

Global Banks and Crisis Transmission*

Sebnem Kalemli-Ozcan
University of Houston and NBER

Elias Papaioannou
Dartmouth College and CEPR

Fabrizio Perri
University of Minnesota, Minneapolis FED, NBER and CEPR

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Abstract

We study how the 2007–2009 crisis has changed the impact of financial integration on the transmission of international business cycles, focusing on a sample of 20 developed countries between 1978 and 2009. We find that while increases in financial linkages were associated with more divergent output cycles before 2007, during the recent crisis more integrated countries co-move more. We document that countries with stronger financial ties to the U.S. both directly and indirectly via financial centers experienced more synchronized cycles with the U.S. We then develop a simple general equilibrium model of international banking allowing for both productivity and credit shocks to interpret these empirical findings. Our model delivers the following predictions. When productivity shocks are the dominant source of fluctuations, a higher level of banking integration results in less synchronized business cycles; if financial shocks become the dominant source of fluctuations, then a higher level of banking integration results in more synchronized business cycles.

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1 Introduction

The recent global crisis started with a financial shock in the United States. In August 2007, the massive problems in the asset/mortgage backed securities market spread to the repo market. This led to a dry-up of liquidity in the interbank market first and then to a complete freeze of the commercial paper, corporate bond, and government bond markets after the collapse of Lehman Brothers in September 2008.¹ The crisis spread rapidly across the Atlantic, first to the United Kingdom, the euro area, Eastern Europe, and then to the rest of the world. The negative shock to the capital base and liquidity of the banking system was followed by a contraction of loan supply to firms and households and a massive deterioration of economic activity.² In the subsequent years, the world has experienced the most severe global recession since the Great Depression.

To this date, the conventional wisdom is that the U.S.-originated negative credit supply shock spread to the rest of the world via international financial (banking) linkages. In line with this conjecture, many theoretical models have been developed showing how international financial integration can amplify and transmit shocks to the financial system across countries.³ Yet, the empirical evidence on this issue is sobering. There seems to be no robust evidence that the crisis spread via financial linkages from the U.S. to the rest of the world.⁴ This appears quite puzzling given the overwhelming synchronization of the economic activity (at least among developed countries) during the recent crisis that dwarfs anything in comparison since 1975. Figure 1 shows these patterns plotting bilateral output correlations among 20 developed countries over the 1978:q1-2009:q4.⁵ The

¹See Diamond and Rajan (2009), Brunnermeier (2009), Krishnamurty (2010), and Gorton (2008), among others.

²See for example Kacperczyk and Schnabl (2010).

³See Perri and Quadrini (2010), Mendoza and Quadrini (2010), Devereux and Yetman (2009), Dedola and Lombardo (2010), Enders, Kolmann, and Muller (2010) for theoretical models with a focus on the recent crisis, where financial linkages and frictions play a key role in the transmission of shocks in the financial system. See Calvo and Mendoza (2000) for the previous emerging market crises periods. See Backus, Kehoe, and Kydland (1992), Kehoe and Perri (2002), Heatcote and Perri (2002), Heatcote and Perri (2004), Iacoviello and Minetti (2006) on the effect of financial integration on business cycle movements in general. These models imply a negative correlation between financial integration and business cycle co-movement. Obstfeld (1994) formalizes another mechanism that goes through industrial specialization that also yields a negative effect of financial integration and business cycle synchronization. Evidence for this mechanism is provided by Imbs (2004) and Kalemli-Ozcan, Sørensen, and Yosha (2001, 2003).

⁴Rose and Spiegel (2010a,b) find no role for international financial linkages in transmitting the crisis both for developed countries and for emerging markets. In contrast, Cetorelli and Goldberg (2009) find that lending supply in emerging markets was affected through a contraction in cross-border lending by foreign banks; a contraction in local lending by foreign banks' affiliates; and a contraction in lending by domestic banks due to a funding shock to their balance-sheet. Employing global VARs, Helbling, Huidrom, Kose and Otrok (2010) find that the U.S. credit market shocks have a significant impact on the evolution of global growth during the latest episode. Chudik and Fratzscher (2010), again using a global VAR approach, find that while the tightening of financial conditions was a key transmission channel for advanced economies, for emerging markets it was mainly the real side of the economy that suffered due to the collapse of worldwide economic activity.

⁵See Perri and Quadrini (2010), Blanchard and Milesi-Ferretti (2010), and Imbs (2010), who have also documented an increased bilateral synchronization of the economic activity in the aftermath of the crisis.

lack of systemic evidence linking financial globalization with output decline during the past years has led many to argue that the group of developed economies experienced one common (global) shock, either in financial intermediation or in the productivity of the “real” economy (e.g. Chari, Christiano and Kehoe (2008); Mulligan (2009)).

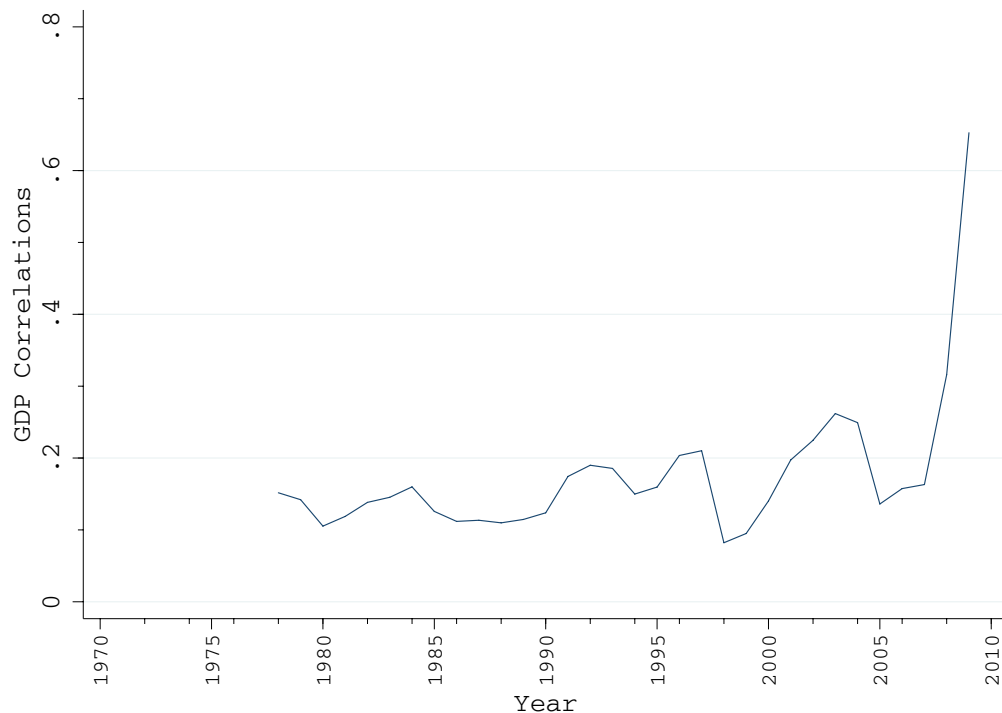


Figure 1: GDP Synchronization

In this paper, we use the recent financial crisis to investigate whether an idiosyncratic U.S. based shock is diffusing internationally via international financial linkages or whether a common global shock is driving the synchronicity of output. The central challenge for identification in the transmission literature is the issue that common movements in output at a point in time may well be manifestations of common shocks that hit different countries differently, rather than idiosyncratic (country-specific) shocks that spill-over contagiously (say via trade or financial linkages). Since common shocks and contagion may be observationally similar, it is hard to separate out one from another in an empirical setting (see Reinhart and Rogoff (2009)).⁶ For example, focusing on the asset backed commercial paper market, Acharya and Schnabl (2010) show that all big international

⁶For the past crisis, Forbes and Rigobon (2001) define contagion as an exceptional increase in the magnitude of international linkages, such as the 50 percent fall in the Brazilian stock market subsequent to the collapse of the Russian ruble in 1998.

banks had positions with similar risk profiles before the crisis, making the roll-over of their debt quite hard when they started experiencing losses. This finding is more in line with a common credit shock hitting financial intermediaries in all developed countries at (roughly) the same period, casting doubt on the belief that the crisis hit just a couple of U.S. banks and then got transmitted via financial linkages. The classic transmission (contagion) story via banks is one where an initial deterioration in the balance sheet of banks in certain countries (namely the U.S. and a couple of other financial centers) leads international banks to ration credit in other countries (e.g. Allen and Gale (2000); Morgan, Strahan, and Rime (2004)).⁷

Identification of the impact of financial integration on business cycle synchronization before and after the recent crisis is challenging as it requires not only distinguishing between different types of country-specific shocks (on the productivity of firms or the efficiency of financial intermediation), but also controlling for common shocks. This is fundamental for identifying any contagion effects. To achieve this goal, we use a unique bilateral (country-pair) data-set from the Bank of International Settlements' (BIS) on the financial linkages between banks in advanced economies over the past three decades. The rich panel structure allows us to control for time-invariant country-pair fixed factors and quite importantly for common shocks. We start our empirical analysis, estimating difference-in-difference specifications that assess whether conditional on global shocks, (within country-pair) increases in banking linkages are associated with a lower or a higher degree of business cycle synchronization and whether this association changes before and after the current crisis. We then compare the coevolution of business cycle synchronization and financial integration during the 2007/2009 period, with other major financial crisis in developed countries in the past three decades (using the banking crisis classification of Reinhart and Rogoff (2009) and Laeven and Valencia (2010)), as this sheds light on the underlying nature of the shocks.

We examine whether country-pairs that have a higher exposure to the U.S. financial system behave differently than the ones with lower exposure to the U.S. before and especially during the 2007/2009 crisis. In contrast to most previous works, we examine the effect of both direct and indirect via financial centers exposure to the U.S. financial system. As argued in detail by Milesi-Ferretti *et al.* (2010), since most available data on bilateral external positions (and our data) are based on the concept of residence—the guiding principle of balance of payments statistics—they

⁷The evidence whether countries with more financial linkages experienced more severe recessions is not there. Rose and Spiegel (2010a,b) and Lane and Milesi-Ferretti (2010) considered several variables that capture the intensity of international financial linkages. They do not find any evidence that countries that are more financially integrated to the world or to the U.S. suffered more severe recessions. As far as we know the only empirical paper that focused on banking linkages and their effect on the transmission of the 2007–2009 crisis is the work by Cetorelli and Goldberg (2009), where they only focused on transmission from the U.S. to the emerging markets.

will overstate exposure to and from small financial centers that play an important role in the international financial system (and understate exposure to the U.S. and the U.K.).⁸ To deal with indirect exposure to the U.S. via financial centers, we construct a lower and upper bound for the exposure to the U.S. As a lower bound we use direct banking linkages between each country-pair and the U.S. As an upper bound we add exposure to the direct exposure linkages to the Cayman Islands.⁹

Our main empirical findings can be summarized as follows. First, we verify the evidence provided in Kalemli-Ozcan, Papaioannou, and Peydro (2009) that the within country-pair effect of financial integration on the synchronization of economic activity is negative in the pre-crisis time. This result is in accord with the macro/business cycle models and also banking models outlined before that suggest financial integration will magnify total-factor-productivity shocks across inter-connected economies. Second, we present novel evidence that the partial effect of financial integration on output synchronicity turns positive during the recent crisis. Interestingly, we obtain similar results when we examine the previous financial crisis episodes in other developed countries such as Finland and Sweden in the early 1990s and Japan in the mid/late 1990s. These results are consistent with the models that introduce financial frictions, financial shocks and contagion to the standard setup in order to obtain a positive correlation between financial integration and output co-movement. Third, we find that the positive correlation between output synchronization and exposure to the U.S. financial system—that supports the contagion via financial linkages explanation of the recent crisis—emerges only when on top of direct links to the U.S. we also consider indirect links via the Cayman Islands and other financial centers.

