Are Banking and Capital Markets Union Complements? Evidence from Channels of Risk Sharing in the Eurozone

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Abstract

EMU was a major step towards deeper financial integration among member states. However, diversification of equity portfolios remained limited while banking integration surged. We argue that *the nature of banking integration* is of first-order importance for understanding the patterns and channels of risk sharing. While EMU was associated with the creation of an integrated interbank market, as witnessed by an explosion in cross-border interbank flows, "real" banking integration (in terms of cross-border bank-to-real sector flows or banking-consolidation) remained limited. But we find that real banking integration is associated with more risk sharing, while indirect integration via interbank flows is not. Further, indirect banking integration proved to be highly procyclical, which contributed to the freeze in risk sharing after 2008. Based on this evidence, and a stylized DSGE model that allows us to explain these patterns in the data, we discuss implications for banking union. Our results show that real banking integration and capital market union are complements and robust risk sharing in the EMU requires both.

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1 Introduction

The first decade of the euro saw a considerable drive towards deeper *de jure* and *de facto* financial integration of the eurozone with concomitant increases in risk sharing. However, the euro's second decade revealed that risk sharing mechanisms were fragile when they were most urgently needed. During the global financial crisis and the European sovereign debt crisis that followed, risk sharing among member countries of the eurozone all but dried up so that divergent output growth led to divergent consumption growth. We revisit the channels and mechanisms through which improved risk sharing was realized in the years from 1999 to 2008, and then we examine which channels were fragile and which resilient during the crisis. From the insights of this exercise, as well as historical experience of risk sharing within the United States, and from a stylized quantitative-theoretical DSGE model, we draw policy lessons for the euro's third decade, in particular with respect to banking and capital market union in Europe.

We depart from the framework pioneered by Asdrubali et al. (1996). These authors were the first to provide an empirical taxonomy of how different broad channels contribute to risk sharing among U.S. federal states. They showed that income smoothing through cross-state income flows (mainly from capital) is the dominant mechanism of risk sharing among U.S. states, more important than both consumption smoothing through countercyclical saving ("credit market smoothing") or fiscal transfers. Subsequent analyses (Sorensen and Yosha (1998)) applied this framework to international data and, in particular, to data for eurozone countries. These studies revealed that the main reason for low international risk sharing is the absence of cross-border income flows—the lack of international income smoothing correlates closely with the home bias in cross-border asset holdings (Sørensen et al. (2007)), in particular at longer horizons (Artis and Hoffmann (2011)), and this explains why U.S. states are able to share permanent idiosyncratic shocks (Becker and Hoffmann (2006)) .

The inception of the euro led to more risk sharing among eurozone member countries, but from a low level and mainly through countercyclical saving. Income smoothing did improve somewhat, but the cross-border ownership of equity that is needed to underpin it remained low. Unsurprisingly, fiscal insurance also remained low because there are almost no fiscal transfer mechanisms between eurozone members. This pattern of risk sharing in the pre-crisis eurozone is very different from the pattern of risk sharing prevailing in a long-established monetary, capital market, and banking union such as the United States, where income smoothing plays a dominant role. Our empirical evidence—summarized in Figure 1—suggests that the consumption smoothing channel proved to be the least resilient during the eurozone crisis. Because counter-cyclical savings are unsuited to absorb persistent idiosyncratic shocks, the absence of income risk sharing can also help explain the divergence in consumption patterns following the eurozone crisis.

The main hypothesis of this paper is that, in the absence of significantly increased cross-border ownership of equity, the nature of banking integration in the eurozone is of first-order importance for understanding channels of risk sharing. Figure 2 illustrates how the inception of the euro led to a boom in cross-border interbank integration (which did not happen to the same extent in other parts of the world). However, during the crisis the retrenchment in cross-border interbank flows in the eurozone was stronger than the retrenchment found for other industrialized countries. By contrast, while the growth in direct cross-border lending to the non-bank sector was more muted before 2008, it was stable throughout the crisis.

Some aspects of this pattern of cross-country banking integration in the eurozone prior to the crisis are reminiscent of the nature of interstate banking integration in the United States prior to state-level banking deregulation: first, in spite of there being a well-integrated interbank market among U.S. federal states, prior to state-level deregulation banks were, on the whole, not allowed to enter markets outside the state in which they were headquartered. In the same mold, the inception of the euro established a well-integrated European interbank market: country spreads on bank CDS were almost zero in the years before the crisis and, as evidenced by Figure 2, cross-border interbank flows grew very fast; but even though there were no formal restrictions for individual banks to move into other markets in the eurozone, few banks entered retail markets in other member countries and the extent of cross-border lending to the non-bank sector remained limited (see also the discussion in Hoffmann et al. (2017)).[1] By contrast, following deregulation, banks in the United States started to consolidate across state borders and to operate internal capital markets. As shown by Demyanyk et al. (2007), and Hoffmann and Shcherbakova-Stewen (2011a), this contributed to more income smoothing and made risk sharing more resilient in recessions when it is most needed. Our conjecture is that the U.S. experience helps understand how banking integration in Europe may have to proceed in order to provide robust risk sharing and, in particular, to prevent future "freezes" in risk sharing during crises.

