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Market power in banking, countercyclical margins and the international transmission of business cycles

María Pía Olivero *

Department of Economics, LeBow College of Business, Drexel University, Matheson Hall, Suite 503-A, 3141 Chestnut Street, Philadelphia, PA 19104, United States

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ABSTRACT

By introducing an imperfectly competitive banking sector into a standard two-country, two-good RBC model with complete asset markets, we study the international transmission of aggregate TFP shocks in an environment with noncompetitive financial intermediation. In this model, price-cost margins in a global loan market are endogenous and countercyclical. As a result, a positive TFP shock in one country spills over to another through a reduction in the global cost of both credit and externally financed investment. The quantitative analysis shows that countercyclical margins on loans play a key role in bringing the predictions of the theory closer to the observed cross-country cyclical co-movements of consumption, employment, investment and output. Recessions are deeper when the cost of credit rises during these economic downturns. Thus, a financial accelerator arises in our framework, unveiling the increased importance of stabilization policies in economies where margins in credit markets are countercyclical.

1. Introduction

A large body of research in international macroeconomics has been devoted to studying the channels through which business cycles are transmitted across countries. Unfortunately and despite all this work, there is still no consensus on what determines the co-movement of consumption, output, investment and employment across countries.

Our goal in this paper is to study a novel channel for the international transmission of business cycles. We build an environment with noncompetitive financial intermediation, and introduce an imperfectly competitive banking sector into a standard two-country, two-good RBC model with complete asset markets. In this model, price-cost margins in a global loan market are endogenous and countercyclical. As a result, a positive TFP shock in one country spills over to another through a reduction in the global cost of both credit and externally financed investment. To our knowledge, imperfect competition in the financial sector has not been studied previously in the context of the international RBC literature.

This framework allows us to study the discrepancies between the observed properties of the data and what standard models with no financial frictions predict regarding the international cyclical co-movement of consumption, employment, investment and output. Backus et al. (1992) first identified these discrepancies for the OECD countries. The "quantity anomaly" relates to the fact that while in the data correlations of output across countries are larger than analogous correlations for consumption, previous theoretical work has consistently obtained cross-country consumption correlations that significantly exceed output correlations. Also, while investment and employment tend to co-move across countries in the data, most preceding models have predicted a negative cross-country correlation[1] (see Table 1 for the cross-country correlations for consumption, output, employment and investment between the United States and other OECD countries).

The intuition behind the transmission mechanism we propose in this paper is as follows: As an economy experiences a positive TFP shock, aggregate economic activity expands and the need for credit-financed investment grows. By charging countercyclical price-cost margins, monopolistically competitive banks begin to compete more aggressively to capture new borrowers who now demand more credit. With global banks engaging in cross-border lending, margins fall in both economies. Then, through a reduction in the global cost of credit and of externally financed investment, the TFP shock in one country spills over to the other. This effect generates an increase in foreign investment, employment and output, and works to offset the fall in the foreign capital stock that occurs in standard models with perfect capital mobility.

* Tel.: +1 215 895 4908.
E-mail address: maria.olivero@drexel.edu.

[1] In models where agents are assumed to have access to a complete set of state-contingent claims, there is perfect international risk-sharing, and consumption levels are perfectly correlated across countries. In the absence of exogenous restrictions to capital mobility, capital flows from the rest of the world into that country whose productivity is relatively higher. This gives rise to the negative cross-country correlations of factors of production, and to the very low cross-country output correlations, driven mainly by the exogenous spillovers in total factor productivity.

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Table 1
Data on international co-movements.
Source: OECD Quarterly National Accounts and OECD Main Economic Indicators for the period 1960–2002.

$\rho(C^{US},C^{OECD})$	0.3311
$\rho(h^{US},h^{OECD})$	0.2167
$\rho(I^{US},I^{OECD})$	0.4151
$\rho(Y^{US},Y^{OECD})$	0.4496

Notes: *C* stands for consumption, *h* for employment, *I* for investment and *Y* for GDP. Correlations between the United States and non-US OECD countries for logged and Hodrick–Prescott filtered quarterly data. The sample period is 1960:I–2002:II. European data refer to the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and United Kingdom. Data for employment between 1972.1 and 1983.4 is only for the following subgroup: Austria, Finland, France, Germany, Italy, Norway, Spain, Sweden and United Kingdom. Data for employment between 1962.1 and 1971.4 is only for the following subgroup: Finland, Germany, Italy, Sweden and United Kingdom.
Worthy of note is the fact that business cycles in the US have become less correlated with those of the other OECD countries over time. Correlations calculated for the period 1970–1990 by Backus et al. (1992) are 0.51 for private consumption, 0.66 for output, 0.53 for investment and 0.33 for employment (see Heathcote and Perri (2003).

In the quantitative analysis we find that the extent of co-movement in output, investment and employment across countries is monotonically increasing in the degree of countercyclicality of banks' price-cost margins. We obtain positive cross-country correlations for employment, investment and output. Moreover, this happens for a degree of countercyclicality of margins consistent with the empirical evidence. We take these findings as evidence that the extent of market power in financial markets and the implied cyclical pattern in the pricing of loans are a key mechanism for the international transmission of business cycles that can help us understand some of the puzzling features of the data discussed above.

The transmission mechanism we propose hinges on the assumption of market power in the financial sector, which is strongly supported by the empirical literature in banking (see Shaffer (1982), Nathan and Neave (1989), Molyneux et al. (1994), Bikker and Groeneveld (1998), Hondroyiannis et al (1999), De Bandt and Davis (2000), Bikker and Haaf (2002), Gelós and Roldós (2002), Hempell (2002), Claessens and Laeven (2004) and Matthews et al (2007), among others). The countercyclical nature of banks price-cost margins is also crucial to our transmission mechanism. In Section 2 we document the empirical evidence on this countercyclicality for a large number of OECD countries, uncovering a new empirical regularity with important implications for the RBC literature.

In a general equilibrium model countercyclical margins produce a novel financial accelerator[2] with relevant policy implications: With margins in the market for credit being countercyclical, credit becomes more expensive in bad times. As a result, firms heavily reliant on credit delay their investment and production decisions, which deepens existing recessions. This result unveils the increased importance of stabilization policies in economies where margins in credit markets are countercyclical.

Related to our work where a countercyclical cost of credit is the main driving force for the international transmission of business cycles is Gilchrist (2004), who models a financial accelerator à la Bernanke and Gertler (1989), such that shocks are transmitted internationally due to their effect on the value of foreign borrowers' net worth. Schmitt-Grohé (1998), Ubide (1999) and Cook (2002) who study the role of countercyclical markups in goods markets in the transmission of business cycles, are also related.

The rest of the paper is structured as follows. Section 2 documents the empirical evidence on countercyclical price-cost margins. Section 3 presents the model. The intuition behind our main transmission mechanism is discussed in Section 4. The calibration strategy is presented in Section 5, and the results in Section 6. Section 7 concludes. Appendices A and B contain the results of several robustness checks performed on the model.[3]

2. Evidence on countercyclical price-cost margins in banking

Dueker and Thornton (1997), Chen et al. (2005) and Aliaga-Díaz and Olivero (2009, forthcoming) provide evidence on the countercyclicality of banks' price-cost margins for the United States. In this section we document the countercyclicality of margins for a large number of OECD countries, uncovering a new empirical regularity with important implications for the RBC literature.