After establishing the main patterns in the data, we develop a dynamic stochastic general equilibrium model of international banking that helps understand our findings. We consider a two-country, two sectors, one-good world. In each sector consumers supply labor and save; firms hire labor and make investment decisions; and banks intermediate funds between firms and consumers. Sector 1 is financially separated from the rest of the economy and banks intermediate only between consumers and firms within the sector. Sector 2 is financially integrated in the sense that consumers

⁸Data on ultimate exposures can in principle be constructed only for bank assets (creditor side) for a limited set of countries by comparing our locational statistics to the consolidated statistics that are also reported by BIS and nets out lending by affiliates. See Milesi-Ferretti *et al.* (2010) and Kubelec and Sa (2010) for such an exercise. There are still remaining issues though such as position vis-a-vis non-banks and the issue of non-affiliate banks. See McGuire and von Peter (2009).

⁹As argued by Lane and Milesi-Ferretti (2010), a considerable portion of international financial flows to and from the U.S. are channeled via the Cayman Islands, and hence our upper bound for the U.S. exposure will add the linkages between the country-pair and the Cayman Islands to the U.S. linkages. We obtain similar results when we also consider other small off-shore financial centers, such as Bermuda, Panama, and the Channel Islands.

in sector 2 in both countries have financial transactions, through banks, with firms in both countries. This two-sector structure allows easily to consider couple of countries with different degree of banking integration simply by varying the size of sector 2. The model predicts that when the shocks are primarily in the productivity side then a higher degree of banking integration results in a lower degree of business cycle synchronization. As in the canonical set-up of Backus, Kehoe, and Kydland (1992) a higher degree of financial integration enables capital to flow from the less to the more productive country; this in turn magnifies output divergence between countries when they are hit by different real shocks (because investment follows different patterns in the two countries).

The new shocks we introduce in the model are exogenous shocks to bank capital (via shocks to returns on risky assets). When banks suffer a shortfall in their revenues they are forced to make up for the lost revenues charging a higher interest rates to firms; this, through a working capital (liquidity) channel has an impact on economic activity. We explain in detail how, with these shocks, a higher degree of banking integration results in higher output synchronization. This is because under banking integration disturbances in the banking sector of a country affect the interest rates charged by global banks in all the countries they operate and hence more integration facilitates the transmission of disturbances. We calibrate the model and use data simulated from our model to run a similar regression as the one we run in the data, relating co-movement to integration in periods dominated by productivity shocks and in periods with prominent banking shocks. Interestingly we find that the relation estimated on artificial data in times with dominant productivity shocks is negative and roughly of the same magnitude as the one estimated on the data in the period 1978-2006; also we find that the coefficient on integration interacted with periods with large credit shocks is positive and again of similar magnitude as the one estimated on the periods of financial crisis in the data. These findings suggest that indeed financial crises can be triggered by banking shocks in one country and then are transmitted abroad. The model also suggests that policies that deal directly with shocks to the banking sector, like the 2008 bailout of the financial sector, might indeed have a substantial stabilization effect.

The remainder of the paper is structured as follows. Section 2 discusses the data on international banking linkages and presents the empirical methodology. Section 3 reports the empirical results. Section 4 lays out the theoretical framework and present the quantitative results. Section 5 concludes.

2 Methodology and Data

2.1 Specification

In our empirical analysis we estimate variants of the following regression equation:

$$Synch_{i,j,t} = \alpha_{i,j} + \lambda_t + \beta Linkages_{i,j,t-1} + \gamma Post_t \times Linkages_{i,j,t-1} + X'_{i,j,t} \Phi + \epsilon_{i,j,t}. \quad (1)$$

$Synch_{i,j,t}$ is a time-varying bilateral index reflecting the synchronization of output between countries i and j in period (quarter) t (data come from OECD's statistical database). $Linkages_{i,j,t-1}$ measures banking activities between country i and j in the previous period/quarter. $Post_t$ is an indicator variable for the crisis period that switches to one in all quarters after 2007:q3 (when the financial crisis in the U.S. mortgage market started unfolding).¹⁰ In all specifications we include country-pair fixed-effects ($\alpha_{i,j}$), as this allows to account for time-invariant bilateral factors that affect both financial integration and business cycle synchronization (such as trust, social capital, geography, etc.).¹¹ We also include time fixed effects (λ_t), to account for common to all countries shocks. We replace the time fixed-effects with country-specific time trends ($trend_i$ and $trend_j$), to shed light on the importance of common shocks versus country-specific shocks. We also estimate specifications including both time fixed-effects and country-specific time trends to better capture common shocks and hard-to-observe country-specific output dynamics. Conditioning on time fixed effects and trends is the key to detect whether this was all a common disturbance or whether financial linkages led to the contagious spread of the crisis. We control for other factors, such as the level of income, bilateral trade, etc.

We augment the specification with measures reflecting the banking exposure of each country-pair to the U.S. financial system both before and during the recent financial crisis. This allows us to examine whether synchronization with the U.S for a given country has increased if that country has stronger financial linkages to the U.S.; moreover we can also test whether synchronization has increased during the recent crisis between pair of countries that were strongly exposed to the U.S.

As argued in the introduction, the canonical IRBC suggests that the β coefficient on financial integration should be negative and significant in regular times (when $Post_t = 0$). This is because

¹⁰We also estimated models where the $Post_t$ indicator switches to one after the collapse of Lehman Brothers in the third quarter of 2008. The results are similar.

¹¹Kalemli-Ozcan, Papaioannou, and Peydro (2010) show that accounting for country-pair fixed-factors is fundamental. Working in a sample of advanced economies during tranquil times (i.e. non crisis years), they show that the typical cross-sectional positive correlation between financial integration and output synchronization changes sign when one simply accounts for the country-pair fixed factors.

during tranquil times, financial integration magnifies the impact of TFP shocks, making the business cycles of financially integrated countries to diverge. In contrast under a credit shock, the γ coefficient might be positive as outlined by the recent models.

2.2 Synchronization

In our benchmark estimates we measure business cycle synchronization (*Synch*) with the negative of divergence in growth rates, defined as the absolute value of GDP growth differences between country i and j in quarter t .

$$Synch_{i,j,t} \equiv -|(\ln Y_{i,t} - \ln Y_{i,t-1}) - (\ln Y_{j,t} - \ln Y_{j,t-1})|. \quad (2)$$

This index, which follows Giannone, Lenza, and Reichlin (2010), is simple and easy-to-grasp. In addition, it is not sensitive to various filtering methods that have been criticized on various grounds (see Canova (1998, 1999)). In contrast to correlation measures that cross-country studies mainly work with, the index does not (directly at least) reflect the volatility of output growth and, therefore, allows us to identify the impact of banking integration on the covariation of output growth. Another benefit of this index is that, as we do not have many post crisis observations the rolling average correlation measures are not very well estimated. Yet we also report some simple before-after specifications with the pairwise correlation of GDP growth rates as the dependent variable.¹²

2.3 International Banking Linkages

To construct the financial linkages measures we utilize proprietary data from Bank of International Settlements' (BIS) Locational Banking Statistics Database. The database reports investments from banks located in up to 40 countries (the "reporting area") into more than 200 countries (the "vis a vis area") at a quarterly basis from the late 1970s till present. Yet data for around 20 "reporting

¹²For robustness and for comparability with the work of Morgan, Rime, and Strahan (2004) on the impact of banking integration on the evolution of business cycles across states in the US, we also experimented with an alternative (though similar) synchronization measure finding similar results. To construct the Morgan, Strahan and Rime (2004) synchronization index we first regress GDP growth separately for country i and j on country fixed-effects and period fixed-effects and take the residuals that reflect how much GDP (and its components) differs in each country and year compared to average growth in this year (across countries) and the average growth of this country over the estimation period. The absolute value of these residuals reflects fluctuations with respect to the cross-country and the across-year mean growth. Second we construct the business cycle synchronization proxy as the negative of the divergence of these residuals taking the absolute difference of residual growth.

area” countries are available only in the past decade or so. We thus limit our attention to a homogenous group of 18/20 advanced economies that we have (almost) complete coverage since 1978. These countries are: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Portugal, Sweden, and the United States.¹³ Thus we have a rich bilateral panel dataset on banks’ positions spanning from 1978:q1 till 2009:q4.¹⁴

The data is originally collected from domestic monetary authorities and supervisory agencies and includes all of banks’ on-balance sheet exposure as well as some off-balance sheet items. The database follows the locational principle and, therefore, also includes lending to subsidiaries and affiliates. Thus the Locational Banking Statistics reflect more accurately the international exposure of countries (and banks) than the consolidated statistics database of the BIS that nets out lending and investment to affiliate institutions. The statistics capture mainly international bank to bank debt instruments, such as inter-banks loans and deposits, credit lines, and trade-related lines of credit. The data also covers bank’s investment in equity-like instruments as well as foreign corporate and government bonds.¹⁵

Our dataset offers important advantages compared to other international investment databases that are essential for understanding the impact of financial globalization on the transmission of the recent crisis. First, the BIS statistics have by far the most extensive coverage both in terms of the cross-section (country-pair) and especially over time (as a comparison to the IMF CPIS database that reports bilateral cross-border financial flows and stocks after 1999). Second, the data reports bilateral financial linkages between each country in the world and the U.S., where the crisis originated. This allows us to investigate the direct impact of the credit shock in the U.S. on the rest of the world. Third, the data includes information on banking activities between almost all countries in the world and some key financial off-shore centers. As a sizable bulk of the U.S. financial transactions are channeled via the Cayman Islands (as well as some others off-shore

¹³In most empirical specifications we exclude Luxembourg and Switzerland, because these countries have exceptionally large financial systems and international financial linkages. The results are almost identical if we were to include these two financial hubs in our analysis.