Our empirical results suggest that the structure of banking integration is important for understanding risk sharing in the eurozone. Specifically, during our sample period interbank and direct cross-border lending were very different in their implications for risk sharing, in particular during the crises. We find that direct cross-border lending had risk sharing benefits similar to the those from cross-border ownership of equity: it led to more income smoothing and was more resilient during the global financial crisis and its aftermath. While interbank lending appeared to be as a partial substitute for direct lending before 2008, it was much less robust than direct lending during the crisis. We find that the collapse in interbank lending was associated with a collapse in consumption smoothing after 2008 and that it was mainly this collapse in countercyclical savings that explains why risk sharing virtually dried up during the eurozone sovereign debt crisis. Hence, the lack of real (or "deep") banking integration (together with the absence of equity market integration and the limited role of bond market integration for most European firms) explains why risk sharing in the eurozone failed when it was most needed.

We interpret our findings with the help of a stylized DSGE model in which firms and banks face financial frictions and where the profits of firms are shared internationally in proportion to the degree of international equity market integration, while labor income can only be smoothed via saving and borrowing. These ways of sharing consumption risk are quite different as profits are shared according to *ex ante* ownership contracts, while savings decisions are made *ex post* after income shocks are realized. In the model, firms have to pre-finance wage payments and investment using either longer-term bank loans or using more expensive short-term finance from other sources. Since current wage payments are financed from fresh loans while the repayment of past loans is pre-determined, banking integration increases the volatility and procyclicality of firm profits (dividends) after a country-specific productivity shock. Hence, for any given level of international equity portfolio diversification, there is a larger role for

[1] Kalemli-Ozcan et al. (2010) document how uneven the *de facto* legal implementation of financial integration was, even after the inception of the euro.

income smoothing. This explains why banking integration leads to more income smoothing in tranquil times, such as the period before 2008, when small idiosyncratic shocks are likely to have prevailed in the data. The model and our empirical results point at an important complementarity between equity market and banking integration that, to our knowledge, has not been explored in the literature so far: In our model, banking integration is desirable because it improves firms' access to finance —but at the cost of making firms' profits more volatile and more procyclical. This, in turn, increases the benefits from international portfolio diversification and thus of equity market integration.

The model can also explain why risk sharing mechanisms could not withstand the drop in interbank lending after 2008: in our model, a global shock to interbank markets hits local banks which partly rely on wholesale funding. This drives up domestic interest rates, making *ex post* borrowing more expensive for households leading to less consumption smoothing, consistent with our empirical findings.

The outline of the paper is as follows: we first document how the patterns of risk sharing evolved prior to and after the European sovereign debt crisis. We then correlate these patterns with measures of equity and banking market integration. A key innovation of this paper is that we focus on the role of international banking flows for risk sharing, distinguishing, in particular, between the role of interbank and direct (bank-to-nonbank) cross-border positions. To gain a better understanding of why the nature of banking integration matters for risk sharing outcomes, we develop a stylized DSGE model of the Eurozone in which we can benchmark the impact of capital market integration (leading to more cross-border ownership of equity) and the impact of various patterns of banking integration (bank-to-bank lending via an interbank market or bank-to-real sector lending via cross-border branching) on risk sharing. Comparing our empirical results with the results from simulated model data allows us to derive policy conclusions and implications for the design of banking and capital market unions.

2 Review of the Literature

Empirical tests of full risk sharing were first designed for micro data by Townsend (1994), Mace (1991), and Cochrane (1991), and for macro data by Canova and Ravn (1996), Obstfeld (1993), and Lewis (1996).[2] Theoretical benchmark models for macroeconomic data were developed by Baxter and Crucini (1995), who highlight the difference between capital market integration (cross-ownership of assets) and credit-market integration (integrated bond market), where only the former provides insurance against permanent shocks, and Backus and Smith (1993) and Kollmann (1995), who generalize the Arrow-Debreu benchmark model to include non-tradeables. A large body of quantitative models attempt to explain risk sharing patterns, starting with Backus et al. (1992); see for example Heathcote and Perri (2004), Corsetti et al. (2008), and Coeurdacier et al. (2015), and many others. This large body of work has delivered many theoretical insights.[3]

Our work uses the accounting framework of Asdrubali et al. (1996), who study risk sharing among U.S. states, and Sorensen and Yosha (1998), who study risk sharing among OECD and EU countries.

[2] A lot of the early work estimated risk sharing among U.S. states as a blueprint for monetary unions, see Sachs and Sala-i Martin (1992), Atkeson and Bayoumi (1993), and Crucini (1999).

[3] An important insight here is the role of valuation effects for international risk sharing. There is a lot of evidence, though, that these valuation effects are driven mainly by nominal exchange rate variation. Clearly, nominal exchange rate fluctuations play no role within the EMU, which is our main focus here. We therefore opt for a simplified model that abstracts from the valuation channel.

These studies suggest that the main cause for the lack of international risk sharing is the almost complete absence of cross-border income flows as a mechanism of risk sharing at the international level. The lack of international income smoothing correlates closely with the home bias in cross-border asset holdings (Sørensen et al. (2007)), in particular at longer horizons (Artis and Hoffmann (2011)) and explains why U.S. states are better at sharing permanent idiosyncratic shocks with each other (Becker and Hoffmann (2006)).