2.1. Evidence based on bank-level data

In this subsection we use bank-level balance sheet and income statement data for a large sample of banks in OECD countries for the period 1996–2007. The source is Bankscope.[4]

For each bank, margins are calculated as interest income minus interest expenses divided by total assets. Then, an average margin for each country is obtained as the asset-weighted average across banks. The advantage of calculating margins based on actual interest income earned by banks (as opposed to quoted interest rate data) is that defaulted loans are already accounted for. Therefore, based on this methodology, the countercyclicality of margins cannot be driven by credit risk premia rising during recessions.

The first column of Table 2 reports the correlations between GDP growth and the first difference of margins. Negative correlations are obtained for 58% of the countries studied, with values ranging from −0.23 in France to −0.7 in Ireland. It is worth noting that the countries where margins are countercyclical held 84% of the banks in the sample and 82% of the total assets in 2007 (see Table 4).

Bankscope data are available only at the yearly frequency and for a very short time series. While this dataset is a good starting point, it is not ideal for conducting a time-series analysis to study the cyclical properties of margins. To overcome this difficulty, in the next subsection we use an alternative dataset available at the quarterly frequency and for a longer period to explore the dynamic properties of margins.

2.2. Evidence based on interest rate data

In this section we use quarterly data on interest rates and GDP from the IMF International Financial Statistics (IFS) for the period 1970–2008. Margins are calculated as the difference between lending rates and deposit rates. With a longer period available at a quarterly frequency, we are able to perform a more rigorous time series analysis and use the filtering procedures standard in the RBC literature.

The first exercise we perform is to obtain the raw correlations between the Hodrick–Prescott filtered logarithm of real GDP and the filtered margins for each country. The second column of Table 2 shows these correlations. As shown in Table 4, correlations are negative for 79% of the countries, which held 91% of the banks in the region and 78% of total assets in 2007. The third column of Table 2 also shows the standard deviations of margins relative to that of GDP. It can be seen that, with a few exceptions, margins are less volatile than economic activity.

[2] In our model it is the endogenous change over the business cycle in the degree of market power in banking what makes credit spreads countercyclical. Thus, this financial accelerator originates in the supply side of the loans market, not in the demand side as the Bernanke and Gertler (1989) financial accelerator.

[3] The appendices are available from the author's website at http://faculty.lebow.drexel.edu/OliveroM/.

[4] Mandelman (2006) provides related evidence using Bankscope data.

Table 2
Evidence on countercyclical margins.

Country	ρ(margin, GDP)		σ(margin)/σ(GDP)	% OECD	% OECD
	Bankscope	IFS	IFS	Banks	Assets
Australia	−0.3735	0.1110	0.4645	1.13%	1.68%
Austria	n.a.	−0.2330	0.0974	1.57%	0.96%
Belgium	−0.3957	−0.1634	0.1514	0.98%	3.29%
Canada	0.0859	0.0699	0.2493	0.57%	1.37%
France	−0.2278	0.0081	0.3551	4.55%	11.31%
Germany	−0.4099	−0.3106	0.1690	11.76%	11.39%
Greece	−0.3337	−0.1099	1.1948	0.37%	0.32%
Ireland	−0.7055	n.a.	n.a.	0.67%	1.47%
Italy	0.2309	−0.1910	0.4234	7.32%	3.37%
Japan	−0.4964	−0.0922	0.0634	4.64%	13.08%
Korea	0.3584	−0.1112	0.3418	0.57%	1.58%
Mexico	0.2252	−0.1914	1.4236	0.50%	0.21%
Norway	−0.3952	−0.3281	0.3166	1.02%	0.75%
Spain	0.4022	−0.0343	0.2118	2.50%	2.98%
Portugal	n.a.	−0.2721	0.1948	0.59%	0.45%
Sweden	0.2435	−0.3235	0.3623	0.80%	1.18%
Switzerland	−0.0123	−0.7366	0.7788	3.10%	3.41%
United Kingdom	−0.4205	−0.2309	0.7742	4.60%	14.69%
United States	−0.2868	−0.4635	0.3239	50.49%	22.10%

For Bankscope data correlations are calculated between the first difference in margins and real GDP growth. For IFS data, correlations and relative standard deviations are calculated using Hodrick–Prescott filtered data for both margins and GDP. Percentages of OECD banks and total bank assets are from Banskcope data for 2007.

2.2.1. A VAR analysis

The second exercise we perform is to use the methodology proposed by den Haan (2000) to further study the co-movement between margins and GDP at business cycle frequencies. This method uses correlations of VAR forecast errors at various horizons to measure the co-movement between variables.[5]

This approach is better than a standard correlation analysis for two reasons. First, since the unconditional correlation coefficients are defined only for stationary series, the data must be detrended, and the correlations become sensitive to the detrending methods used. In the den Haan (2000) method the VAR can contain any combination of stationary processes and processes integrated of arbitrary order, and there is no need for detrending the data. Second, this methodology captures important information about the dynamic aspects of the co-movement of variables that even conditional correlations fail to present. The reader is referred to Rotemberg (1996), den Haan (2000) and references therein for a detailed presentation of this methodology.

We estimate the following VAR:

$$X_t = \alpha + \mu_1 t + \mu_2 t^2 + \sum_{l=1}^{L} \beta_l X_{t-l} + \varepsilon_t \quad (1)$$

where t denotes time, L is the total number of lags included in the equations, and X_t is a vector of two random variables: a measure of margins and a business cycle indicator. The Akaike information criterion is used to determine the optimal number of lags for the VAR system in each country.

By estimating this VAR, we compute the K-period ahead forecast of the variables ($E_t X_{t+K}$). We then obtain the K-period ahead forecast errors ($X^{ue}_{t+K,t}$) as $X^{ue}_{t+K,t} \equiv X_{t+K} - E_t X_{t+K}$, and their variance–covariance matrix as a function of the coefficients β and of $Var(\varepsilon)$. Using this variance–covariance matrix, we can compute the correlation coefficient between the K-period ahead forecast errors of the two random variables in X. Negative correlation coefficients between the forecast errors of margins and the business cycle indicator provide evidence for countercyclical margins.[6]

The first four columns in Table 3 show these correlation coefficients derived from the bivariate VAR for selected K horizons: 1, 2, 5 and 10 years. The countercyclicality of price-cost margins is documented with negative correlation coefficients for Australia, Austria, Canada, Germany, Italy, Korea, Mexico, Norway, Portugal, Sweden, Switzerland, the United Kingdom and the United States. These countries are 81% of the countries studied, and in 2007 they held 88% of the banks, and 68% of the assets in the region (see Table 4).

Another advantage of the methodology in den Haan (2000), as opposed to standard regression analysis, is that it allows us to better control for the cyclical pattern of credit risk. This is important because it could be argued that the only reason for countercyclical margins is that the credit risk faced by lenders rises during recessions, driving margins up in these periods. Therefore, presenting evidence in favor of our model – where the countercyclicality of margins does not originate in countercyclical credit risk –, requires showing that there is an independent relationship between business cycles and margins, and that the co-movement between them is not entirely explained by the cyclical pattern of risk.

To control for the effects of risk, we run a multivariate version of the VAR in (1) where the X matrix of endogenous variables includes the margin measure, GDP and a risk measure. The credit risk measure is constructed using IFS and Board of Governors data. Following Kidwell and Trzcinka (1979), credit risk in the United States is proxied by the spread between Moody's seasoned Baa and Aaa corporate bonds. To get a risk measure for each country, we add to this measure of risk in the United States a country-risk measure given by the difference between the country's real yield on government bonds of long maturity and the real yield in the US.