¹⁴The data has been used in recent work by Kalemli-Ozcan, Papaioannou, and Peydro (2009, 2010) to assess the effect of financial globalization on the synchronization of business cycles in rich OECD countries and the effect of the single European currency and the associated legislative policies on financial integration, respectively. Other notable works that have uses the BIS Locational and Consolidated Statistics to assess the effect of cross-border banking linkages on contagion include Van Rijckeghem and Weder (2003) and Degryse, Elahi, and Penas (2010)

¹⁵Assets include mainly deposits and balances placed with non-resident banks, including bank’s own related offices abroad. They also include holdings of securities and participation (i.e. permanent holdings of financial interest in other undertakings) in non-resident entities. Data also include trade-related credit, arrears of interest and principal that have not been written down and holdings of banks own issues of international securities. They also cover portfolio and direct investment flows of financial interest in enterprises.

financial centers), this allows us to better measure the exposure of countries to the U.S. Fourth, banking activities is the largest component of cross-border investment. The country-level aggregate statistics of Lane and Milesi-Ferretti (2008) indicate that the stock of cross-border banking is more than 50% of the overall amount of international holdings (that includes also FDI and portfolio investment). For the 1980s and 1990s banking activities were more than two-thirds. Fifth, most argue that the recent financial crisis spread internationally through banking linkages (rather than other forms of financial integration).

We measure cross-border banking activities/linkages ($Linkages_{i,j,t-s}$) with two measures. We use the sum of bilateral assets and liabilities of countries i and j standardized with the sum of the two countries GDP in each quarter.

$$\left[Linkages_1 = \frac{Assets_{i,j,t} + Liabilities_{i,j,t} + Assets_{j,i,t} + Liabilities_{j,t,t}}{(GDP_{i,t} + GDP_{j,t})} \right]$$

We also use the share of bilateral assets and liabilities between countries i and j to the sum of the total external assets and liabilities of each country in each quarter.

$$\left[Linkages_2 = \frac{Assets_{i,j,t} + Liabilities_{i,j,t} + Assets_{j,i,t} + Liabilities_{j,t,t}}{Tot_Assets_{i,t} + Tot_Liabilities_{i,t} + Tot_Assets_{j,t} + Tot_Liabilities_{j,t}} \right]$$

Likewise we measure banking exposure to the U.S. financial system with the sum of bilateral assets and liabilities of each country-pair vis a vis the U.S. standardized with the sum of the two countries' GDP in each quarter and standardized with the sum of total external assets and liabilities of the two countries in each quarter. Since we have complete data coverage for the international banking activities with the Cayman Islands and other small financial centers, we also construct two broader indicators of linkages to the U.S. where we also add to the exposure of each country-pair to the U.S. the exposure to the Cayman Islands (and other centers for robustness). Table 1 gives descriptive statistics for the variables employed in the empirical analysis.

3 Results

3.1 Preliminary Evidence (2002–2009)

Before we present our benchmark estimates, we report results in Table 2 from a simpler variant of the above regression equation, focusing on the period 2002 : q1 – 2009 : q4. We split the sample into two 4-year periods and for each time-span we estimate the correlation of real p.c. GDP growth

Table 1: Descriptive Statistics

	N	mean	sd	min	max	p1	p5	p25	p50	p75	p95	p99
Pairwise corr. of GDP	25061	.1757	.2963	-.8462	.9698	-.5085	-.3066	-.0278	.1708	.3815	.6664	.8578
Synch. of GDP	27911	-4.303	4.587	-45.66	-.0007	-22.37	-12.90	-5.638	-2.93	-1.320	-.2571	-.0511
Synch. of Investment	27911	-13.0	13.10	-145.1	0	-61.24	-36.97	-17.29	-9.436	-4.407	-.818	-.151
Synch. of P. Cons.	27911	-3.914	3.969	-54.28	0	-19.21	-11.23	-5.249	-2.802	-1.302	-.2494	-.0526
Synch. of Gov. Cons.	27911	-4.287	4.409	-56.63	0	-21.11	-12.20	-5.754	-3.083	-1.409	-.2723	-.0572
Banking Links/GDP	18192	.0187	.0418	0	.6444	.0000	.000	.0011	.0046	.0170	.0809	.2316
US Banking Links/GDP	15322	.1324	.1615	.0061	1.486	.0095	.0171	.0419	.0850	.145	.4591	.8783
Banking links/total	18183	.0260	.0348	0	.2478	.0002	.000	.0042	.0118	.035	.0980	.1702
US Broad Links/GDP	13156	.1846	.2054	.0099	1.853	.0195	.0309	.0707	.1203	.2078	.6110	1.099

between each country-pair using quarterly data over 16 quarters. We then regress the correlation in output growth on banking linkages in the beginning of each period (in 2006 and in 2002). In columns (2), (3), (5), and (6) we allow the coefficient on banking integration to differ in the (beginning of the) two periods. As we include country-pair fixed-effects and a period constant (for the crisis period), this model can be thought as a difference-in-difference specification that besides reflecting how much the average correlation changed, also explores whether the effect of the main explanatory variable, banking integration, has changed over the two periods, as a result of the crisis.

The table reveals some noteworthy patterns. First, the coefficient on the second period time effect (the crisis dummy) that captures the financial crisis is positive and highly significant across all model permutations. This reflects the fact that during the past three years output growth correlations have increased tremendously (see Figure 1). The estimate suggests that output growth correlations increased by around 0.4 – 0.5 during the recent crisis period (as compared to the four year period before). Second, the coefficient on banking integration in columns (1) and (4) is negative and highly significant. This suggests that within country-pairs and conditional on common to all countries shocks in the two time spans (captured by second period constant), within country-pair increases in banking (financial) integration are followed by less synchronized output cycles. This result is line with the panel evidence in Kalemli-Ozcan, Papaioannou, and Peydro (2010), who however do not study the recent financial crisis period.¹⁶ Third, when we allow the coefficient on

¹⁶Kalemli-Ozcan, Papaioannou, and Peydro (2010) also employ a bilateral time-varying IV approach to account for reverse causation and other sources of endogeneity (for example Buch, Carstensen, and Schelter (2010) show that banks' international portfolio reacts to macroeconomic shocks, while Heathcote and Perri (2004) show theoretically how divergent output cycles may increase the equilibrium level of financial integration). These authors link in the first-stage financial sector regulatory/legislative harmonization policies in the context of the EU Financial Services Action Plan with increases in bilateral financial integration and in the second stage with output synchronization.

Table 2: Bilateral Financial Linkages and Output Correlations

	Dependent Variable: Pairwise GDP Growth Correlations					
	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All	All	No LUX, CHE	All	All	No LUX, CHE
Crisis Indicator	0.4390*** (0.0627) 7.00	0.5344*** (0.0852) 6.27	0.6316*** (0.0930) 6.79	0.3822*** (0.0608) 6.29	0.4974*** (0.0820) 6.06	0.5560*** (0.0869) 6.40
Linkages/GDP	-0.1107*** (0.0379) -2.92	-0.0914** (0.0384) -2.38	-0.1202*** (0.0440) -2.73			
Linkages/GDP $\times$ Crisis		0.0263** (0.0121) 2.18	0.0340*** (0.0129) 2.63			
Linkages/Total Linkages				-0.1027** (0.0400) -2.57	-0.1139*** (0.0405) -2.81	-0.1239*** (0.0435) -2.85
Linkages/Total Linkages $\times$ Crisis					0.0278** (0.0137) 2.03	0.0314** (0.0147) 2.13
Country-pair fixed	yes	yes	yes	yes	yes	yes
R-squared (within)	0.813	0.801	0.806	0.798	0.803	0.804
Observations	340	340	287	340	340	287

Notes: The table reports panel (country-pair) fixed-effect coefficients estimated in two non-overlapping 4-year periods, in the period 2002q1–2005q4 and the period 2006:q1–2009q4, using 20 $\times$ 19 country-pairs. The dependent variable is the pair-wise correlation of real GDP per capita between country i and country j in each of the two periods. The Crisis indicator equals one for the second period (and zero in the first-period). In columns (1)–(3) financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in quarter t relatively to the sum of the two countries' GDP in the beginning of each period (Linkages/GDP). In columns (4)–(6) financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in quarter t relatively to the sum of the two countries' external assets and liabilities in the entire world in the beginning of each period (Linkages/Total Linkages). Columns (3) and (6) omits LUX and CHE. All specifications also include the log of the product of the two countries' GDP in the beginning of each period and the log of the product of the two countries population.

banking integration to differ in the two 4-year periods that are characterized by different types of shocks, we find that the partial effect of financial integration changes sign. The highly positive and significant coefficient of banking linkages in the beginning of the second period implies that countries that were strongly integrated via the international banking system before the recent crisis (in the beginning of 2006) experienced more synchronized contractions during the past four years.

Since the banking integration measure is expressed in logs and the dependent variable is the correlation of output growth, the estimates in Table 2 are semi-elasticities. The coefficient on banking integration of about -0.1 in tranquil times implies that a typical rise in bilateral integration from the 50th percentile to the 75th percentile of the distribution, which is similar to the increase in integration between Italy and Portugal during our sample (a tripling), is followed by

an average decrease in GDP growth correlations of 0.3 (one standard deviation; see Table 1). Yet during the crisis for the same pair of countries the marginal effect of banking integration on output synchronization turns positive. The implied economic effect of the estimates are also sizeable from the perspective of changes. The average increase in GDP correlation from the first period to the second period is 0.5. The estimates thus imply that approximately 20% of the actual change in output convergence during the crisis is driven by the degree of financial linkages before the crisis.

3.2 Financial Integration and Output Synchronization before and after the 2007 Crisis

Table 3 reports our benchmark estimates on the effect of financial integration on output synchronization in the period 1978 – 2009. The estimates in column (1) are in line with the simple difference-in-difference estimates reported in Table 2 (with the correlation measure as the dependent variable that focused on the period 2002 – 2009). In tranquil (non financial crisis) times, there is a strong negative within country-pair association between banking integration and output synchronization. In line with the standard IRBC an increased degree of financial integration is followed by more divergent output growth cycles. Yet the coefficient on banking integration changes sign when we focus on the recent crisis period. The estimate on the interaction term between bilateral banking activities and the recent crisis period implies that during the past two-three years an increased degree of banking integration was followed by more synchronized cycles. This result offers support to the idea that the major source of fluctuations during this period was the negative shock to the U.S. (and more generally to the international) banking/financial system.