To our knowledge, ours is the first paper to draw attention to the role of banking integration (as opposed to equity and general credit or bond market integration) for risk sharing in the EMU. The conjecture that banking integration is key in understanding the patterns and channels of risk sharing among EMU members is informed by our earlier work in Demyanyk et al. (2007), and Hoffmann and Shcherbakova-Stewen (2011a) on the United States. Specifically, Demyanyk et al. (2007) show that the removal of bank branching restrictions in the United States during the 1980s led to more income smoothing. Hoffmann and Shcherbakova-Stewen (2011a) show that, prior to banking deregulation and similar to what we find for Europe today, *ex post* consumption smoothing used to decline in aggregate (i.e. U.S.-wide) recessions. Following banking deregulation, this procyclicality in risk sharing was removed and the patterns of risk sharing changed, with a shift from *ex post* consumption smoothing to more income smoothing. All this contributed to make risk sharing more resilient against aggregate U.S.-wide downturns.

We interpret our empirical results in the context of stylized international business cycle model, following the approach of Kalemli-Ozcan et al. (2013), who study the role of banks in the transmission of international business cycles. In addition to their framework and similar to our companion paper, our model incorporates global and local banks and therefore allows for a distinction between direct and indirect (interbank) cross-border lending. Using a version of the model calibrated to eurozone data, we can replicate the empirical observations that direct banking integration leads to more income smoothing and that declines in indirect bank-to-bank lending leads to a decline in *ex post* consumption smoothing.

While our results hold potentially important insights for the design of banking union and suggest that banking union "done right" may at least partly substitute for equity market integration, we do not discuss details of the political economy of banking union.We also abstract from the role of fiscal smoothing, fiscal integration, and its relation to sovereign debt. The literature on the European sovereign debt crisis in the wake of the Great Recession has been discussed by many others; for a survey, see Lane (2012). For a discussion of the role of the euro in financial market integration, see Kalemli-Ozcan et al. (2010).

3 Channels of Risk Sharing in the Eurozone

3.1 Empirical framework

In the benchmark model with one tradeable good, the (optimal) full risk sharing allocation implies that idiosyncratic consumption growth rates are not affected by other idiosyncratic shocks such as changes in income or output (see, e.g., Cochrane (1991)). Now consider the coefficient β_U in the panel regression

$$\Delta \log \frac{C_t^k}{C_t^*} = \beta_U \left[\Delta \log \frac{GDP_t^k}{GDP_t^*} \right] + \tau_{Ut} + \delta_U^k + \varepsilon_{Ut}^k, \tag{1}$$

run on a sample of representative agents (countries in our case), where C_t^k is real per capita consumption in country k in period t, GDP_t^k is real country output ('gross domestic product') per head and the asterisk denotes the aggregate per capita average of the respective variable. The terms τ_{Ut}, δ_U^k, and ε_{Ut}^k stand for time- and country-fixed effects and an error term, respectively. Under full risk sharing, β_U should then be zero. More generally, we can think of the estimate of β_U as the amount of uninsured idiosyncratic output risk faced by the average country in our sample. In empirical data, the estimated value of β_U is regularly between 0 (no risk sharing) and unity (full risk sharing). The coefficient β_U in (1) then tells us how much of the idiosyncratic risk faced by the average country remains uninsured and $1 - \beta_U$ can be interpreted as the share of the average country's idiosyncratic output risk that gets diversified away.

To better understand what drives departures from the full-risk sharing allocation, we also want to know *how* risk sharing is achieved. Sorensen and Yosha (1998) have adopted a framework proposed by Asdrubali et al. (1996) that allows us to explicitly identify several broad channels of international risk sharing. Here, we refer to these channels as income smoothing, fiscal transfers smoothing, depreciation smoothing (of little interest because most depreciation is imputed), and consumption smoothing. The method of Asdrubali et al. (1996) is based on a decomposition of the cross-sectional variance of state output growth. To derive this decomposition, we rewrite country output growth as

$$\Delta\widetilde{gdp}_t^k = \left[\Delta\widetilde{gdp}_t^k - \Delta\widetilde{gni}_t^k\right] + \left[\Delta\widetilde{gni}_t^k - \Delta\widetilde{ni}_t^k\right] + \left[\Delta\widetilde{ni}_t^k - \Delta\widetilde{nndi}_t^k\right] + \left[\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k\right] + \Delta\widetilde{c}_t^k,$$

where $\widetilde{gdp}$, $\widetilde{gni}$, $\widetilde{ni}$, and $\widetilde{nndi}$ denote the logarithms of gross national product, gross national income, net national income, and net national disposable income of each country, divided by the aggregate value of the group of countries studied, respectively We will discuss these income concepts shortly. We focus on the idiosyncratic, country-specific component of all these variables, because the countries in the sample may face common shocks that cannot be insured by definition.[4] Taking the covariance with $\Delta\widetilde{gdp}_t^k$ on both sides and rearranging, we get

$$\beta_I + \beta_D + \beta_F + \beta_C = 1 - \beta_U,$$

where

$$\begin{aligned}
\beta_I &= cov(\Delta\widetilde{gdp}_t^k - \Delta\widetilde{gni}_t^k, \Delta\widetilde{gdp}_t^k)/var(\Delta\widetilde{gdp}_t^k),\\
\beta_D &= cov(\Delta\widetilde{gni}_t^k - \Delta\widetilde{ni}_t^k, \Delta\widetilde{gdp}_t^k)/var(\Delta\widetilde{gdp}_t^k),\\
\beta_F &= cov(\Delta\widetilde{ni}_t^k - \Delta\widetilde{nndi}_t^k, \Delta\widetilde{gdp}_t^k)/var(\Delta\widetilde{gdp}_t^k),\\
\beta_C &= cov(\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k, \Delta\widetilde{gdp}_t^k)/var(\Delta\widetilde{gdp}_t^k),\\
\beta_U &= cov(\Delta\widetilde{c}_t^k, \Delta\widetilde{gdp}_t^k)/var(\Delta\widetilde{gdp}_t^k).
\end{aligned}$$