The last columns in Table 3 show the correlations of VAR forecast errors derived from this multivariate VAR. Negative coefficients are obtained for 75% of the countries studied, which held 85% of the banks and 62% of the assets in the region in 2007.

Our results indicate that margins and economic activity are negatively correlated even after controlling for the cyclicality of credit risk. This uncovers a new empirical regularity with important implications for the RBC literature. In this literature credit margins are mostly constant and if time-varying, their cyclical behavior is usually driven *only* by the cyclical nature of credit risk.

3. The model

We extend a standard two-country, two-good, dynamic, stochastic, general equilibrium model by introducing a friction in credit markets. Specifically, firms in the model finance investment through external credit, by borrowing from an imperfectly competitive financial sector with a cyclical degree of market power. This degree of market power is measured by price-cost margins in credit markets, which vary endogenously over the business cycle.

To model financial intermediation we build on Schargrodsky and Sturzenegger (2000), extending their partial equilibrium, closed economy framework to a two-country model and allowing the demand for credit faced by financial intermediaries to vary over the business cycle. Thus, we model imperfect competition in banking using a monopolistic competition circular road model of horizontal product differentiation à la Salop (1979), where N rival banks compete in the price dimension.

[5] Rotemberg (1996) also proposes the correlation coefficient of one-period ahead VAR forecast errors to measure the co-movement between two variables.

[6] The Stata codes for implementing this methodology are available from the author upon request.

Table 3
Evidence on countercyclical margins: VAR methodology.

Country	Correlation of bivariate VAR forecast errors at various forecast horizons				Correlation of Multivariate VAR forecast errors at various forecast horizons				% OECD Banks	% OECD Assets
	1 year	2 years	5 years	10 years	1 year	2 years	5 years	10 years		
Australia	−0.1031	−0.1809	−0.1976	−0.1989	−0.0472	−0.1191	−0.1384	−0.1397	1.13%	1.68%
Austria	−0.3050	−0.2561	−0.2386	−0.2380	−0.1411	−0.0822	−0.0714	−0.0713	1.57%	0.96%
Belgium	0.6618	0.9760	0.9987	0.9989	0.7229	0.9879	0.9994	0.9994	0.98%	3.29%
Canada	0.0386	−0.0107	−0.0362	−0.0324	0.0513	−0.0003	−0.0222	−0.0169	0.57%	1.37%
France	0.1643	0.1566	0.1522	0.1519	0.3465	0.4010	0.4209	0.4223	4.55%	11.31%
Germany	−0.1578	−0.1820	−0.1951	−0.1958	−0.0171	−0.0605	−0.0845	−0.0857	11.76%	11.39%
Greece	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.37%	0.32%
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.67%	1.47%
Italy	−0.1738	−0.1751	−0.1772	−0.1773	−0.1461	−0.1588	−0.1708	−0.1716	7.32%	3.37%
Japan	0.2770	0.4093	0.4778	0.4855	0.3130	0.4204	0.4822	0.4894	4.64%	13.08%
Korea	−0.3142	−0.3499	−0.3896	−0.4049	−0.2900	−0.3279	−0.3388	−0.3472	0.57%	1.58%
Mexico	−0.0261	−0.0183	−0.0176	−0.0176	0.4122	0.3678	0.3557	0.3543	0.50%	0.21%
Norway	−0.1956	−0.2274	−0.2435	−0.2447	−0.2007	−0.2410	−0.2548	−0.2549	1.02%	0.75%
Spain	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2.50%	2.98%
Portugal	−0.4151	−0.4015	−0.3990	−0.3990	−0.5547	−0.5702	−0.6284	−0.6284	0.59%	0.45%
Sweden	−0.4469	−0.5501	−0.5743	−0.5737	−0.4517	−0.5517	−0.5685	−0.5677	0.80%	1.18%
Switzerland	−0.6648	−0.7281	−0.7483	−0.7501	−0.6692	−0.7356	−0.7515	−0.7526	3.10%	3.41%
United Kingdom	−0.1234	−0.0525	−0.0061	0.0015	−0.1116	−0.0402	−0.0013	0.0051	4.60%	14.69%
United States	−0.4262	−0.4100	−0.4033	−0.4032	−0.4140	−0.4037	−0.3967	−0.3966	50.49%	22.10%

The bivariate VAR specification includes margins and a business cycle indicator. The multivariate specification also includes a credit risk measure. Percentages of OECD banks and total bank assets are from Banskcope data for 2007. The data series for Greece, Ireland and Spain are short, and do not leave enough degrees of freedom for the VAR estimation.

Based on substantial empirical evidence on the internationalization of banking (see Dahl and Shrieves (1999), Houpt (1999) and Barron and Valev (2000) and data by the Federal Reserve System and the Bank of International Settlements[7]), we assume that these intermediaries are global, selling securities to households in both economies and lending to firms in both countries.

International financial markets offer a complete set of state-contingent securities that allows consumers in each country to buy insurance against adverse realizations of productivity shocks. For simplicity, as in Boileau (1996) we assume that international financial markets offer one-step ahead state-contingent securities. The state of the world is denoted by S_t, and follows a Markov process with transition probability density $f(S_{t+1},S_t)$. Each of N banks indexed by i issues state-contingent securities, sells them to households in both countries, and uses these proceeds to finance lending to firms in both economies.

The setup for the home country is presented in this section. Both countries are symmetric, so that analogous optimization problems apply to all agents in the foreign country. Stars are used to denote foreign country variables.

3.1. The households

To maximize its expected lifetime utility, a representative household in each country chooses consumption of domestic and imported goods (c_1 and c_2, respectively), labor (h) and holdings of the state-contingent securities issued by N financial intermediaries indexed by i (B_i^H). The representative household's optimization problem is given by:

$$\max_{c_{1t},c_{2t},h_t,B_i^H(S_{t+1})} \quad E_0\left[\sum_{t=0}^{\infty}\beta^t U(C_t,h_t)\right] \quad s.t.$$

$$c_{1t}+T_t c_{2t}+\sum_{i=1}^{N}\int_{S_{t+1}}P(S_{t+1},S_t)B_i^H(S_{t+1})dS_{t+1}=\sum_{i=1}^{N}B_i^H(S_t)+w_t h_t+\pi_t^F+g_t\sum_{i=1}^{N}\pi_{it} \tag{2}$$

$$C_t=[\varepsilon_C c_{1t}^{\rho_C}+(1-\varepsilon_C)c_{2t}^{\rho_C}]^{1/\rho_C} \tag{3}$$

$$\lim_{t\to\infty}\beta^t E_0\left\{U'(C_t)\int_{S_{t+1}}P(S_{t+1},S_t)B_i^H(S_{t+1})dS_{t+1}\right\}\geq 0\ \forall i \tag{4}$$

Preferences $U(C,h)$ are defined over consumption and work effort. In Eq. (3) C represents the domestic consumption aggregate over goods produced in the home country (good 1, $c1$) and in the foreign country (good 2, $c2$), where $\frac{1}{(1-\rho_C)}$ is the elasticity of substitution between domestic and foreign goods.

Eq. (2) is the household's budget constraint, where T_t are terms of trade defined as the relative price of the foreign good in terms of

Table 4
Evidence on countercyclical margins: percentage of OECD countries with countercyclical margins.
Source: Tables 2 and 3.