In column (2) we include time (quarter) fixed-effects to account for common global shocks, while in column (3) we include time fixed-effects and country-specific trends. In both specifications, the coefficient on banking integration continues to enter with a negative and significant estimate; however, the coefficient changes sign and turns positive (and significant) in the recent crisis period. The total effect of financial integration ($\beta + \gamma$) is negative and significant, with the exception of column (1) when we do not include time fixed effects. This indicates the need to include time fixed effects so as to separate the effect of financial contagion from the impact of common shocks. In column (4) we control for bilateral trade in goods. The coefficient on goods trade is small and statistically indistinguishable from zero. Most importantly conditioning on goods trade does not affect the coefficient on banking integration both during tranquil periods and during the recent

Table 3: Bilateral Financial Linkages and GDP Synchronization

Dependent Variable: GDP Growth Synchronization								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Linkages/GDP	-0.2479*** (0.0638) -3.88	-0.3022*** (0.0675) -4.48	-0.2200*** (0.0645) -3.41	-0.2212*** (0.0685) -3.23				
Linkages/GDP $\times$ Crisis	0.2645*** (0.0326) 8.12	0.1931*** (0.0425) 4.54	0.1233** (0.0496) 2.49	0.1241** (0.0495) 2.51				
Crisis Indicator	-0.1148 (0.1666) -0.69				-0.1972 (0.1656) -1.19			
Linkages/Total Linkages					-0.1615** (0.0689) -2.34	-0.3549*** (0.0760) -4.67	-0.1408** (0.0666) -2.11	-0.1376* (0.0700) -1.97
Linkages/Total Linkages $\times$ Crisis					0.2739*** (0.0366) 7.48	0.1370*** (0.0514) 2.67	0.0878 (0.0590) 1.49	0.0890 (0.0588) 1.51
Trade				-0.0394 (0.0598) -0.66				-0.0538 (0.0589) -0.91
Country-pair fixed	yes	yes	yes	yes	yes	yes	yes	yes
Time fixed	no	yes	yes	yes	no	yes	yes	yes
Country trends	yes	no	yes	yes	yes	no	yes	yes
R-squared (within)	0.095	0.166	0.187	0.186	0.093	0.166	0.187	0.185
Observations	14328	14328	14328	13567	14328	14328	14328	13567

Notes: The table reports panel (country-pair) fixed-effect coefficients estimated over the period 1978:q1–2009:q4, using 18×17 country-pairs omitting LUX and CHE. The dependent variable (GDP Synchronization) is minus one times the absolute value of the difference in the growth rate of GDP between countries i and j in quarter t . In columns (1)–(4) financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in the previous quarter relatively to the sum of the two countries' GDP in the previous period (Linkages/GDP). In columns (5)–(8) financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in the previous quarter relatively to the sum of the two countries' external assets and liabilities in the entire world in the previous period (Linkages/Total Linkages). The Crisis indicator variable equals one in all quarters after 2007:q3 (and zero before that). All specifications also include the log of the product of the two countries' GDP in the beginning of each period and the log of the product of the two countries population. The specifications in columns (4) and (8) also include the sum of the logs of real bilateral exports and imports between countries i and j in the previous quarter (Trade). The specifications in columns (1) and (5) include country-specific linear time-trends. The specifications in columns (2) and (6) include time fixed-effects. The specifications in columns (3), (4), (7), and (8) include time fixed-effects and country-specific linear time-trends. Standard errors adjusted for panel (country-pair) specific auto-correlation and heteroskedasticity and corresponding t -statistics are reported below the coefficients.

financial crisis.¹⁷

¹⁷A priori it looks important to account for differences in bilateral trade, as previous works show that trade in goods and financial services tend to move in tandem (e.g. Rose and Spiegel (2004); Aviat and Coeurdacier (2007)) and that trade has a significantly positive effect on business cycle synchronization. Yet in the high-frequency quarterly dimension there is no significant within country correlation between goods trade and business cycle synchronization.

These estimates imply an economically significant effect. Again, since the banking integration measure is expressed in logs and the dependent variable is in percentage points, the estimates in columns (1)-(3) are semi-elasticities. The coefficient in column (3) implies that for a typical rise in bilateral integration from the 50th percentile to the 75th percentile of the distribution, which is similar to the increase in integration between Italy and Portugal during our sample (a tripling), is followed by an average decrease in GDP synchronization of 0.6 percentage points of these two countries in tranquil times. Yet during the crisis for the same pair the effect of banking integration on output synchronization turns positive; a 0.3 percentage point increase in synchronization. Given the median degree of synchronization (2.7%) these are significant effects. The effects are also sizeable from the perspective of changes. The actual average increase in synchronization is 1% during the crisis period of 2007 – 2009. Thus, our estimates can explain up to 30% of the actual changes in output convergence during the crisis.¹⁸

In columns (4)-(6) we report estimates that are otherwise similar to the ones in columns (1)-(4) using the alternative banking integration index, the log of the share of bilateral banking assets and liabilities to the total amount of external banking assets and liabilities of each pair). The results are similar to the ones in columns (1)-(4). In tranquil times a higher degree of banking linkages is followed by less synchronized, more divergent, output cycles. Yet the effect of banking integration on output synchronization during the recent financial crisis turns positive.

3.3 U.S. Exposure and Crisis Transmission

The recent financial crisis started with the problems in the U.S. sub-prime market and spread to the rest of world when the major U.S. investment banks, Bear Stearns and Lehman Brothers, experienced massive losses in 2008. Many commentators and policy makers have recently argued that financial linkages enabled the quick transmission of the crisis from a corner of the U.S. capital markets to the rest of the world. As we have argued in the introduction, several recent papers fail to find evidence for the importance of the financial ties to the U.S. for the severity of the crisis.

In Table 4 we examine whether output synchronization during the past two years has been stronger among country-pairs that had stronger linkages to the U.S. banking system relative to the pairs that have weaker connections. Controlling for direct exposure to the U.S. has no major effect

¹⁸As can be seen from the descriptive statistics in Table 1 there are some outliers in the dependent variable (GDP growth divergence exceeding 15%). We thus re-estimated all models windsorizing the dependent variable at the 1% and 5%. We also estimated all specifications with median (least absolute deviation) regression. The estimates are similar to the ones reported in the main tables and available upon request.

Table 4: Bilateral Financial Linkages, U.S. Financial Linkages, and GDP Synchronization

Dependent Variable: GDP Growth Synchronization						
	(1)	(2)	(3)	(4)	(5)	(6)
Linkages/GDP	-0.3096*** (0.0667) -4.64	-0.2460*** (0.0655) -3.76	-0.2460*** (0.0655) -3.76	-0.3012*** (0.0698) -4.31	-0.2422*** (0.0664) -3.65	-0.2066*** (0.0697) -2.96
Linkages/GDP $\times$ Crisis	0.2321*** (0.0525) 4.42	0.1284** (0.0555) 2.31	0.1284** (0.0555) 2.31	0.1663*** (0.0503) 3.30	0.1737*** (0.0484) 3.59	0.1176** (0.0553) 2.13
US Linkages/GDP	0.2298 (0.1556) 1.48	0.0204 (0.1563) 0.13	0.0204 (0.1563) 0.13			
US Linkages/GDP $\times$ Crisis	0.2251* (0.1322) 1.70	0.1263 (0.1344) 0.94	0.1263 (0.1344) 0.94			
Crisis Indicator	0.0044 (0.1911) 0.02			0.5409*** (0.1840) 2.94		
US Broad Linkages/GDP				-0.7337*** (0.1518) -4.83	-0.0191 (0.1560) -0.12	-0.4836*** (0.1705) -2.84
US Broad Linkages/GDP $\times$ Crisis				0.5613*** (0.1483) 3.79	0.2277* (0.1343) 1.70	0.4075** (0.1580) 2.58
Country-pair fixed	yes	yes	yes	yes	yes	yes
Time fixed	no	yes	yes	no	yes	yes
Country trends	yes	no	yes	yes	no	yes
R-squared (within)	0.097	0.194	0.194	0.076	0.156	0.170
Observations	12452	12452	12452	10847	10847	10847

Notes: The table reports panel (country-pair) fixed-effect coefficients estimated over the period 1978:q1–2009:q4. The dependent variable (GDP Synchronization) is minus one times the absolute value of the difference in the growth rate of GDP between countries i and j in quarter t . Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in the previous quarter relatively to the sum of the two countries' GDP in the previous period (Linkages/GDP). In columns (1)–(3) we measure U.S. linkages by the log of the share of the stock of bilateral assets and liabilities between each *country* and the U.S. in the previous quarter relatively to the two countries' GDP in the previous period (US Linkages/GDP). In columns (4)–(6) we measure U.S. linkages by the log of the share of the stock of bilateral assets and liabilities between each *country-pair* and the U.S. and the Cayman Islands in the previous quarter relatively to the two countries' GDP in the previous period (US Broad Linkages/GDP). The Crisis indicator variable equals one in all quarters after 2007:q3 (and zero before that). All specifications also include the log of the product of the two countries' GDP in the beginning of each period and the log of the product of the two countries population. The specifications in columns (1) and (4) include country-specific linear time-trends. The specifications in columns (2) and (5) include time fixed-effects. The specifications in columns (3) and (6) include time fixed-effects and country-specific linear time-trends. Standard errors adjusted for panel (country-pair) specific auto-correlation and heteroskedasticity and corresponding t-statistics are reported below the coefficients.

on our evidence in Table 3. The coefficient on bilateral banking linkages between the two countries is negative and significant, implying that in tranquil times an increase in banking linkages is followed by more divergent output cycles. As in our previous results (in Tables 2 and 3), the coefficient on bilateral banking linkages changes sign and becomes positive and significant during the recent financial crisis. In contrast to the bilateral banking integration measures that enter with stable and significant coefficients, columns (1)-(3) show that direct U.S. banking linkages variable enters with an insignificant coefficient both before and after the recent financial crisis. The insignificant coefficient on US banking linkages during the recent financial crisis is in line with the recent work of Rose and Spiegel (2010a,b), who also fail to find a systematic correlation between international linkages to the US and the magnitude of the recessions across countries in 2007 – 2009.

In columns (4)-(6) of Table 4 we report otherwise similar to columns (1)-(3) estimates, but we now use a broader measure of exposure to the U.S. that incorporates not only banking activities of each country-pair with the U.S., but also linkages to the Cayman Islands.¹⁹ Accounting for indirect links to the U.S. financial system appears fundamental. The coefficients on the U.S. linkages measures that were insignificant in the analogous specifications in columns (1)-(3) enter now with significant estimates. In all three permutations the post crisis estimate on the U.S. linkages variable—that now incorporates assets and liabilities in the U.S. and the Cayman Islands—is positive and statistically significant at standard confidence levels. This implies that country-pairs with strong linkages to the U.S. financial system experienced more synchronized cycles during the recent crisis period. Most importantly this effect seems to work on top of the positive effect of bilateral banking activities on output synchronization during the 2007/2009 crisis. This appears consistent with the transmission of the crisis from the U.S. to the pairs that are highly exposed to the U.S. and in turn to other countries. Moreover, the negative and significant coefficient on U.S. banking linkages in column (6) suggests that increases in financial integration between a country-pair and the U.S. financial system in tranquil periods is followed by more divergent cycles.