The five coefficients β_I, β_D, β_F, β_C and β_U provide us with a decomposition of the cross-sectional variance of country-specific output growth. The coefficient β_U is the same as in the basic regression

[4]Normalizing by aggregate variables is an alternative to including time-fixed effects in the regressions—our results below are not sensitive to this choice.

(1) above and measures the fraction of a typical country output shock that remains unshared while the coefficients β_I, β_D, β_F and β_C provide a breakdown into the contribution of the different channels of risk sharing.

We refer to the first channel, captured by β_I, as income smoothing. Gross national income reflects all income flows to a country, whereas GDP measures the quantity of goods and services produced in the country. The wedge between the two variables is therefore a measure of net factor income flows and β_I measures to what extent these cross-country income flows systematically buffer a country's income against fluctuations in its output.

The difference between gross national income and national income yields capital depreciation, whereas the wedge between national income and disposable net national income represents international net transfers[5]. The coefficients β_D and β_F therefore indicate to what extent capital depreciation and fiscal transfers allow a country's residents to smooth disposable income after a shock to output.

Finally, country's residents or its government may save or dissave after observing their (disposable) income. We refer to this third channel as consumption smoothing, and we denote its contribution to overall risk sharing with β_C.

At a practical level, the pattern of risk sharing ($\boldsymbol{\beta}= [\beta_I, \beta_F, \beta_C, \beta_U]$) can easily be estimated from the four regressions

$$\begin{aligned} \Delta\widetilde{gdp}_t^k - \Delta\widetilde{gni}_t^k &= \delta_I^k + \beta_I \Delta\widetilde{gdp}_t^k + \varepsilon_{It}^k, \\ \Delta\widetilde{gni}_t^k - \Delta\widetilde{nndi}_t^k &= \delta_F^k + \beta_F \Delta\widetilde{gdp}_t^k + \varepsilon_{Ft}^k, \\ \Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k &= \delta_C^k + \beta_C \Delta\widetilde{gdp}_t^k + \varepsilon_{Ct}^k, \\ \Delta\widetilde{c}_t^k &= \delta_U^k + \beta_U \Delta\widetilde{gdp}_t^k + \varepsilon_{Ut}^k, \end{aligned} \tag{2}$$

where the coefficients δ_X^k and capture state-specific fixed effects. Note that the last equation is just the basic risk-sharing regression (1).

The set of regressions (2) assumes that $\boldsymbol{\beta}$ is time-invariant. However, in the next step we augment our setup (following Sørensen et al. (2007)) to allow the whole pattern of risk sharing to vary over time and across countries. We do so in two ways, first, we estimate the regressions in (2) as cross-sectional regressions at any given point in time t (of course, this does not allow us to identify fixed effects). This gives us a sequence of $\beta_X(t)$ where $X = I, C, U$ stands for the different channels where $\boldsymbol{\beta}$ varies over time. Secondly, we allow β_X to vary over time and across countries as a linear function of a vector of country-characteristics $\boldsymbol{z}_t^k$ such that $\beta_X = a_X + \boldsymbol{b'}_X \boldsymbol{z}_t^k$. Here, a_X measures the average amount of risk sharing obtained at channel X within the group, whereas the elements of the vector $\boldsymbol{b}_X$ yield the additional amount of risk sharing that country k obtains at time t due to the country- and time-specific variation in the corresponding elements of the vector $\boldsymbol{z}_t^k$.

Specifically, we parametrize $\boldsymbol{\beta}$ as

$$\beta_{Xt}^k = a_X + b_X \times \left(TB_{t-1}^k - \overline{TB}_{t-1} \right), \tag{3}$$

[5]We include this channel for the completeness of variance decomposition, but will skip them in our analysis due to the focus on the financial markets channels.

where TB_{t-1}^k measures total cross-border lending in country k and at time $t-1$ (relative to GDP), $\overline{TB}_{t-1}$ is the average across countries of TB_{t-1}^k at time $t-1$. The pattern of risk sharing is allowed to vary freely with cross-border bank lending. For example, $a_I + b_I \times \left(TB_{t-1}^k - \overline{TB}_{t-1}\right)$ measures the amount of income smoothing obtained by country k in period $t-1$ with total cross-border lending TB_{t-1}^k. The parameter b_I measures how much higher-than-average bank lending increases the amount of income smoothing obtained.

We perform an analogous analysis using the sub-components of total bank lending: bank-to-bank cross-border lending ($B2B$) and bank-to-nonbank cross-border lending ($B2N$) or both (again normalized with GDP). In these cases $\beta_{Xt}^k = a_X + b_X \times \left(B2B_{t-1}^k - \overline{B2B}_{t-1}\right)$, $\beta_{Xt}^k = a_X + b_{1X} \times \left(B2N_{t-1}^k - \overline{B2N}_{t-1}\right)$ or $\beta_{Xt}^k = a_X + b_{1X} \times \left(B2B_{t-1}^k - \overline{B2B}_{t-1}\right) + b_{2X} \times \left(B2N_{t-1}^k - \overline{B2N}_{t-1}\right)$ respectively.