Dataset	Statistic used	Equally weighted	Bank weighted	Asset weighted
Bankscope	ρ(Δmargin, GDPgrowth)	58%	84%	82%
IFS	ρ(margin, GDP) (HP filtered data)	79%	91%	78%
IFS	correlations of bivariate VAR forecast errors	81%	88%	68%
IFS	correlations of multivariate VAR forecast errors	75%	85%	62%

The first column shows the percentage of OECD countries where margins are found to be countercyclical. In the second and third columns these percentages are weighted by the number of banks and total bank assets in each country, respectively.

[7] Bank structure data from the Board of Governors of the Federal Reserve System show that foreign assets represented 12% of total consolidated assets for insured U.S. large commercial banks for the period 2001–2004. According to the Report of Condition and Income data, in the first quarter of 2001, deposits of non-U.S. addressees represented 38% of total deposits of individuals, partnerships and corporations. In 2004 loans to non-U.S. addressees represented 16% of commercial and industrial loans. This includes loans counted in international banking facilities and loans granted by foreign branches of U.S. banks. Based on the international banking statistics published by the Bank of International Settlements, for U.S. banks external loans vis-a-vis non-bank sectors typically represent an average of 3% of GDP, and external deposits represent an average of 2% of GDP.

the domestic good. $B^H(S_{t+1})$ denotes the net amount of period $t+1$ domestic goods that households buy at time t, at a price of $P(S_{t+1}, S_t)$ contingent on the economy being in state S_{t+1} next period. Domestic households own the domestic firms and a fraction g_t of the global banks. Profits for the firms and for each of N financial intermediaries (π^F and $\sum_{i=1}^{N}\pi_i$, respectively) are rebated to households in a lump-sum fashion.

Eq. (4) is the constraint that prevents households from engaging in Ponzi schemes.

The Euler equation for consumption that governs households' savings decisions in this complete markets economy is:

$$P(S_{t+1}, S_t) = \beta \frac{U'(C_{t+1})/p^C_{t+1}}{U'(C_t)/p^C_t} f(S_{t+1}, S_t) \quad (5)$$

where p^c_t denotes the time t price of the consumption aggregate in terms of domestic goods in the home country. It is given by Eq. (6), as a weighted average of the price of the domestic good and the terms of trade T_t.

$$p^C_t = \left[\varepsilon_C^{1/(1-\rho_C)} + T_t^{\rho_C/(\rho_C-1)}(1-\varepsilon_C)^{1/(1-\rho_C)}\right]^{(\rho_C-1)/\rho_C} \quad (6)$$

Notice that since the market for securities is a single global market accessed by households in both economies, Eq. (5) ensures that ex-post intertemporal marginal rates of substitution are equalized across consumers of either country.

3.2. The financial intermediation sector

There are N global monopolistically competitive financial intermediaries or banks. They issue securities (acquired by both domestic and foreign households) and lend to both domestic and foreign firms.

Based on Fama (1985) and on the vast empirical evidence on market power in loans, we assume that while these banks price securities competitively, they exhibit market power in loan markets.[8]

The structure of the banking industry is described using a model of horizontal product differentiation á la Salop (1979). Consider a circular city with a perimeter equal to one. N banks are located symmetrically around the circle, and each bank is allowed to choose only one location, such that the distance between any two banks is $\frac{1}{N}$. Along the Salop circle there is a continuum of mass one of domestic borrowers indexed by their exact location x, and a continuum of mass one of foreign borrowers, whose location is indexed by x^*. Each domestic (foreign) firm borrows an amount B^F_x (B^{F*}_x), with $B^F \equiv \int_0^1 B^F_x dx$ ($B^{F*} \equiv \int_0^1 B^{F*}_x dx^*$) denoting the aggregate amount of credit in the domestic (foreign) economy. Therefore, in this framework each bank engages in cross-border lending by getting state-contingent securities from households in both economies and using them to finance lending in both countries.

As discussed in Schargrodsky and Sturzenegger (2000), we interpret this model as one of sectorial product differentiation, so that there is a continuum of sectors around the circle, and a particular bank's location on the circle can be thought of as a particular sector towards which the bank targets its financial services. For example, when providing the financial services associated with a loan (investment project evaluation, valuation of borrowers' assets and firms' monitoring, among others), the bank chooses to focus on the agricultural sector, industrial producers or the service sector.

In period t each bank i maximizes the present value of its expected lifetime profits (Π_i) by pricing securities offered to the production sector, and charging a markup $\mu_i(S_{t+1},S_t)$ over its marginal cost $P(S_{t+1},S_t)$. Therefore, conditional on the state of the economy being S_{t+1} in period $t+1$, the total cost for firms of $B^F(S_{t+1})$ units of the domestic good in $t+1$ is $\mu_i(S_{t+1},S_t)P(S_{t+1},S_t)$ when borrowing from bank i. Bank i's optimization problem is given by[9]:

$$\max_{\mu_i(S_{t+1},S_t)} \Pi_i = E_0 \sum_{t=0}^{\infty} \int_{S_{t+1}} P(S_{t+1},S_t)\pi_{it}(S_{t+1})dS_{t+1}$$

$$s.t.$$

$$\pi_{it}(S_{t+1}) = P(S_{t+1},S_t)\left(B^H_i(S_{t+1}) + B^{H*}_i(S_{t+1})\right) + \mu_i(S_{t+1},S_t)P(S_{t+1},S_t)l_i(S_{t+1}) - \left(B^H_i(S_t) + B^{H*}_i(S_t) + l_i(S_t)\right) \quad (7)$$

$$B^H_i(S_{t+1}) + B^{H*}_i(S_{t+1}) + l_i(S_{t+1}) = 0 \quad (8)$$

$$l_i(S_{t+1}) \equiv 2\int_0^{\hat{x}_t} B^F_{ix}(S_{t+1})dx + 2\int_0^{\hat{x}^*_t} B^{F*}_{ix}(S_{t+1})dx^* \quad (9)$$

Eq. (7) defines bank i's per-period profits. Eq. (8) is the balance sheet condition for bank i. Notice that by this condition, $B^H_i(S_{t+1}) + B^{H*}_i(S_{t+1}) = -l_i(S_{t+1})$. l_i is negative (see The production sector section), so that households in both countries go long in asset holdings (i.e. $B^H > 0$ and $B^{H*} > 0$) and firms go short (i.e. $B^F < 0$ and $B^{F*} < 0$). Eq. (9) denotes the fact that bank i internalizes the demand for credit l_i that it faces from borrowers. This condition states that bank i will provide loans to all domestic firms located from its location through a threshold $\hat{x}$ on each side of the circle, and to all foreign firms located through $\hat{x}^*$ on each side of the circle, where the threshold $\hat{x}$ ($\hat{x}^*$) indexes the location of a domestic (foreign) firm that is just indifferent between borrowing from bank i and its adjacent neighbor bank. Conditional on the state of nature in period $t+1$ being S_{t+1}, each domestic firm located along the range $[0,\hat{x}]$ demands $B^F_x(S_{t+1})$, and each foreign firm located along the range $[0,\hat{x}^*]$ demands $B^{F*}_x(S_{t+1})$.

The pricing equation obtained from the FOCs for these financial intermediaries is given by:

$$\mu_i(S_{t+1}, S_t) = \left(1 + \frac{1}{\varepsilon_{it}}\right)^{-1} \quad (10)$$

where $\varepsilon_{it} \equiv \frac{\partial l_i(S_{t+1})}{\partial \mu_i(S_{t+1},S_t)} \frac{\mu_i(S_{t+1},S_t)}{l_i(S_{t+1})}$ is the elasticity of the demand for credit l_i faced by bank i. This is a standard non-competitive pricing condition that equates the ratio of price to marginal cost to a function of the price elasticity of demand.