3.4 Is this Time Different?

Our finding that during the recent crisis period the partial effect of financial integration on output synchronization turns from negative to positive raises the question on whether a similar pattern was present during previous financial crisis episodes. While we focus on a group of advanced

¹⁹The results are similar if we also add Bermuda, Panama, and the Channel Islands. We prefer the estimates only with the Cayman Islands because the BIS database records these transactions since 1983. In contrast data for the other financial centers are available only after 2000.

economies in a period of relative financial stability up until the recent crisis of 2007–2009, there were some episodes of systemic banking crises in our sample. Reinhart and Rogoff (2008) argue that the 2007/2009 financial crisis is comparable with some previous banking crises episodes in other advanced economies, namely Spain (1977 – 1985), Finland (1991 – 1994), Sweden (1991 – 1994), and Japan (1997 – 2001).²⁰

We thus estimated specifications allowing the effect of banking integration to differ when one of the two countries was under a major banking crisis in each quarter before the 2007/2009 crisis. Table 5 reports the results. In columns (1) and (2) we use the Reinhart and Rogoff (2008) banking crisis classification, while for robustness in columns (3) and (4) we use the banking crisis chronology of Laeven and Valencia (2010). The effect of banking integration on output synchronization is positive during banking crises, even before 2007. The coefficient is estimated quite precisely, and appears significant at the 99% confidence level in all permutations. The coefficient in column (2) where besides including country-pair fixed-effects and time-effects, we also include linear country trends (-0.10) implies that a doubling in the degree of financial integration leads to an increased synchronization of output by one percentage point. The magnitude of the coefficient is also quite similar with the coefficient on banking integration during the recent financial crisis (in column (2) is -0.11), thus suggesting that the mechanisms under play during the 2007/2009 crisis were not fundamentally different than that of previous financial crises. In all specifications we can not reject the null hypothesis that the two coefficients on banking integration during financial crisis episodes are the same.

4 A model of international business cycles with banks

In this section we develop a simple international business cycle model where global banks intermediate funds from workers/consumers/savers to managers/borrowers. There are two types of shocks driving economic fluctuations: a standard productivity shock and a shock that affects the efficiency of banks in financial intermediation. The objective of our theoretical model is to illustrate how the impact of financial integration on business cycle synchronization depends crucially on the nature of the underlying shocks. Understanding this impact enables to use the findings described above to learn more about the nature of the shocks hitting the economies.

When we find, as in the the pre-2007 period, that more banking integration results in less

²⁰Reinhart and Rogoff (2009) also list Norway’s banking crisis in the late 1980s as comparable, but Norway is not included in our sample.

Table 5: Financial Linkages and Output Synchronization in Tranquil and Turbulent Times

Dependent Variable: GDP Growth Synchronization				
	(1)	(2)	(3)	(4)
	RR	RR	LV	LV
Previous Crises				
Linkages/GDP	-0.2179*** (0.0616) -3.54	-0.1889*** (0.0672) -2.81	-0.2321*** (0.0613) -3.79	-0.2138*** (0.0643) -3.32
Linkages/GDP $\times$ Crisis	0.1817*** (0.0491) 3.70	0.1107** (0.0532) 2.08	0.2056*** (0.0506) 4.06	0.1285** (0.0531) 2.42
Linkages/GDP $\times$ Previous Crises	0.1467*** (0.0254) 5.78	0.1035*** (0.0295) 3.51	0.1857*** (0.0246) 7.55	0.1866*** (0.0256) 7.29
US Broad Linkages/GDP	0.0600 (0.1444) 0.42	-0.4074** (0.1663) -2.45	0.0965 (0.1447) 0.67	-0.3467** (0.1704) -2.04
US Broad Linkages/GDP $\times$ Crisis	0.2400* (0.1323) 1.81	0.3691** (0.1500) 2.46	0.2072 (0.1350) 1.53	0.3547** (0.1468) 2.42
Country-pair fixed	yes	yes	yes	yes
Time fixed	no	yes	no	yes
Country trends	yes	yes	yes	yes
R-squared (within)	0.160	0.171	0.164	0.176
Observations	10847	10847	10847	10847

Notes: The table reports panel (country-pair) fixed-effect coefficients estimated over the period 1978:q1–2009:q4. The dependent variable (GDP Synchronization) is minus one times the absolute value of the difference in the growth rate of GDP between countries i and j in quarter t . Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in the previous quarter relatively to the sum of the two countries' GDP in the previous period (Linkages/GDP). We measure U.S. linkages by the log of the share of the stock of bilateral assets and liabilities between each country-pair and the U.S. and the Cayman Islands in the previous quarter relatively to the two countries' GDP in the previous period (US Broad Linkages/GDP). The Crisis indicator variable equals one in all quarters after 2007:q3 (and zero before that). The Previous Crisis indicator variable equals one when a major financial turmoil episode is present in country i or j in period/quarter t . In columns (1)-(2) we identify previous crises using the Reinhart and Rogoff (2007) classification of main financial turmoil episodes, while in columns (3)-(4) we use the Laeven and Valencia (2010) classification that includes both systemic and non-systemic banking crises. All specifications also include the log of the product of the two countries' GDP in the beginning of each period and the log of the product of the two countries population. Standard errors adjusted for panel (country-pair) specific auto-correlation and heteroskedasticity and corresponding t-statistics are reported below the coefficients.

business cycle synchronization, the model suggests that the predominant disturbances are on the productivity side. The reason is that more banking integration, enabling capital flows from the less to the more productive, enhances divergence between countries when they are hit by different real shocks.

When we find, as in the post 2007 period, that more banking integration results in higher synchronization, the model suggests that disturbances are of financial nature. This is because under banking integration disturbances in the banking sector of a country spread to banking sectors of other countries and hence more integration facilitates the transmission of disturbances.

We find the model also useful as it spells out a precise mechanism through which shocks to the domestic banking sector affect the domestic and foreign economy so it also suggests how policy responses might affect the international transmission of banking shocks.

4.1 The economy

We consider a two-countries, two-sectors, one-good world. In each country there are two sectors and in each sector there are consumers, who supply labor and save, firms, which borrow from banks, hire labor and make investment decisions, and banks that intermediate funds between firms and consumers. The difference between the two sectors is banking integration. Sector 1 is financially separated from the rest of the economy and banks intermediate only between consumers and firms within the sector. Sector 2 in both countries are financially integrated in the sense that all consumers and firms in sector 2 in both countries have financial transactions, through banks in sector 2, with each other. Banks in sectors 2 are global banks as, since the sectors are integrated, their national identity does not matter. The two sectors have size $1 - \lambda$ and λ , respectively, so λ is a measure of the banking integration. Note that for the extreme value of $\lambda = 0$ the model nests the case of financial autarky in which all banks only operate domestically and there are no financial flows between the two countries. At the other extreme there is the case of $\lambda = 1$ (maximum internationalization) in which all banks are global and intermediation markets are fully integrated. Besides financial integration the two sectors in each country are identical in every respect and they are hit by the same country specific shocks.

We first describe the consumers/workers problem; we then describe the firms' problem, and we conclude with the maximization problem of the banking sector. Notice that our model of banks is highly stylized: our objective is not to provide a realistic description of how the world banking system works, but to provide a simple set-up in which shocks to banking activities can have real repercussions in multiple countries under a different degree of banking integration. Also our modeling of financial integration is highly simplified as the degree of internationalization of the banking system is simply captured by the exogenously given parameter, λ .

4.2 Consumers

In each country (foreign country variables will be denoted by $*$) and in each sector (denoted by i) there is a continuum of identical infinitely lived consumers whose preferences are given by

$$E \sum_{t=0}^{\infty} \beta^t U(c_{it}, l_{it}), \quad i = 1, 2 \quad (3)$$

where E represents expectations across time and possible states of the world, c_{it} denotes consumption, l_{it} is labor effort, $0 < \beta < 1$ is the discount factor and $U(.,.)$ is a standard utility function. Consumers in each sector enter each time period with an amount of bank deposits, b_{it} , carried over from the last period; consumers also receive labor income $w_{it}l_{it}$ (where w_{it} is the wage rate), and dividends d_{it} from domestic firms.²¹ In each period they allocate resources between consumption and savings in the form of domestic bank deposits. Consumers in sector 1 (the financially segmented) receive interest rate R_{1t} on their deposits while consumers in sector 2 (the financially integrated) receive interest rate R_{2t} ; consumers' budget constraints in the two sectors are

$$c_{it} + \frac{b_{1t+1}}{R_{it}} = w_{it}l_{it} + d_{it} + b_{it}, \quad i = 1, 2 \quad (4)$$

Consumers' problem is to choose sequences for consumption, labor, and bank deposits to maximize (3) subject to (4) taking as given the sequences for bank deposit rates, wages, and dividends (as well as the initial conditions for bank deposits). Consumers in country 2 solve an analogous problem. Financial integration implies that consumers in sector 2 can shop for banks in the two countries so deposit rate for sector 2 consumers is equalized across countries i.e.

$$R_{2t} = R_{2t}^*, \quad \text{for all } t$$

Notice that in this simple set-up deposits are effectively constituted by physical goods, set aside by consumers in banks, so we can think of them (and also refer to them) as banking capital.