3.2 Data

We use quarterly data for gross domestic product, gross national product, net national disposable income, and consumption from Eurostat for the period 1998-2013. Our main group of countries is limited to 10 long-standing EMU-member countries due to data availability and we exclude from the EMU sample Ireland and Luxembourg because of the particular structure of capital flows in these financial hubs.[6] As a control group, we use non-EMU countries that are members of the EU. We calculate real per capita values of $\widetilde{gdp}$, $\widetilde{gni}$, $\widetilde{nndi}$ and $\widetilde{c}$ by deflating with the respective national harmonized index of consumer prices (HICP) and using population data from the same source. Since quarterly data can be very noisy, we look at annual growth rates of these variables by taking differences between quarter t and $t-4$, so that $\Delta x = \frac{x_t - x_{t-4}}{x_{t-4}}$ for $x = \left[\widetilde{gdp}, \widetilde{gni}, \widetilde{nndi}, \widetilde{c}\right]$ throughout the paper. Our measures of cross-border total, bank-to-bank, and bank-to-non-bank lending (by all reporting countries) for each of the countries in our sample are from the locational banking statistics of the Bank for International Settlements (BIS). We normalize these data by GDP of the receiving country.

3.3 Empirical results

We start by presenting evidence on the risk sharing channels before and after the financial crisis. Table 1 provides the results of the channels decomposition 2, for both EMU and non-EMU countries. The first line presents results for the entire sample period 1998–2013. As is apparent, 80% of shocks to output remain uninsured across EMU countries. Whereas cross-country factor income flows contribute about seven percent to cross-country risk sharing, savings and dissavings smooth 23% of shocks. Fiscal smoothing only plays a very limited role over the entire sample period, as does the depreciation channel. Note that in "non-EMU Europe," there is almost no risk sharing among the countries during this period.

In the second and third lines, we split the sample and focus on the first decade of the euro (1999-2008), and the European sovereign debt crisis and its aftermath (2009-2013), respectively. A salient feature of these results is that, among EMU countries, there is a clear drop in risk sharing after 2008. Before 2008, almost 60% of idiosyncratic output risk was shared among EMU members, after 2008 this fraction drops to less than 20%. Turning to the channels that drive this freeze in risk sharing, we find that, in percentage points, it is mainly the drop in *ex post* consumption smoothing that accounts for almost 20

[6] The countries in the EMU sample are Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal and non-EMU Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Sweden, and the UK.

percentage points of this decline. Again, we find the fiscal channel to be essentially dormant in both subperiods, while the depreciation channel accounts for most the remaining decline in risk sharing.[7] The panel regressions in Table 1 also shows a slight drop in income smoothing, but income smoothing on the individual subperiods is too imprecisely estimated to interpret this finding any further.

We therefore conclude that the decomposition of risk sharing into channels presented in Table 1 reveals a clear drop in international risk sharing among EMU countries after the crisis and that this drop is associated with a considerable decline of consumption smoothing. This pattern is also revealed by the results obtained from the period-by-period cross-sectional risk sharing regressions for income and consumption smoothing that we report in Figure 1: consumption smoothing drops sharply during the crisis while income smoothing remains stable at a low level.

In trying to understand these patterns, our analysis focuses on the possibility that direct (bank-to-nonbank) flows affect risk sharing differently and through different channels than indirect (interbank) flows. We document the empirical facts here, and the next section provides a model that helps us to understand them in a more structural way. Specifically, we will argue that prior to 2008, the longer-term trends in banking integration improved risk sharing outcomes, and that this happened mainly through direct cross-border lending. Conversely, during the crisis, financial market seized and risk sharing collapsed, mainly through a collapse in consumption smoothing. We illustrate these points in Tables 2 and 3.

Panel A of Table 2 displays the amount of income and consumption smoothing and the fraction of shocks left unsmoothed as a function of cross-border bank lending for the EMU countries for the period prior to 2009. The key innovation relative to earlier studies is that we look at the risk sharing implications of international bank lending and, in particular, of the distinction between direct (bank-to-nonbank) and indirect cross-border (interbank) lending. The regression in the first three columns consider total banking flows (relative to GDP). The first result is that higher cross-border banking liabilities relative to GDP are indeed associated with higher risk sharing. Interestingly though, cross-border bank liabilities impact risk sharing primarily via the income smoothing channel, not via consumption smoothing. This pattern is in line with the findings in Demyanyk et al. (2007), and Hoffmann and Shcherbakova-Stewen (2011a) for the United States. It is, however, also somewhat surprising because it seems to question the conventional interpretation of the income and consumption smoothing channels as mainly being associated with capital and credit markets, respectively.

The second and third blocks of channel regressions (columns 4-6 and 7-9 respectively) provide similar results, but now we break down total cross-border liabilities into their bank-to-bank ($B2B$) and bank-to-nonbank ($B2N$) components, respectively. The results obtained for these sub-components are very similar to those obtained for the total: cross-border banking liabilities are associated with higher risk sharing and mainly so through the income smoothing channel. The last block of channel regressions (columns 10-12) considers both ($B2B$) and ($B2N$) in one regression. Here, it becomes apparent that direct cross-border liabilities account for the positive impact of banking integration on income smoothing. Interbank positions are no longer positively associated with risk sharing once we control for direct positions. In fact, the estimated coefficient on the *ex post* channel turns negative.