3.3. The production sector

There is a continuum of mass one of infinitely-lived, perfectly competitive firms indexed by their exact location x on the Salop circle. They use country-specific labor and capital to produce a final good operating a constant returns to scale Cobb–Douglas technology.

[8] Fama (1985) shows that the banking industry has to exhibit some degree of market power in lending, or banks would be driven out from a competitive credit market by institutions with a lower cost of funds, such as the market for commercial paper. The empirical evidence for market power in loan markets extends to Shaffer (1982), Nathan and Neave (1989), Molyneux et al. (1994), Bikker and Groeneveld (1998), Hondroyiannis et al (1999), De Bandt and Davis (2000), Bikker and Haaf (2002), Gelós and Roldós (2002), Hempell (2002), Claessens and Laeven (2004) and Matthews et al (2007), among others. Conversely, the empirical evidence for the deposits side of the market is limited to Berger and Hannan (1989), Hannan and Berger (1991) and Neumark and Sharpe (1992).

[9] Because of the assumption that households own the banks, the discount factor for banks is the weighted sum of the households' intertemporal marginal rates of substitution in both countries, with weights given by g_t and $(1-g_t)$, respectively. Further, the intertemporal marginal rate of substitution is equalized across countries for all states of nature and at all times, and it equals $P(S_{t+1},S_t)$. Thus, the discount factor for the banks equals $P(S_{t+1},S_t)$. Notice that $P(S_{t+1},S_t)$ is also the banks marginal cost of funds.

In each period t firm x chooses employment (h_x), investment(I_x) and borrowing conditional on the state of nature in period $t+1$ being S_{t+1} $(B_x^F(S_{t+1}))$ to maximize the expected present discounted value of its lifetime profits. Thus[10]:

$$\max_{h_{xt},K_{xt+1},I_{xt},B_x^F(S_{t+1})} \Pi_x^F = E_0 \sum_{t=0}^{\infty} P(S_{t+1},S_t)\pi_{xt}^F$$

s.t.

$$\pi_{xt}^F = Y_{xt} - w_t h_{xt} - p_t^I I_{xt} + B_x^F(S_t) - \int_{S_{t+1}} \mu(S_{t+1},S_t)P(S_{t+1},S_t)B_x^F(S_{t+1})dS_{t+1} - \theta x \quad (11)$$

$$Y_{xt} = A_t F(K_{xt},h_{xt}) = A_t K_{xt}^{\alpha} h_{xt}^{1-\alpha} \quad (12)$$

$$I_{xt} = [\varepsilon_I \iota_{1xt}^{\rho_I} + (1-\varepsilon_I)\iota_{2xt}^{\rho_I}]^{1/\rho_I} \quad (13)$$

$$\int_{S_{t+1}} \mu(S_{t+1},S_t)P(S_{t+1},S_t)B_x^F(S_{t+1})dS_{t+1} \le -\phi p_t^I I_{xt} \quad (14)$$

$$K_{xt+1} = I_{xt} + (1-\delta)K_{xt} \quad (15)$$

$$\log(\mathbf{A_{t+1}}) = \Lambda \log(\mathbf{A_t}) + \boldsymbol{\nu}_{t+1} \quad (16)$$

Eq. (11) defines firm x's cash flow for period t as sales revenue minus labor and investment costs plus borrowing minus repayment of loans contracted in the previous period. The costs of purchasing differentiated financial services (i.e. loans) from a monopolistically competitive banking sector are given by the last term in Eq. (11). Following the standard assumption in circular road models à la Salop (1979), these costs are linear in the "distance" x to the bank and the degree of differentiation θ. With these costs given by θx, the parameter θ can be interpreted as the per-unit distance transport cost of "traveling" the distance to the bank of choice. The more general purpose the services offered by any bank (i.e. the lower the degree of product differentiation and the lower θ), the better the services offered by this bank accommodate the needs of all borrowers. Therefore, a lower θ implies lower costs of borrowing from that bank for all firms, and a larger demand faced by that bank.

Eq. (12) presents the standard constant returns to scale Cobb–Douglas technology operated by firm x to produce a final good Y_x.

Eq. (13) shows the investment aggregate over domestic (ι_1) and foreign (ι_2) goods, which are imperfect substitutes in the investment technology. p_t^I denotes the price of the investment aggregate in terms of domestic goods in the home country.

Eq. (14) states that at least a share ϕ of investment spending needs to be financed externally. With market power in banking Eq. (14) always binds in equilibrium. Also, notice that Eq. (14) imposes that firms always need to borrow in asset markets, so that $B_x^F(S_t) < 0\ \forall S_t$.

Eq. (15) describes the standard law of motion followed by the capital stock.

Last, Eq. (16) shows the VAR(1) in logarithms process followed by total factor productivity, where $\mathbf{A_t} \equiv (A_t, A_t^*)$ is part of the state vector of the model. Λ is a matrix of coefficients and $\boldsymbol{\nu}_t \equiv (\nu_t, \nu_t^*)$. The off-diagonal elements of Λ define the spillovers from one country to the other. The elements of ν_t are serially independent, bivariate, normal random variables with contemporaneous covariance matrix V. TFP processes are related across countries through the off-diagonal elements of both Λ and V.

3.4. Derivation of the demand l_i

In this subsection we derive the demand l_i that each bank i internalizes and its interest rate elasticity. Plugging this elasticity into the bank's loan pricing Eq. (10), we are able to derive an expression for equilibrium price-cost margins and to study their properties over the business cycle.

To do so, we solve for a non-cooperative Nash equilibrium with N banks. A firm will borrow from bank i located at a distance x from her (with $0 \le x \le \frac{1}{N}$) if and only if the firm's profits when borrowing from bank i exceed those when borrowing from any other neighbor located at a distance $\left(\frac{1}{N}-x\right)$ from her. Analytically, if and only if:

$$\pi_{xt}^F + P(S_{t+1},S_t)\pi_{xt+1}^F \ge \bar{\pi}_{xt}^F + P(S_{t+1},S_t)\ \bar{\pi}_{xt+1}^F \quad (17)$$

where $\bar{\pi}_{xt}^F$ denotes the profits earned by firm x when borrowing from bank i's adjacent neighbor located at a distance $\left(\frac{1}{N}-x\right)$ from the firm.[11]

Using Eq. (17) we can solve for $\hat{x}_t$, the location of the firm that is just indifferent between borrowing from bank i and its adjacent neighbor. In doing this, we obtain $\hat{x}_t = f(\mu_i(S_{t+1},S_t), \bar{\mu}(S_{t+1},S_t))$, where $\bar{\mu}(S_{t+1},S_t)$ denotes the cost of borrowing from bank i's neighbor.

The Nash equilibrium is one in which all domestic firms located from bank i through $\hat{x}_t$ and all foreign firms located from bank i through $\hat{x}_t^*$ on each side of the circle find it optimal to borrow from bank i. Each firm demands B_x^F in the domestic country and B_x^{F*} in the foreign.