4.3 Firms

Firms in both sectors and both countries operate, on behalf of consumers in that sector, a constant return to scale technology $F(.,.)$, which uses capital stock (k_{it}) and labor (l_{it}) to produce a con-

²¹Throughout this paper we assume 100% home bias in equity markets. The results presented below are not dependent on this assumption.

sumption good. Production in each sector is subject to stochastic, country specific, productivity shocks z_t . The crucial assumption that connects the banks with firms is that firms, in order to undertake production, need to borrow from banks an amount of working capital equal to the wage bill. This assumption is usually motivated by a timing structure in which firms need to pay workers before they receive the proceeds from their sales (see for example Christiano and Eichenbaum (1992) or Neumeyer and Perri (2005)). The real world correspondence will be the liquidity requirement of the firm. Firms in sector i pay a gross lending rate R_{it}^e on loans from banks. As it will become clear later, due to the intermediation process, the lending rate R_{it}^e is not, in general, equal the deposit rate R_{it} . Firms' dividends d_{it} are thus given by the value of production minus the wage bill (including interests) and minus investment

$$d_{it} = e^{z_t} F(k_{it}, l_{it}) - R_{it}^e w_{1t} l_{1t} - x_{it} \quad (5)$$

where x_{it} represents investment in physical capital. The capital stock evolves according to

$$k_{it+1} = (1 - \delta)k_{it} + x_{it} - \phi k_{it} \left[\frac{x_{it}}{k_{it}} - \delta \right]^2, \quad i = 1, 2 \quad (6)$$

where δ is the depreciation rate of capital and ϕ is a parameter that determines the magnitude of capital adjustment costs. Finally we assume that the log of productivity follows a bivariate autoregressive process

$$\begin{bmatrix} z_t \\ z_t^* \end{bmatrix} = A_z \begin{bmatrix} z_t \\ z_t^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t^z \\ \varepsilon_t^{z^*} \end{bmatrix} \quad (7)$$

where A_z is a 2×2 matrix and $[\varepsilon_t^z, \varepsilon_t^{z^*}]$ is a vector of *i.i.d.* innovations with mean 0, standard deviation σ_ε^z and correlation ρ_ε^z . The problem of firms in country 1 and sector i is then

$$\begin{aligned} & \max_{l_{1t}, k_{1t}, x_{1t}} E \sum_{t=0}^{\infty} d_{it} Q_{it} \\ & s.t. \\ & (5), (6), (7) \quad k_{i0} \text{ given} \end{aligned}$$

where $Q_{it} = \beta^t U_c(c_{it}, l_{it})$ is the marginal rate of substitution of domestic consumers in sector i which are the owners of the firm. The problem of firms in both sectors of country 2 is analogous. Notice finally that in the financially integrated sectors firms can shop for banks in the two countries

so we will have for the lending rates that

$$R_{2t}^e = R_{2t}^{e*}$$

4.4 Banks

To complete the model we now describe how banks intermediate funds from consumers to firms/managers. In each sector there is a continuum of identical competitive banks. Banks in the financially segmented sector only receive deposits D_{1t} from consumers in those sectors. Banks in the financially integrated sectors are “global banks” and receive deposits/banking capital from consumers in both financially integrated sectors. Deposits are then given by

$$D_{1t} \equiv \frac{b_{1t+1}}{R_{1t}}, D_{1t}^* \equiv \frac{b_{1t+1}^*}{R_{1t}^*} \quad (8)$$

$$D_{2t} \equiv \frac{b_{2t+1} + b_{2t+1}^*}{R_{2t}} \quad (9)$$

Banks allocate deposits to two types of assets: country-specific risky technologies (which are intended to capture returns on assets held by banks and not explicitly modelled here, such as mortgages or stocks), and risk free loans to firms, as described above. In sector 1 banks only lend to firms in that sector and in that country and only invest in the risky technology of that country. In sector 2 (the global banks sector) banks lend to firms in both countries and invest in a diversified international fund which contains equal shares of the risky technologies of both countries.²² We denote with R_t^m and R_t^{m*} the stochastic gross returns on risky technologies in the two countries, which we assume to have equal mean in each country. Banks first, without knowing the realizations of returns R_t^m, R_t^{m*} , decide how much to invest in the risky asset. We assume that the expected return on the risky asset is always high enough so that each bank invests in it the maximum share of its deposits allowed by bank regulation i.e. $0 < \bar{m} < 1$ (this appears to be the relevant case). After returns R_t^m, R_t^{m*} are observed (but not cashed in), banks compete among each other offering loans to firms in their sector. Since firms borrow to finance the wage bill, equilibrium loans of banks L_{it} are given by

$$\begin{aligned} L_{1t} &= w_{1t} l_{1t}, L_{1t}^* = w_{1t}^* l_{1t}^* \\ L_{2t} &= w_{2t} l_{2t} + w_{2t}^* l_{2t}^* \end{aligned}$$

²²This is a very simple way of capturing the idea that in general global banks will be affected by shocks in the risky technology in both countries.

At the end of the period banks receive the proceeds from lending to firms, from risky investments and pay back deposits plus interests to consumers. Competition between banks insures that the loan rate will be set such that bank profits are 0.

To complete the description of the banking problem we have to specify a process for shocks to the return to risky assets: we assume that they follow a bivariate autoregressive process given by

$$\begin{bmatrix} R_t^m \\ R_t^{m*} \end{bmatrix} = \begin{bmatrix} \bar{R}^m \\ \bar{R}^{m*} \end{bmatrix} + A_R \begin{bmatrix} R_{t-1}^m \\ R_{t-1}^{m*} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^R \\ \varepsilon_t^{R*} \end{bmatrix}$$

where A_R is a 2×2 matrix and $[\varepsilon_t^R \ \varepsilon_t^{R*}]$ is a vector of *i.i.d.* innovations with mean μ , standard deviation σ_ε^R and correlation ρ_ε^R . We conclude this section by acknowledging that we modeled banks portfolio decision in a rather stark fashion, basically assuming that banks invest a constant fraction of their portfolio in risky assets. Obviously in reality any given bank can and do change the composition of their portfolio. If one interprets our model as a representation of the entire financial sector then the assumption that the proportion of risky and safe assets is rather constant through time is not too far-fetched. Also the crucial ingredient here is that banks are always exposed to some additional risk that interferes with their lending to firms; the assumption that the size of this risk is constant is made for analytical simplicity.

4.5 Equilibrium

An equilibrium, for a given size of the two sectors λ , is a collection of price sequences, $R_{it}^e, R_{it}, w_{it}, Q_{it}, R_{it}^{e*}, R_{it}^*, w_{it}^*, Q_{it}^*$, exogenous shock processes $z_t, R_t^m, z_t^*, R_t^{m*}$ and quantities $c_{it}, l_{it}, k_{it}, x_{it}, d_{it}, b_{it}, c_{it}^*, l_{it}^*, k_{it}^*, x_{it}^*, d_{it}^*, b_{it}^*$ such that

1. Given prices and shocks, consumers and firms solve their problems, banks invest a share $\bar{m}$ in the risky portfolio and lending rates are set so that banks make zero profits in each period and in each sector i.e.

$$\bar{m}D_{1t}R_t^m + (1 - \bar{m})D_{1t}R_{1t}^e = b_{1t+1} \quad \text{for all } t \quad (10)$$

$$\bar{m}D_{1t}^*R_t^{m*} + (1 - \bar{m})D_{1t}^*R_{1t}^{e*} = b_{1t+1}^* \quad \text{for all } t \quad (11)$$

$$\frac{\bar{m}}{2} (D_{2t} + D_{2t}^*) (R_t^m + R_t^{m*}) + (1 - \bar{m}) (D_{2t} + D_{2t}^*) R_{2t}^e = b_{2t+1} + b_{2t+1}^* \quad \text{for all } t \quad (12)$$

Note that the right hand sides of (10, 11) represent banks' payouts in the segmented sectors in the two countries and the right hand side in (12) represents the typical global bank payout;

similarly the left hand sides of (10, 11) represent revenues from risky capital and revenues from lending to firms in the segmented sectors and the left hand side of (12) represents the global banks revenues.

2. Goods markets clear i.e.

$$\begin{aligned}
c_{1t} + x_{1t} + (b_{1t+1} - b_{1t}) &= e^{z_t} F(k_{1t}, l_{1t}) + \bar{m} D_{1t} (R_t^m - 1) \\
c_{1t}^* + x_{1t}^* + (b_{1t+1}^* - b_{1t}^*) &= e^{z_t^*} F(k_{1t}^*, l_{1t}^*) + \bar{m} D_{2t} (R_t^{m^*} - 1) \\
c_{2t} + c_{2t}^* + x_{2t} + x_{2t}^* + (b_{2t+1} - b_{2t}) + (b_{2t+1}^* - b_{2t}^*) \\
&= e^{z_t} F(k_{2t}, l_{2t}) + e^{z_t^*} F(k_{2t}^*, l_{2t}^*) + \frac{\bar{m}}{2} (D_{2t}^* + D_{2t}) (R_t^m + R_t^{m^*})
\end{aligned}$$

Note that the left hand side of the market clearing equilibrium conditions includes, besides consumption c_{it} and investment in physical capital x_{it} , the term $(b_{it+1} - b_{it})$ which represents the investment in banking deposits, which are used either as working capital or as investment in the risky technology. The right hand side includes production by firms $z_{it} F(k_{it}, l_{it})$ and value added by banks $\bar{m} D_{it} (R_i^m - 1)$ which are the payouts that banks receive from investing in the risky technology.

3. Financial intermediation markets clear, that is in each period in the segmented sectors the demand for working capital from the firms in the sector is equal to the supply of loans in that sector, while for the global banks the demand for working capital in both countries is equal to the global supply of loans i.e.

$$L_{1t} = (1 - \bar{m}) D_{1t} \quad \text{for all } t \quad (13)$$

$$L_{1t}^* = (1 - \bar{m}) D_{1t}^* \quad \text{for all } t \quad (14)$$

$$L_{2t} + L_{2t}^* = (1 - \bar{m}) (D_{2t} + D_{2t}^*) \quad \text{for all } t \quad (15)$$

4.6 The effects of shocks

Productivity shocks in this model operate similarly as in a standard two country RBC model. In the segmented sector a negative domestic productivity shock lowers labor demand and investment and hence output in the home sector, but, absent spillovers in the productivity itself, has no effects abroad. In sector 2 (the financial integrated one) a negative domestic productivity shock reduces labor demand and output but also reduces global demand for credit which causes a fall in the (common across countries) deposit and lending rates. The fall in the lending rate causes