[7] In the sequel of empirical analysis as well as in our theoretical model, we abstain from examining these channels any further. As we see in the data, the fiscal channel is of very limited importance in our sample. As regards the depreciation channel, its procyclicality during the crisis is to a large extent a mechanical function of past capital investments.

Panel B of Table 2 provides the results for data from the period 2009–13. During the crisis-period the drop in private cross-border interbank lending was partially offset in many southern European countries by the provision of emergency liquidity assistance to local banks by the European Central Bank (ECB). These official flows find their direct reflection in widening TARGET 2-Balances within the eurozone. In our post-2008 regressions we therefore also include (the negative of) a country's TARGET 2 balance, scaled by GDP, as a potentially important control variable in our set of interactions. It turns out that countries with higher Target 2 liabilities did obtain less risk sharing, and this mainly via the consumption smoothing channel. This is likely a case of reverse causality and should not be interpreted to mean that TARGET 2 was detrimental to risk sharing.[8] All coefficients on direct and interbank positions are insignificant during that period. Overall, the post-2008 data appear to offer too little cross-sectional variation for us to make any conclusions concerning the determinants of risk sharing during that period based on our regressions which are set up to emphasize differences in risk sharing between countries.

The upshot of the results in Table 2 is that the risk-sharing benefits from cross-border banking liabilities are mainly associated with direct lending, at least during the pre-crisis period. Once direct lending is controlled for, interbank lending does not seem to have a positive impact on risk sharing and, if anything, seems to be associated with lower risk sharing. Another key feature of the results for this period is that the impact of direct lending on risk sharing mainly works through the income smoothing channel. This is very similar to what we would expect to be the impact of equity diversification on risk sharing to be. To understand this pattern better, Table 3 compares the impact of banking flows on risk sharing to that of equity.

The first three columns confirm the intuition that countries with higher equity (portfolio) claims relative to GDP indeed experience more risk sharing and, specifically, more income smoothing.[9] This pattern remains unchanged once we add interbank liabilities into the regression. As before, interbank liabilities themselves do not have a significant impact on risk sharing. Once we include both equity and direct cross-border banking positions into the risk sharing regressions, we see that the estimate of the marginal effect on income smoothing is of similar magnitude for direct banking liabilities and equity claims but both coefficients now seem imprecisely estimated. This happens because of collinearity between equity assets and direct banking liabilities. We therefore also run a fourth set of regressions, in which we include the sum of equity claims and direct banking liabilities which turns out to be highly significant. We interpret these regressions as evidence that, during the pre-crisis period, it is impossible to identify the risk sharing effects of direct cross-border bank lending and equity positions separately. Instead, there is an important common component driving the cross-sectional heterogeneity in these two variables.

4 A theoretical model

We construct a model in order to highlight the interactions between equity market integration and banking integration in the form of either bank-to-bank or bank-to-real sector. The purpose of the model is to study the effects of financial integration, rather than to determine the optimal extent of financial integration, so we take equity and banking market integration as exogenous while global banks face exogenous funding

[8] In our regressions, the build-up of TARGET 2 liabilities essentially acts like a dummy that identifies crisis from non-crisis countries.

[9] Results for FDI claims or the sum of FDI and portfolio claims are qualitatively similar

shocks. The model has several layers of financial frictions that interact with equity and banking market integration to generate the patterns we observe in the data. First, firms need to pre-finance investment and wages. Second, to obtain finance, firms have the choice between bank loans and other more expensive loans (which we do not model in detail). Third, firms cannot costlessly substitute between loans provided by local and global banks. Fourth, local banks face costs of substituting interbank funding for deposits. While these features of the model are stylized and introduced in a deliberately *ad hoc* fashion, the model provides an interpretation of the data; in particular, the model interprets the patterns in risk sharing through the channels identified from our empirical regressions.

Agents and markets

There are two small open countries in our model, each populated by a representative household, a firm, and a local bank. Additionally, there is a global bank, which operates in the two countries and has access to wholesale funding in the rest of the world (e.g., the U.S. money market).

Firms A representative firm in each country has the production function

$$Y_t = \theta_t (K_{t-1})^{\alpha} (N_t)^{1-\alpha},$$

where Y_t ,θ_t, K_{t-1}, N_t, and α denote output, total factor productivity, capital (at the end of the previous period), labor, and capital intensity, respectively. Firms operate in a perfectly competitive environment, and maximize the present discounted value of their profits (dividends):

$$\max_{\{N_t,\ K_t,\ L_t\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \Lambda_{0:t}^{firm} \text{DIV}_t \right],$$

where $\Lambda_{t:t+l}^{firm}$ is the household stochastic discount factor (SDF) at horizon l, being a weighted average of SDFs of the home and the foreign households (as determined by the respective Euler equations). Total dividends are defined as:

$$\text{DIV}_t = Y_t - W_t N_t - \left(I_t + \varphi_t^I \right) + L_t - L_{t-1}(1 + r_{t-1}^l) - \widetilde{L}_t \iota,$$

where W_t is wages, I_t is investment, L_t is total bank borrowing, and r_t^l is the net effective interest rate, $\widetilde{L}_t$ is borrowing from other sources (about which we are not specific), and $\boldsymbol{\iota}$ is the net interest rate on this borrowing.[10] The law of motion for aggregate capital is given by $K_t = (1 - \delta_t) K_{t-1} + I_t$, and both capital and investment are produced out of the final good.[11] Given a quadratic adjustment cost in investment; i.e., $\varphi_t^I = \frac{1}{2} \varphi^I K_{t-1} \left(\frac{I_t}{K_{t-1}} - \delta \right)^2$, this setup leads to a standard Tobin's Q equation for the price of capital: $Q_t = 1 + \varphi^I \left(\frac{I_t}{K_{t-1}} - \delta \right)$.