Therefore, at time t the total demand faced by bank i from all firms is:

$$l_i(S_{t+1}) = 2\int_0^{\hat{x}_t} B_{ix}^F(S_{t+1})dx + 2\int_0^{\hat{x}_t^*} B_{ix}^{F*}(S_{t+1})dx^* \quad (18)$$

The amount borrowed by each firm is not a function of firm x's location x. Therefore, Eq. (18) becomes:

$$l_i(S_{t+1}) = 2\left[B_{ix}^F(S_{t+1})\hat{x}_t + B_{ix}^{F*}(S_{t+1})\hat{x}_t^*\right] \quad (19)$$

The interest rate elasticity ε_{it} of the demand faced by bank i is:

$$\varepsilon_i = \frac{\partial l_i(S_{t+1})}{\partial \mu_i(S_{t+1},S_t)}\frac{\mu_i(S_{t+1},S_t)}{l_i(S_{t+1})} = -\frac{1}{\theta}P(S_{t+1},S_t)\left[\left(B_{ix}^F(S_{t+1})\right)^2 + \left(B_{ix}^{F*}(S_{t+1})\right)^2\right]\frac{\mu_i(S_{t+1},S_t)}{l_i(S_{t+1})} \quad (20)$$

Imposing symmetry among both firms and banks, in equilibrium $\mu_i = \mu\ \forall i$, $B_{ix}^F = B^F$, $B_{ix}^{F*} = B^{F*}\ \forall x$ and $\hat{x}_t = \hat{x}_t^* = \frac{1}{2N}$ such that $l_{it} = l_t = \frac{(B^F + B^{F*})}{N}\ \forall i$, Eq. (20) becomes:

$$\varepsilon_t = -\frac{N}{\theta}\mu(S_{t+1},S_t)P(S_{t+1},S_t)\frac{\left[(B^F(S_{t+1}))^2 + \left(B^{F*}(S_{t+1})\right)^2\right]}{\left[B^F(S_{t+1}) + B^{F*}(S_{t+1})\right]} \quad (21)$$

Plugging Eq. (21) into Eq. (10), we can derive an expression for the equilibrium price-cost margin in the market for loans:

$$\mu(S_{t+1},S_t) = 1 + \frac{\theta}{N}\frac{1}{P(S_{t+1},S_t)}\frac{\left[B^F(S_{t+1}) + B^{F*}(S_{t+1})\right]}{\left[\left(B^F(S_{t+1})\right)^2 + \left(B^{F*}(S_{t+1})\right)^2\right]} \quad (22)$$

Eq. (21) shows that the interest rate elasticity is larger when the competition is more intense, i.e. when the number of banks N is large and the degree of product differentiation θ is small. Thus, by Eq. (22), margins are positively related to market concentration (i.e. a drop in N raises margins), and to θ (i.e. product differentiation provides a source of market power for banks).

[10] By the same reasoning used for banks, firm x's discount factor is $P(S_{t+1},S_t)$. See footnote 8 for details.

[11] Profits earned at time $t+1$ enter this equation because loans contracted at time t are repaid in $t+1$.

Also, the elasticity is increasing in the volume of loans (see Eq. (21)). This implies unambiguously countercyclical price-cost margins in international financial markets.

This is a fundamental result because countercyclical margins are the key mechanism for the international transmission of business cycles in the model. The intuition for these countercyclical margins is that as an economy is hit by an aggregate TFP shock, and the aggregate volume of investment and lending rises, each borrower demands a larger amount. Banks faced with a larger price elasticity of demand, now have the incentives to compete more aggressively. This is true because for a given reduction in the interest rate that banks charge and a given number of new borrowers they can capture doing so, each borrower now demands more. As a result, and consistent with the empirical evidence presented in Section 2, banks compete more aggressively, and lower their price-cost margins in the upward phase of the business cycle.

3.5. Equilibrium

We restrict attention to the case of symmetric equilibria, so that the i subscripts can be dropped and $\sum_{i=1}^{N} z_i = Nz$ for all variables z.

Eqs. (23) and (24) are the market clearing conditions in the domestic and foreign goods markets, respectively. They state that the world output of each good is devoted to consumption, investment and paying the costs of product differentiation in banking.

$$(c_{1t} + c_{1t}^{*}) + (\iota_{1t} + \iota_{1t}^{*}) + \int_0^1 \theta x \, dx = Y_t \quad (23)$$

$$(c_{2t} + c_{2t}^{*}) + (\iota_{2t} + \iota_{2t}^{*}) + \int_0^1 \theta x^{*} \, dx^{*} = Y_t^{*} \quad (24)$$

Combining Eqs. (8) and (9) we get the market clearing condition in international financial markets:

$$\sum_{i=1}^{N} \left\{ \left[B_i^H(S_{t+1}) + B_i^{H*}(S_{t+1}) \right] + \left[B_i^F(S_{t+1}) + B_i^{F*}(S_{t+1}) \right] \right\} = 0 \quad (25)$$

The recursive symmetric equilibrium in this economy is defined by a set of prices $\{w_t, w_t^{*}, T_t, p_t^c, p_t^{c^*}, p_t^I, p_t^{I^*}, \mu(S_{t+1}, S_t), P(S_{t+1}, S_t)\}$, and a set of allocations $\{c_{1t}, c_{1t}^{*}, c_{2t}, c_{2t}^{*}, C_t, C_t^{*}, \iota_{1t}, \iota_{1t}^{*}, \iota_{2t}, \iota_{2t}^{*}, I_t, I_t^{*}, h_t, h_t^{*}, Y_t, Y_t^{*}, B^H(), B^{H^*}(), B^F(), B^{F^*}(), l_t\}$, such that all agents FOCs and the no-Ponzi game constraints in each country are met, the households' budget constraint holds in both countries, the labor and international financial markets clear at all times, and the domestic and foreign economies resource constraints hold.

4. A discussion of the transmission mechanisms

The mechanism for the international transmission of business cycles introduced in this paper is given by time-varying price-cost margins in monopolistically competitive international financial markets. We call this channel the *countercyclical margins channel*.

The simulation results in Section 6 show that the co-movement of macroeconomic aggregates is monotonically increasing in the negative response of margins to economic activity. The intuition for this result is as follows: When a positive productivity shock hits the domestic economy, both investment and the demand for credit rise. The interest rate elasticity of that demand also increases, implying a falling degree of market power and lower margins charged by the monopolistically competitive global banks. The shock spills over to the other country through a reduction in the global cost of credit and of externally financed investment. Even with foreign productivity being unaffected on impact, this generates an increase in investment in the foreign country. As the capital stock increases there, both the demand for labor and employment rise, exerting a positive effect on foreign output. This effect works to offset the fall in the foreign capital stock that occurs in a standard model with perfect capital mobility and no financial frictions, where capital flows out from the rest of the world into the more productive economy.

International trade in two goods gives another transmission channel in this model: the *trade channel*. This follows Stockman and Tesar (1998) and Heathcote and Perri (2002), among others. Each country exogenously specializes in the production of one of the goods, which are imperfect substitutes in consumption for households and in investment for firms. This generates a *demand channel*: when one of the countries is hit by a positive TFP shock, its wealth increases and it raises its demand for foreign goods, so that some of the benefits spill over abroad. In addition, the change in the relative supply of the two goods generated by the exogenous TFP shock creates a *terms of trade channel*. The country for which terms of trade improve receives a positive wealth effect. Both the *demand channel* and the *terms of trade channel* are part of the overall *trade channel*. These features of the model are consistent with the empirical results in Baxter and Kouparitsas (2005), who show that bilateral trade is a robust variable in explaining co-movements.

5. Calibration

Our model is solved through log-linearization in the neighborhood of the deterministic steady state.

Preferences are of the Greenwood, Hercowitz, Huffman (GHH) type, with no wealth effects on labor supply, i.e. $U(C,h) = \frac{\left(C - \gamma \frac{h^{\omega}}{\omega}\right)^{1-\sigma}}{(1-\sigma)}$.

