{**}	0.068^{**}	0.112^{**}	0.078^{**}
	(0.007)	(0.007)	(0.013)	(0.015)		(0.014)	(0.014)	(0.029)	(0.030)
S	-0.087^{**}	-0.092^{**}	-1.136^{**}	-0.356^{*}	S	-0.129^{**}	-0.128^{**}	-0.541^{**}	-0.611^{**}
	(0.027)	(0.026)	(0.156)	(0.184)		(0.031)	(0.031)	(0.155)	(0.159)

	MAD OLS	MAD OLS	MAD GMM	MAD GMM		RS OLS	RS OLS	RS GMM	RS GMM
F	-0.142^{**}		0.100		F	0.056^{**}		0.258^{**}	
	(0.035)		(0.086)			(0.014)		(0.073)	
C		-0.067^{**}		-0.737^{**}	C		0.006		0.190^{**}
		(0.025)		(0.088)			(0.009)		(0.058)
K		-0.105^{*}		1.046^{**}	K		0.050^{**}		-0.201^{**}
		(0.055)		(0.131)			(0.011)		(0.059)
T	0.070^{**}	0.066^{**}	0.147^{**}	0.213^{**}	T	0.050^{**}	0.054^{**}	0.024^{**}	-0.039^{**}
	(0.011)	(0.011)	(0.020)	(0.022)		(0.006)	(0.007)	(0.012)	(0.019)
S	-0.084^{**}	-0.079^{**}	-0.644^{**}	0.700^{**}	S	-0.114^{**}	-0.129^{**}	-1.070^{**}	-1.248^{**}
	(0.031)	(0.032)	(0.139)	(0.191)		(0.025)	(0.025)	(0.107)	(0.115)

Notes: Robust standard errors are written in parenthesis. ** implies significant at the 5% level, * implies significance at the 10% level. F, C, K, T, S are the natural logs of the variables listed in the text.

Table 6: Benchmark Parameter Values

Symbol	Value	Description
β	0.99	discount factor
δ	0.025	depreciation rate
α	0.36	capital's share of income
χ^b	0.01	cost of adjusting foreign bond holdings
σ_n	1	labor supply elasticity
σ	10	substitution elasticity across goods from domestic firms
θ	21	substitution elasticity across differentiated labor inputs
κ	0.25	capital adjustment cost parameter
ξ_p	0.62	probability that a firm cannot change prices in the current period
ξ_w	0.75	probability that a worker cannot change wages in the current period
θ_i	0.9	interest rate smoothing parameter
θ_p	1.5	weight on inflation in the Taylor rule
ϕ	0.308	fixed cost in production
ψ	0.380	coefficient on labor effort in the utility function
φ	0.0272	portion of net worth that is rebated to households as dividends
σ^b	1.110	standard deviation of idiosyncratic bank shocks
μ^e	0.275	cost of liquidation in the entrepreneurial sector
σ^e	0.335	standard deviation of idiosyncratic entrepreneur shocks

Table 7: Shock Processes used in the simulation

TFP Shocks:

$$\boldsymbol{\rho}^A = \begin{bmatrix} 0.775 & 0.099 \\ 0.099 & 0.775 \end{bmatrix} \qquad \boldsymbol{\Omega}^A = 10^{-5} \begin{bmatrix} 3.747 & 0.131 \\ 0.131 & 3.747 \end{bmatrix}$$

Monetary Policy Shocks:

$$\boldsymbol{\rho}^M = \begin{bmatrix} 0.013 & 0.015 \\ 0.015 & 0.013 \end{bmatrix} \qquad \boldsymbol{\Omega}^M = 10^{-5} \begin{bmatrix} 1.141 & 0.592 \\ 0.592 & 1.141 \end{bmatrix}$$

Table 8: The model's predictions for the effect of credit and capital market integration on business cycle co-movement

Bilateral output correlation:			
	Benchmark	$2 \times C$	$2 \times K$
Monetary shock	0.542	0.629	0.457
Monetary shock (No FA)	0.454	0.467	0.409
Productivity shock	0.686	0.694	0.670
Productivity shock (No FA)	0.726	0.736	0.714

Table 9: The model's predictions for the effect of credit and capital market integration on business cycle co-movement under alternative versions of the model

Bilateral output correlation:	Benchmark	$2 \times C$	$2 \times K$
Flexible Wages			
Monetary shock	0.625	0.728	0.531
Monetary shock (No FA)	0.437	0.459	0.387
Productivity shock	0.559	0.567	0.541
Productivity shock (No FA)	0.602	0.613	0.587
Flexible Prices			
Monetary shock	0.548	0.624	0.468
Monetary shock (No FA)	0.445	0.429	0.407
Productivity shock	0.528	0.533	0.521
Productivity shock (No FA)	0.579	0.585	0.574
Working Capital			
Monetary shock	0.546	0.634	0.465
Monetary shock (No FA)	0.466	0.480	0.424
Productivity shock	0.708	0.716	0.695
Productivity shock (No FA)	0.745	0.755	0.736
Indexed Bonds			
Monetary shock	0.524	0.598	0.454
Monetary shock (No FA)	0.457	0.472	0.420
Productivity shock	0.690	0.702	0.672
Productivity shock (No FA)	0.725	0.736	0.713
IRBC			
Monetary shock	*N/A*	*N/A*	*N/A*
Monetary shock (No FA)	*N/A*	*N/A*	*N/A*
Productivity shock	0.474	0.489	0.459
Productivity shock (No FA)	0.499	0.506	0.489