Firms need to borrow in order to finance their operating expenses; i.e., the wage bill and investment. We assume that only a fraction, ϕ, can be satisfied with bank credit while the remaining fraction, $(1 - \phi)$, needs to be raised by the firm from other sources. These sources could be the firm's own internal cash

[10] We normalize the price of the goods to unity in both countries, assuming that the law of one price holds.

[11] We choose a pro-cyclical rate of depreciation, of functional form: $\delta_t = \delta + 0.08 \Delta \log Y_t$, for the model to match the amount of risk-sharing achieved by this channel in the data.

holdings or direct injection of funds by the owner of the firm. In our model here, we assume that households directly injects these funds but can only do so at an (exogenous) penalty rate of interest ι that is always higher than the cost of bank credit. The identity for external finance is thus

$$L_t + \widetilde{L}_t = W_t N_t + I_t,$$

where $L_t = \phi \left(W_t N_t + I_t \right)$ and $\widetilde{L}_t = (1 - \phi) \left(W_t N_t + I_t \right)$. ϕ measures the degree of credit availability (banking integration) in the economy and higher ϕ leads to overall lower cost of funds, given high ι.

Regarding bank loans, we posit the following bank borrowing technology:

$$L_t = \left(\tau^{\frac{1}{\nu}} L_t^{\mathrm{GB}\,\frac{\nu-1}{\nu}} + (1-\tau)^{\frac{1}{\nu}} L_t^{\mathrm{LB}\,\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}},$$

where L_t^{GB} and L_t^{LB} are firm borrowing from global and local banks, respectively, and τ captures the degree to which firms depend on local bank credit (lower τ translating into higher dependence). Firms decide how much to borrow from global and local banks by minimizing the expected repayment $L_t \left(1 + r_t^l\right) = L_t^{\mathrm{GB}} \left(1 + r_t^{l,\mathrm{GB}}\right) + L_t^{\mathrm{LB}} \left(1 + r_t^{l,\mathrm{LB}}\right)$, subject to the borrowing technology.[12]

This setup implies that loans from local and global banks are imperfect substitutes, with an elasticity of substitution being captured by the parameter ν. This is meant to reflect that global and local banks have different business models. Large international banks engage mainly in arm's-length lending, while local banks engage mainly in relationship-lending.[13]

Banks In each country, there is a local (domestic) bank. Additionally, local households own a constant fraction, μ^{GB}, of the global bank. Local banks fund themselves by borrowing from global banks and by raising deposits, while global banks have access to funds in a global money market (which we do not model). This setup is meant to reflect the structure of the "double-decker" banking integration that was characteristic for the Eurozone in the years before the crisis, as documented by Bruno and Shin (2015) and Hale and Obstfeld (2014). In particular, big French, German, and Dutch banks borrowed in the U.S. money market, while Southern European local banks borrowed short-term from the global northern European banks.

The *local bank* is owned by households and maximizes expected discounted profits (dividends, $\mathrm{DIV}_t^{\mathrm{LB}}$) by lending to local firms and funding itself from deposits and through borrowing cross-border from the global bank. Its objective is:

[12] A similar approach to modeling the demand for loans is used by Gerali et al. (2010). However, they do not distinguish between different bank types, which is one of the main distinct features of our model. Note also, that under the CES assumption, effective funds available to firms for productive purposes (L_t) are less than or equal to the sum of loans extended to them by local and global banks ($L_t^{\mathrm{GB}} + L_t^{\mathrm{LB}}$). We interpret this discrepancy as an implicit borrowing cost.

[13] The relationship-based business model arguably gives local banks a comparative advantage in lending to relatively opaque borrowers such as SMEs, which constitute a large fraction of firms in the countries in our sample—ca. 60% on average, measured by value added. Long-term relationships with local banks allow firms to borrow even in circumstances in which arms-length lenders might not provide credit. However, during a long-term relationship local banks acquire information about the firm which leads to the well-known hold-up problem (Sharpe (1990) and Petersen and Rajan (1994)), which makes it difficult for the borrowing firm to move away from the local bank. These considerations suggest that loans from global and local banks are imperfect substitutes from the point of view of the borrowing firm, and the borrowing technology captures this imperfect substitutability in reduced form.

$$\max_{\left\{L_t^{\text{LB}},\ D_t^{\text{LB}},\ M_t\right\}_{t=0}^{\infty}} \mathbb{E}_0\left[\sum_{t=0}^{\infty}\Lambda_{0:t}\text{DIV}_t^{\text{LB}}\right].$$