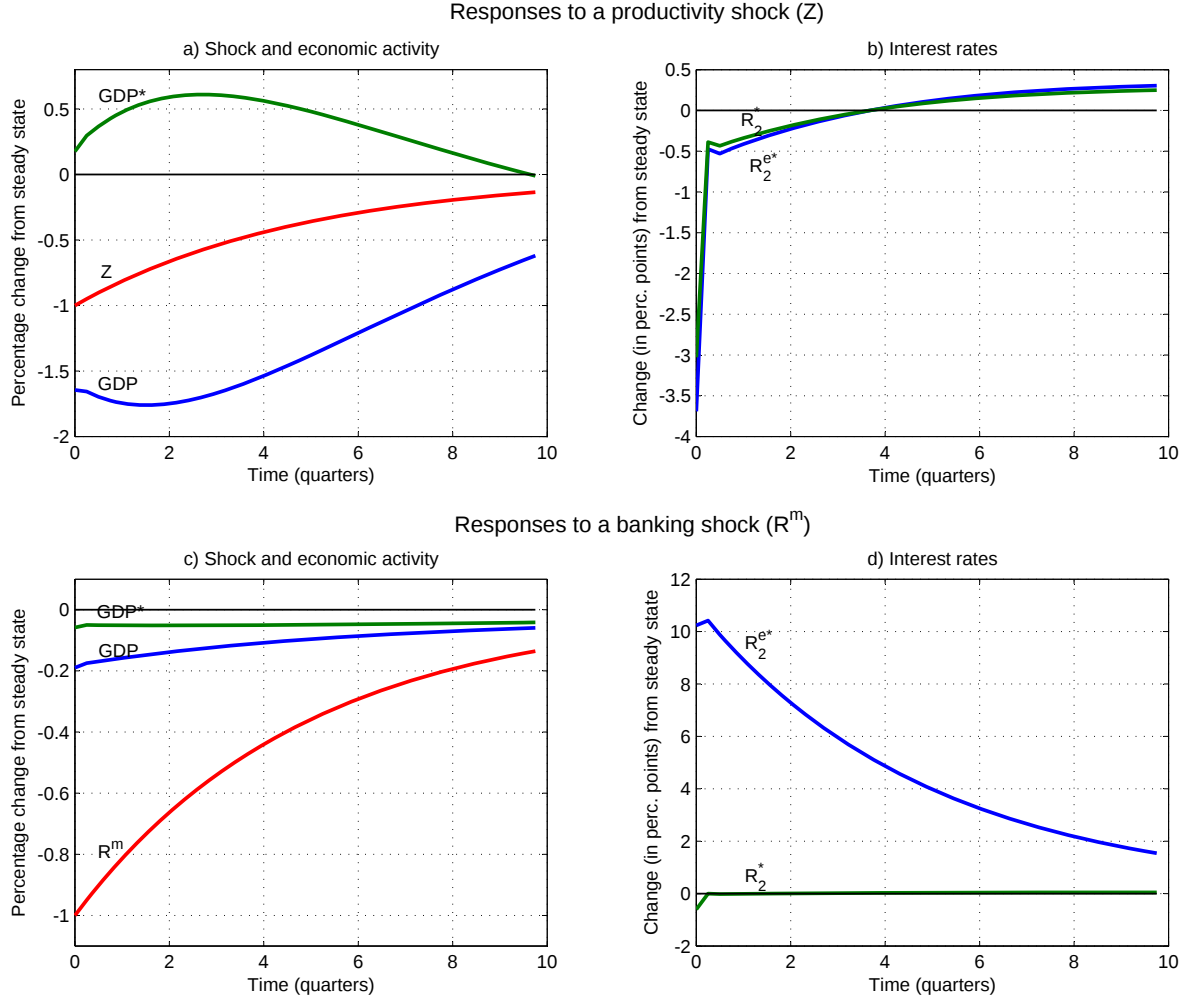


Figure 2: Impulse responses to productivity and banking shocks

an increase in labor demand and employment abroad and the fall in the deposit rate induces an increase in investment abroad. The larger the financially integrated sector (i.e. the larger λ) the more integrated are the two economies and the more a negative productivity shock at home has an expansionary effect abroad and hence the less the economies are correlated; financial integration, enabling resource flows from the less productive to the more productive country, reduces correlation between the economies. The top two panels of figure 2 show the responses of a negative domestic productivity shock. The home country contracts and foreign country expands (panel a) and the reason why foreign country expands is the fall in the sector 2 (the financially integrated) interest rates (panel b).

The shocks which are novel are the ones to returns to risky bank assets R_t^m and R_t^{m*} . To get some intuition on how these work it is useful to first focus on the segmented sector, say, in country 1. Remember that the two key interest rates are, R_{1t} , the rate depositors receive, which represents the cost of raising funds for banks; and R_{1t}^e , the lending rate banks charge firms. The reason why these two rates differ in equilibrium, even though banks make zero profits, is that banks make losses or gains on investment in the risky technology. These gains/losses plus the zero profit conditions drive a wedge between R_t and R_t^e and this wedge, through the working capital channel, has an effect on economic activity. To see this formally substitute the expression for D_{1t} in (8) into (10) and cancel out D_{1t} to get

$$R_{1t}^e = \frac{1}{1 - \bar{m}} R_{1t} - \frac{\bar{m}}{1 - \bar{m}} R_{1t}^m. \quad (16)$$

Equation (16) shows that

- i) Unless $\bar{m} = 0$ (i.e. banks are prohibited to invest in risky assets) or $R_{1t}^m = R_{1t}$ (i.e the return on the risky technology is the same as the equilibrium deposit rate), the rate banks charge to firms is different from the depositors rate
- ii) Negative shocks to the return to the risky asset (rate) increase the spread between depositor rate and lending rate
- iii) The larger the share invested in risky assets, $\bar{m}$, the more sensitive is the lending rate to shocks in the risky rate. Banks make up for losses on risky assets by charging a high interest rate to firms. If bank portfolio contains a large share of risky assets interest the rate hikes necessary to cover the losses are larger.

To further understand the effect of a financial shock figure 3 below represents equilibrium in the financially segmented sector, for a given level of k_1 , z and R^m . The positively sloped line ZP represent a combination of deposit rates and lending rates that yield zero profit for banks (equation 16); they are positively sloped because a high deposit rate induces, *ceteris paribus*, a high lending rate so that banks break even. The negatively sloped line represents the locus of lending and deposit rates that constitute an equilibrium in intermediation markets (equation 13). It is in general negatively sloped because a higher R_1 induces a higher supply of deposits D_{1t} and thus requires a lower R_1^e to induce a high demand for credit from the firms. The graph allows to easily understand the effect of shocks. Consider for example a fall in R^m . This represents lower revenues for banks and thus implies a shift up of the zero profit condition from ZP to ZP' . In equilibrium this will result in a fall in deposit rates from R_1 to R_1' and an increase in lending rates from R_1^e to $R_1^{e'}$. Higher lending rates, through the working capital channel, reduce firms labor

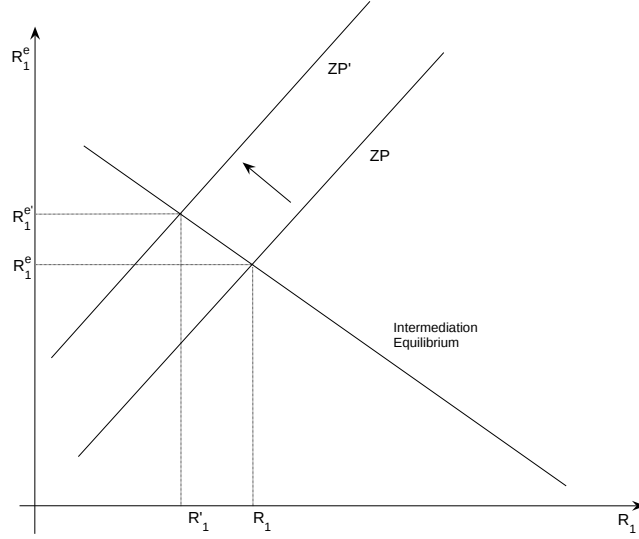


Figure 3: Equilibrium interest rates and the effect of credit shocks

demand and hence equilibrium employment and economic activity falls, as a result of the shock to the revenues of the banking sector.

The effects of a negative shock to R^m in the financially integrated sector is similar with the difference that the shock gets transmitted in the financially integrated sector abroad through interest rates. Since financially integrated sectors share both deposit rates and lending rates the rate changes that caused the reduction of economic activity at home also cause a reduction of economic activity abroad. The bottom panels in figure 2 above show how in response to an adverse credit shock economic activity in both countries contract (panel c). In country 1 activity contracts in both sectors because lending rates in both sectors raises, in country 2 it contracts because the lending rate in the financially integrated sector, R_2^{e*} , raises (see panel d). One important thing to notice is that, in response to a credit shock, interest rates in the model raise substantially. Again this is due to the stylized nature of our model: in the real world besides the interest rates additional conditions in credit markets, such as borrowing restrictions or bank failures, are likely to manifest in credit markets as a result of shocks. Since our model completely abstracts from those additional variables, interest rates need to be volatile for credit conditions to have sizeable effect on economic activity.

4.7 Numerical experiments

In this section we use the model to assess the effects of banking shocks on business cycles and to show that banking shocks can account for the change, documented in the empirical section, in the impact that integration has on comovement. Unfortunately the equilibrium described above does not admit analytical solution so in order to perform this task we need to first assign functional forms to utility and production and numerical values to the model parameters and then proceed to derive a numerical solution to the model using standard linearization techniques. Functional forms, preference and technology parameters are standard in this literature and they are reported in table 6 below.

Table 6: Functional forms and baseline parameter values

Functional forms	
Utility	$U(c, l) = \log(c) - Al$
Production	$F(k, l) = k^\alpha l^{1-\alpha}$
Preference parameters	
Discount factor	$\beta = 0.99$
Weight of labor	$A = 2.3$
Technology parameters	
Capital share	$\alpha = 0.36$
Depreciation rate	$\delta = 0.025$
Productivity process	$A_z = \begin{pmatrix} 0.95 & 0.0 \\ 0.0 & 0.95 \end{pmatrix}, \sigma_\varepsilon^z = 0.007, \rho_\varepsilon^z = 0.3$
Adjustment cost	$\phi = 0.43$
Banking parameters	
Degree of integration	$\lambda = 15\%$
Share of risky assets	$\bar{m} = 18\%$

The last two parameters in the table, i.e. λ which determines the degree of financial integration between the two countries and $\bar{m}$ which determines the share of assets banks invest in the risky technology are set as follows. First we consider a version of the model in which the volatility of credit shocks (σ_R^ε) is set to 0. We then set λ and $\bar{m}$ so that the model generates volatility of net exports (relative to percentage volatility GDP) roughly equal to 50% and a correlation of net

exports and GDP which is about -0.5 : these values are consistent with statistics computed for US and other developed countries.²³

4.7.1 Banking shocks and business cycles

The rows in table 7 labelled “productivity only” reports standard business statistics for the model only with productivity shocks. Note that the model generates business cycles statistics very similar (thereby sharing successes and failures) to those generated by a standard IRBC model (see for example Baxter and Crucini (1995)).

Next to assess the importance of banking shocks on overall business cycles we assume that banking shocks and productivity shocks are uncorrelated, that the transition matrix of the stochastic process for banking shocks and the correlation of the innovations in banking shocks are the same as the ones for the process for productivity (i.e. $A_{R^m} = A_z$ and $\rho_\varepsilon^R = \rho_\varepsilon^z$).²⁴ We then reduce the standard deviation of the innovation to productivity shocks σ_ε^z and increase the standard deviation of the innovations to banking shocks σ_R^ε so that

i) The volatility of GDP in the model with both shocks is the same as in the model with only productivity shocks (this is just to facilitate comparison between the two models).

ii) Credit shocks alone are responsible for a standard deviation of growth rate of GDP of about 0.3%. To obtain this number we have simply observed that the standard deviation of quarterly growth rate of GDP increase from about 0.5% in the 1984-2006 period to about 0.8% in the 2007-2010 period and so attributing the entire increase in US volatility to credit shocks yields the number.