We calibrate the model to match some of the post-war stylized facts of the US and other non-US OECD economies. The time period is a quarter. The parameter values are shown in Table 5.

The parameter β is set to match a steady state price of securities $P(S_{t+1}, S_t)$ that equals the reciprocal of the quarterly gross 20-year inflation-indexed interest rate on Treasury Bills.

The number of banks N is set to match a steady-state $\mu^{-1} = 1.04$, and θ is chosen to match the average correlation between margins and GDP across the countries studied in Section 2.

The parameter ω is set to match the price elasticity of labor supply, and γ to have households devoting 30% of their time to work. Following standard practice, σ is set to 4. In the consumption and investment aggregators, ε_c and ε_I is set to 0.85 to match the share of imported goods in total absorption. Following the benchmark in Heathcote and Perri (2002), the parameters ρ_C and ρ_I are set to reproduce an elasticity of substitution between local and foreign goods of 0.9.

The depreciation rate is set to 0.025 as standard in the literature. ϕ is chosen to match the 0.5 ratio of loans outstanding to assets in the Flows of Funds Accounts of the Federal Reserve System. This is also the value used by Bernanke and Gertler (1989).

Table 5
Calibration.

Utility function	Consumption aggregator
$\omega = 2$ $\sigma = 4$	$\varepsilon_c = \varepsilon_I = 0.85$ $\rho_c = \rho_I = -1/9$
Production function	
$\alpha = 0.36$	
Capital accumulation	**Financial parameters**
$\delta = 0.025$	$\phi = 0.5$ $N = 0.028$ $\theta = 0.0002$
TFP process	
$\lambda_{11} = \lambda_{22} = 0.906$ $\sigma^2(\varepsilon_t) = \sigma^2(\varepsilon_t^{*}) = (0.0085^2)$	$\lambda_{12} = \lambda_{21} = 0.08$ $\rho(\varepsilon, \varepsilon^{*}) = 0.25$

Table 6
Simulation results: domestic business cycle statistics.

	Data		Imperfectly competitive banks		Competitive banks		Imperfectly competitive banks		Competitive banks	
			Two goods				One good			
	$\frac{\sigma(x)}{\sigma(Y)}$	$\rho(x,Y)$	$\frac{\sigma(x)}{\sigma(Y)}$	$\rho(x,Y)$	$\frac{\sigma(x)}{\sigma(Y)}$	$\rho(x,Y)$	$\frac{\sigma(x)}{\sigma(Y)}$	$\rho(x,Y)$	$\frac{\sigma(x)}{\sigma(Y)}$	$\rho(x,Y)$
Macroeconomic variables										
C	0.8	0.8734	3.3017	0.2104	0.6268	0.9432	3.2312	0.2102	0.5458	0.954
h	0.88	0.5494	0.5882	0.9041	0.4615	0.9785	0.4989	0.9993	0.5013	0.9997
I	2.61	0.9245	30.538	0.171	3.3821	0.8741	39.7018	0.0425	48.9932	0.0546
K			1.6619	0.8258	0.2398	0.3796	1.6518	0.862	0.8029	0.7138
A	0.68	0.96	0.3648	0.2657	0.7133	0.6306	0.3321	0.2567	0.5347	0.5564
A^*			0.38	0.2771	0.743	0.6478	0.346	0.288	0.5569	0.5924
NX			5.9646	−0.271	0.7458	−0.2383	18.1222	0.0177	18.3266	0.0306
$\frac{NX}{Y}$	0.69	−0.37	1.3582	−0.271	0.253	−0.2383	6.8545	0.0177	11.034	0.0306
Financial variables										
μ	0.4387	−0.2002	0.3635	−0.135	–	–	0.3332	−0.1144	–	–

Notes: The data statistics refer to quarterly data for the United States. The sample period is 1960:I–2002:II. The data statistics on financial variables are based on IFS data from Section 2, average for all countries. All series are logged and Hodrick–Prescott filtered, using 1600 as the smoothing parameter. The model statistics are the averages of 100 simulations of length 100.

The parameters that govern the exogenous process followed by total factor productivity are standard in this literature and taken from Backus et al. (1992).

6. Results

In this section we study the properties of our model with market power in banking and countercyclical margins, and compare them to those of a model with competitive banks. In an online appendix we present the results of a model where households in both economies are assumed to have access to a risk-free asset only, and several robustness checks performed on that model.

Simulation results are presented in Tables 6 and 7.[12] In the benchmark version of the model consumption, employment, investment and output all co-move across countries. Notice that this happens for a degree of countercyclicality of margins consistent with our empirical results in Section 2 (see Tables 2 and 3). In this complete markets economy, domestic and foreign consumption are almost perfectly correlated and, consistent with the "quantity anomaly", the cross-country correlation of consumption is higher than that of output.

Fig. 1 shows that the cross-country correlations for consumption, employment, investment and output are all monotonically increasing in the countercyclicality of the price-cost margins in global financial markets. As the "*countercyclical margins channel*" becomes stronger, investment and employment become less negatively correlated across countries.

The intuition for this behavior is consistent with the discussion in Section 4. First, after a productivity shock hits the domestic economy, and with countercyclical price-cost margins in credit markets, the cost of credit in the foreign country falls relative to a standard model with perfectly competitive banks. This allows foreign investment to increase relative to the standard model and therefore, $\rho(I, I^*)$ increases. Second, as investment becomes positively correlated across countries, so do the capital stock, the marginal product of labor and the demand for labor. Consequently, employment co-moves across countries.

It is obvious from the behavior of consumption that we would need to impose more frictions in the market for households savings (i.e. more restrictions to international risk sharing) to be able to address the "quantity anomaly". However, following the assumption in BKK that households have access to a complete set of state-contingent securities allows us to isolate the effects of imperfect competition and countercyclical margins in the financial sector on the international transmission of business cycles.

Tables 6 and 7 also show the results for a model with perfectly competitive banks. This model delivers cross-country correlations for investment and output that are consistently smaller in magnitude, and domestic and foreign investment are now strongly negatively correlated. We take this as evidence of the importance of the *countercyclical margins channel* in understanding the international transmission of business cycles.

The results for a model with only one good, both with and without market power in international financial markets are also presented in Tables 6 and 7. These results show the importance of the *trade channel* for international real business cycles. In the absence of trade in goods, investment is still mildly negatively correlated across countries, even when margins in credit markets are countercyclical. Finally, the model with competitive banks and one good delivers results that resemble those in Backus et al. (1992), i.e. negative co-movements for output, investment and employment.

With plausible degrees of countercylicality, we are able to reproduce the positive cross-country correlations for consumption, output and factors of production observed in the data, bringing the quantitative predictions of a two-country RBC model closer to the data and providing a potential solution to the co-movement puzzle identified by Backus et al. (1992). Overall, we contribute to the literature by showing that countercyclical market power in credit markets plays a key role in the international transmission of aggregate shocks.

Now we study the response of macroeconomic aggregates to a one standard deviation shock to TFP in the domestic economy. Fig. 2 shows that foreign TFP is not affected on impact. However, when the productivity shock is transmitted from the domestic economy, foreign

Table 7
Simulation results: cross-country correlations.