This simple procedure yields a value of $\sigma_R^\varepsilon = 3\%$. It is obviously hard, in such a stylized model, to identify the data equivalent of returns on risky investment undertaken by the banking sector and the volatility of returns of these risky investment. The simple calibration approach though suggests that in order for these shocks to explain a significant fraction of GDP volatility, the volatility of

²³It is easy to see how the parameter λ affects directly the volatility of net exports, as when λ is 0 the economies are closed and the volatility of net exports is 0. Why does the parameter $\bar{m}$ affects the correlation between net exports and output? The parameter $\bar{m}$, even in absence of banking shocks, affects the sensitivity of domestic lending rates R^e to changes in the deposit rates R (see equation 16). A large $\bar{m}$ implies that when the country is hit by a productivity shock R^e raises more than R . This implies that firms do not hire much in response to higher productivity and hence do not invest much. This in turns implies that the country as a whole does not need to import goods to finance investment and that makes the correlation between net exports and output less negative than in the model with low $\bar{m}$.

²⁴We recognize that these are rather arbitrary assumptions. Our key results though, that concern the impact of integration under two different type of dominant shocks are robust to significant perturbations in these assumptions.

returns of these risky investment in the banking/financial sector has to be large: much larger than the volatility of productivity shocks and comparable to the volatility of returns in stock prices. The lines labelled “Productivity & banking” in table 7 report business cycles statistics for this version of the model.

Three differences between the productivity only and productivity and banking model are worth noticing. The first is that the model with banking shocks display more correlated GDP and GDP components than the model with only productivity shocks. To understand why this the case recall that in the segmented sectors the correlation in economic activity is simply driven by the correlation of the shocks (which we assumed to be the same for both shocks). The correlation between financially integrated sectors instead depends on the composition of the shocks: with dominant productivity shocks financially integrated sector tend to be negatively correlated while with dominant banking shocks they tend to be positively correlated. Since the overall correlation of the economy is a combination of the correlation in the two sectors, the economies with both shocks comove more relative to the economies with only productivity shocks. Interestingly the model with credit shocks increases more the international correlation of output, employment and investment than it does the international correlation of consumption so it partially help explain the so-called “quantity anomaly” i.e. the fact that the model predicts that consumption patterns are more correlated than output internationally while in the the data usually the opposite is observed.

The second feature is that the model with both shocks generates a more volatile employment relative to GDP than the model with only productivity (0.77 v/s 0.66). This is due to the fact that credit shock induces movements in lending rates that cause, through the working capital channel, autonomous (i.e. not driven by productivity) movements in employment. This feature of the model is qualitatively consistent with US evidence from the recent crisis showing that much of decline of US GDP during the crisis is due to employment changes. The final feature to notice is that the model with banking shocks display net exports that are less volatile and less (in absolute value) correlated with GDP. This is because banking shocks, due to their stronger international transmission, hit both countries similarly and thus reduce international flow of resources (net exports).

Overall this exercise shows that introducing banking shocks in a standard model generates plausible business cycles, and helps understanding some of the features that the standard model has trouble with.

Table 7: Business cycle statistics

	GDP	Percentage Standard Deviations Relative to GDP			
		Consumption	Investment	Employment	Net Exports
Productivity only	1.16	0.30	3.59	0.66	0.50
Productivity & banking	1.16	0.33	3.08	0.77	0.35
Correlations with GDP					
Productivity only		0.98	0.95	0.99	-0.50
Productivity & banking		0.98	0.96	0.99	-0.25
International Correlations					
Productivity only	0.25	0.42	-0.30	0.16	
Productivity & banking	0.32	0.43	-0.06	0.35	

Note: all statistics are average over 20 simulations each 200 periods long. All statistics except net exports refer to first difference in the log of the variables. Net exports statistics refer to first differences in the ratio (Exports-imports)/GDP.

4.7.2 The impact of banking integration

In this last section we connect directly the quantitative results of the model with the empirical results in the first part of the paper. We do this in two ways. First we consider the two parameterizations of the model described above (productivity shocks alone and productivity and banking shocks) and for each parameterization we vary the degree of banking integration from no integration ($\lambda = 0$) to complete integration ($\lambda = 1$). For each value of the integration we report the international correlation of GDP growth rates. The results of this exercise are reported in figure 4. Note how in the model with only productivity shocks the slope of the line is always negative, i.e more integration leads to lower correlation. This is consistent with the finding in table 2 for the “tranquil time” period.

The curve for the model with both shocks is initially positively sloped and then declining suggesting that, in times with both shocks, the overall effect of integration on comovement is ambiguous. Notice though that the difference between the lines is always positive and increasing, showing that the marginal effect of integration on co-movement in a crisis times is positive, consistently with findings in table 2.²⁵

To make the comparison between model and data quantitatively more precise we use data

²⁵By marginal effect here we mean the the more two countries are integrated the higher is the increase in their co-movement in crisis times over and above their co-movement during tranquil times.

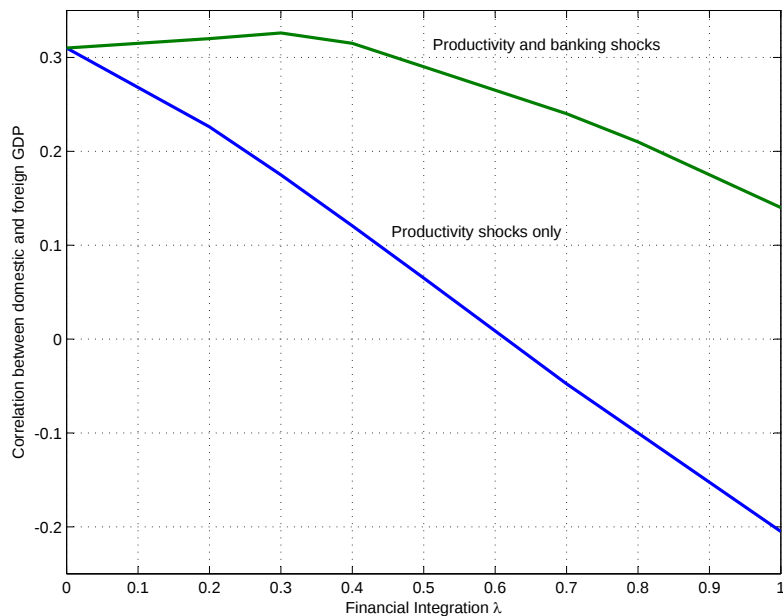


Figure 4: Integration and correlation

simulated by the model to run the same regression we run in table 3 above. In particular we simulate the model for ten couples of countries with integration parameter (λ) varying smoothly from 0.1 to 1. For each couple of countries we simulate the model for 200 periods with only productivity shocks (tranquil times) and with productivity shocks and banking shocks (crisis times). We then construct the same measure of GDP synchronization we used in the data analysis in tables 3 above and then regress it on the log of integration ($\log$ of λ), on a dummy for crisis times and on an interaction between crisis times and integration. Results are reported in table 8 below.

On the data simulated from the model we find that integration leads to lower synchronization and that the coefficient on the interaction between integration and crisis times (i.e. period with credit shocks) is positive, suggesting again a positive marginal effect of integration. For comparisons in the table we report also the coefficients on the same regression in the data. (in particular we report specifications (1),(2) and (3) from table 3) and note that the implications of the model for the impact of integration on comovement are remarkably close to those measured in the data. This validates our initial hypothesis that business cycles in the pre 2006 period are driven by productivity type shocks while recent crisis times and indeed times in which credit shocks have become prominent.

Table 8: Bilateral Financial Integration and GDP Synchronization: model v/s data

Dependent variable: GDP growth synchronization				
	Model	Data		
		(1)	(2)	(3)
Integration	-0.34	-0.249 (0.06)	-0.302 (0.07)	-0.220 (0.06)
Integration $\times$ Crisis	0.23	-0.264 (0.03)	0.192 (0.04)	0.123 (0.05)

We conclude this section summarizing its main findings. The data shows a substantial change in the link between integration and comovement. This link was strongly negative before 2006 and has weakened substantially during the recent crisis. In order to understand this change we have studied a simple modification of the standard international business cycles by introducing stylized domestic and global banks and shocks to financial intermediation conducted by these banks. The model suggests that the change in the link can be explained by the presence of large banking shocks in recent times.

We model banking shocks as really capital losses suffered by banks and by the financial sector in general. These losses can have sizeable impact on domestic and foreign economic activity so the model provides a simple benchmark to analyze the effectiveness, as a stabilization tool, of policies geared toward reducing capital losses of the financial/banking sector.

5 Conclusion

We study the role of global banks in transmitting the recent crisis of 2007–2009 from the corner of the U.S. financial markets to the rest of the developed world. In the first part of our analysis we use quarterly data on country-pair banking linkages from a sample of 20 developed countries between 1978 and 2009. We find that while the relationship between banking linkages and output synchronization has been negative for almost all of the times before the recent crisis, the partial correlation turned positive during the recent crisis. We also find evidence in favor of the transmission of the crisis through banking linkages. We document that countries with stronger financial ties to the U.S. and the Cayman Islands experienced more synchronized cycles with the U.S. during the past 3 years. In fact, we show that there is nothing different about this crisis since when we examine

previous financial crises periods among the developed countries in our sample, we find a similar positive association between the financial linkages and output synchronization.

In the second part of our paper we develop a simple dynamic general equilibrium model of international banking that allows for both productivity and credit (bank capital) shocks. Our model nests the standard mechanism of the workhorse international real business cycle model (e.g. Backus, Kehoe, and Kydland (1992)) that financial integration magnifies total-factor-productivity shocks leading to more divergent output cycles with the contagion mechanism of recent international macro models (e.g. Perri and Quadrini (2010); Mendoza and Quadrini (2009)) where financial shocks may spread quickly globally among interconnected economies. The theoretical model delivers predictions that are consistent with our empirical findings. Under the assumption that the productivity shocks are the dominant source of fluctuations, a higher degree of banking integration results in less synchronized business cycles, whereas if financial shocks become the dominant source of fluctuations, then a higher level of banking integration results in more synchronized business. The model has policy implications, since it highlights a precise mechanism through which shocks to the domestic banking sector affect the domestic and foreign economy. In particular it suggests that capital losses to the financial sector have repercussions on domestic and foreign economic activity and thus policies like the 2008 bailout of the financial sector might have a substantial stabilization effect.

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