	Data	Imperfectly competitive banks		Competitive banks	
		Two goods	One good	Two goods	One good
$\rho(C,C^*)$	0.3311	0.9856	0.99	0.8542	0.3459
$\rho(h,h^*)$	0.2167	0.1709	0.456	0.6818	−0.2151
$\rho(I,I^*)$	0.4151	0.2269	−0.1655	−0.4014	−0.4784
$\rho(Y,Y^*)$	0.4496	0.6161	0.4548	0.4015	−0.2147

Notes: The data statistics on international correlations refer to the correlation of United States quarterly series with series for non-US OECD countries. The sample period is 1960:I–2002:II. All series are logged and Hodrick–Prescott filtered, using 1600 as the smoothing parameter. The model statistics are the averages of 100 simulations of length 100.

[12] The results are all qualitatively robust to changes in parameter values. Sensitivity analyses are available from the author upon request.

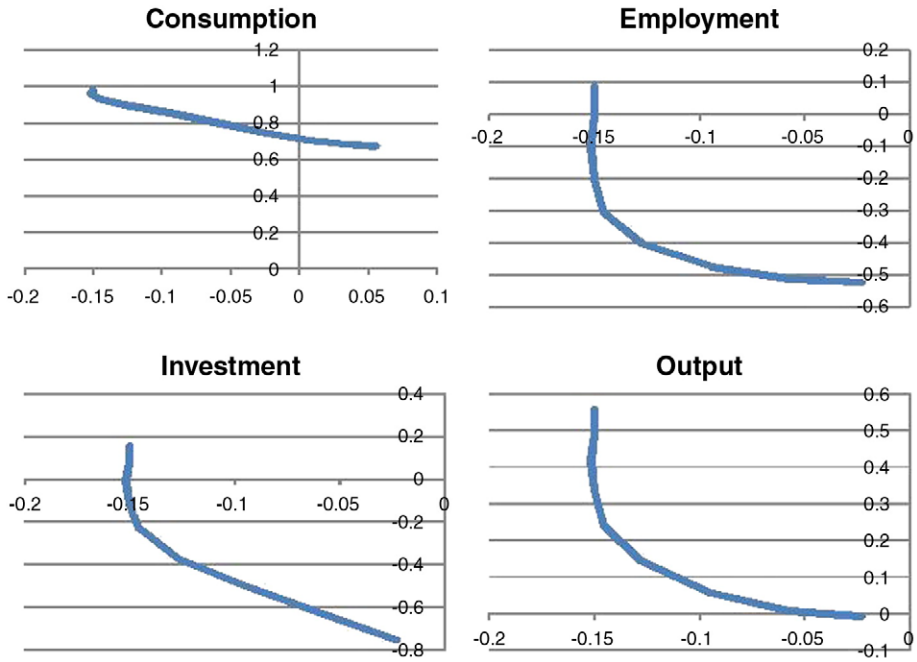

Fig. 1. Varying the cyclicality of margins – cross-country correlations of macro variables. Note: The horizontal axis measures increasing degrees of countercyclicality of margins, as obtained by raising the value assigned to N/θ in the equation for margins. The vertical axis measures the cross-country correlation of each macro variable.

TFP starts increasing and remains above the steady state for several quarters.

There is perfect international risk-sharing in this economy since agents have access to a complete set of state-contingent claims. Thus, both domestic and foreign consumption rise at the period of impact and stay above their steady state levels for nearly 30 quarters. Intuitively, the increase in the foreign country is smaller than in the domestic economy. Also, the increase in foreign consumption is in part a result of the positive wealth effect for the foreign country, and stems from the *demand channel* and the *terms of trade channel*.

The computed responses for output and employment in the period of impact are positive in both countries, though less so in the foreign one. Margins in credit markets fall. Therefore, only a few quarters after the shock investment is above the steady state level in both countries. The capital stock begins to increase in both economies, raising the demand for labor, employment and output. On impact though, foreign capital flows out into the domestic economy, as expected in a world with perfect capital mobility.

7. Concluding remarks

In this paper we study the international transmission of business cycles by extending an otherwise standard DSGE two-country, two-good RBC model through the introduction of a novel type of credit market

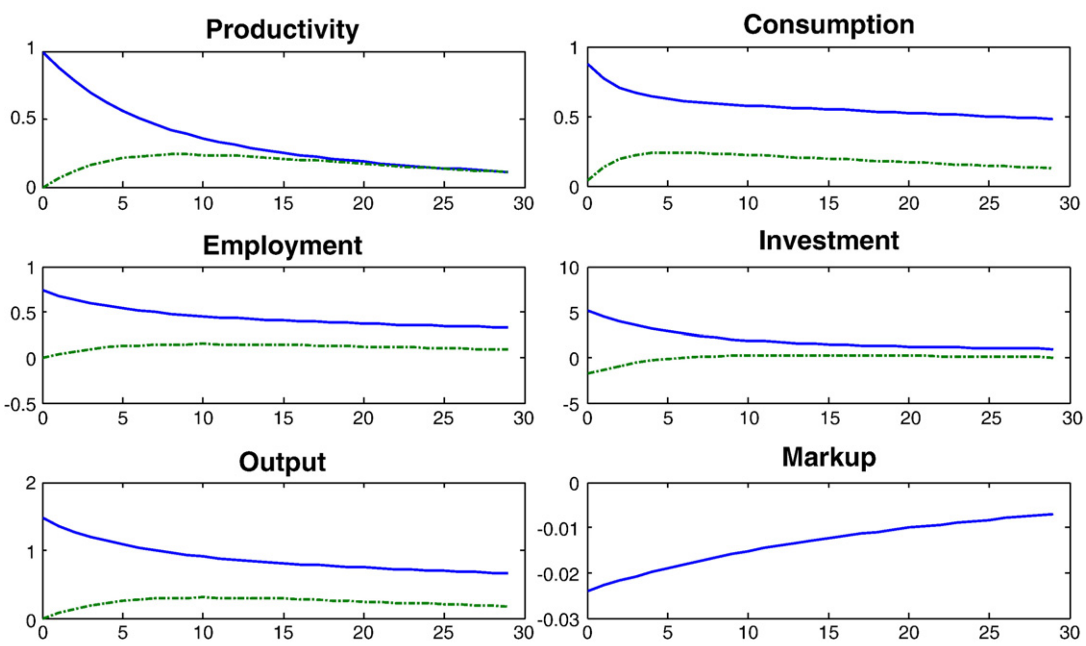

Fig. 2. Impulse response functions – benchmark model. Note: The solid (dashed) line corresponds to domestic (foreign) economy variables.

friction. Specifically, in the model domestic investors finance investment by borrowing from an international, imperfectly competitive financial sector with endogenously countercyclical price-cost margins. The countercyclical nature of these margins is the key transmission mechanism at the core of the model.

This structure enables us to contribute to the debate on the discrepancies between the data and the predictions of standard two-country models, first identified by Backus et al. (1992). We obtain positive co-movement across countries for employment, investment and output, and we show that cross-country correlations are monotonically increasing in the countercyclicality of banks' price-cost margins. Based on our results, the *countercyclical margins channel* in an imperfectly competitive banking sector appears to be an important link because it is capable of explaining the international transmission of business cycles observed in the data. This channel has not been considered in the existing literature.

The paper models a financial accelerator driven by the supply side of the loans market. With margins in the market for credit being countercyclical, credit becomes more expensive in bad times. As a result, firms heavily reliant on credit delay their investment and production decisions, which deepens recessions. This result provides an additional rationale for stabilization policy in economies where margins in credit markets are countercyclical. Exploring these policy implications is an interesting area for further research.

Using our framework to study the implications of prudential banking regulations for the cyclicality of margins and the international transmission of macroeconomic shocks is another avenue for future work.

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