The local banks' total lending consists of loans to firms, while it raises funds, M_t, in the interbank market and accepts deposits, D_t^{LB}, so that its balance sheet identity is

$$L_t^{\text{LB}} = M_t + D_t^{\text{LB}}.$$

Profits are disbursed as dividends at the beginning-of-next period and are given by:

$$\text{DIV}_t^{\text{LB}} = \Pi_{t-1}^{\text{LB}} = L_{t-1}^{\text{LB}} r_{t-1}^{l,\text{LB}} - M_{t-1} r_{t-1}^{m} - D_{t-1}^{\text{LB}} r_{t-1}^{d} - \varphi_{t-1}^{D,\text{LB}},$$

where the last term, $\varphi_t^{D,\text{LB}}$, is a quadratic "adjustment cost" in deposits.[14] This term reflects the difficulty for banks to undergo short-term changes in their funding structure, i.e., the relative importance of interbank funding and deposits. In the presence of asymmetric shocks to loan demand, these adjustment costs lead to different deposit rates between the two countries. From the point of view of households in the two countries, this drives a wedge between their respective stochastic discount factors and, hence, between expected consumption growth paths.

The *global bank* in our model provides funds to firms in both countries, but additionally lends in the interbank market. It holds equity and refinances itself through wholesale funding in the global interbank market. Its objective is to maximize expected discounted dividends:

$$\max_{\left\{L_t^{\text{GB}},\ L_t^{\text{GB}^*},\ M_t,\ M_t^*,\ E_t\right\}_{t=0}^{\infty}} \mathbb{E}_0\left[\sum_{t=0}^{\infty}\Lambda_{0:t}^{\text{GB}}\text{DIV}_t^{\text{GB}}\right],$$

where (*) indicates the foreign country. $\Lambda_{t:t+l}^{\text{GB}}$ is the stochastic discount factor at horizon l, used by the global bank to discount future dividend. Because the global bank is owned in constant proportions by the home and foreign households, we assume that the discount factor is equal to the weighted average of the discount factors of the two countries, using ownership shares as weights. With these assumptions, the bank's consolidated balance sheet is given by:

$$L_t^{\text{GB}} + L_t^{\text{GB}^*} + M_t + M_t^* = B_t + E_t,$$

where L_t^{GB} is the bank's financing of the real sector, M_t is lending to local banks in the interbank market, and E_t is bank equity. With this notation, the global bank's (end-of-period) profits are given by

$$\Pi_t^{\text{GB}} = \left(L_t^{\text{GB}} + L_t^{\text{GB}^*}\right) r_t^{l,\text{GB}} + \left(M_t + M_t^*\right) r_t^{m} - B_t r_t^{b} - \varphi_t^{E} + E_t,$$

where φ_t^E is a quadratic adjustment cost function for equity. This quadratic cost of equity makes it more attractive for the global bank to adjust assets rather than equity in order to adjust leverage. This is consistent with Adrian and Shin (2014) who show that, at least in the years before the crisis, global

[14] Let X_t denote the relative deviation from the steady state, i.e. here $X_t = \frac{D_t^{\text{LB}} - D^{\text{LB}}}{D^{\text{LB}}}$. Then, throughout the paper, the adjustment cost functions have the form $\varphi_t^X(X) = \varphi^{X'}\bar{X}X_t + \frac{1}{2}\varphi^{X''}X_t^2$,where $\bar{X}$ is the steady-state level of X. Adjustment costs are defined similarly for X_t referring to deposits in the other country and for equity.

banks adjusted leverage mainly via changes in risk weighted assets (RWA_t). The bank's equity evolves according to

$$E_t = \Pi_{t-1}^{\mathrm{GB}} - \mathrm{DIV}_t^{\mathrm{GB}},$$

where $\mathrm{DIV}_t^{\mathrm{GB}}$ denotes dividends paid out by the global bank and, in our model, the need for the global bank to hold equity arises due to a leverage constraint of the form

$$\frac{E_t}{RWA_t} = \kappa^E.$$

κ^E is a given constant and RWA_t are the bank's risk-weighted assets, which in our case are given by:

$$RWA_t = \gamma^L \left(L_t^{\mathrm{GB}} + L_t^{\mathrm{GB}^*} \right) + \gamma^M \left(M_t + M_t^* \right),$$

and where γ^L and γ^M are the risk weightings associated with real-sector and bank-to-bank loans, respectively. The leverage constraint must hold with equality. We can think of it as being directly imposed by the regulator or as the reflection of a value-at-risk (VaR) constraint.[15]

Given adjustment costs in equity, the global bank primarily funds itself through wholesale borrowing B_t in the global interbank market at net rate r_t^b. In our model, direct lending to firms will yield a higher interest than lending interbank market. The risk weights on interbank and firm-lending therefore crucially determine the composition of the asset side of the global banks' balance sheet. With a binding leverage constraint, the bank will need to economize on its risk taking capacity when liquidity B_t is increasing, shifting relatively more liquidity in to the interbank market. Conversely, when facing a sudden exogenous drop in liquidity (as happened during the financial crisis) this would tend to lower the banks leverage ratio, which cannot be optimal for a profit-maximizing bank. The bank will therefore shift its scarce funds to firm lending, which yields higher returns (but is also penalized with higher risk weighting), thus ensuring that the leverage constraint binds.

Households Households consume goods, produced in both countries, supply labor to firms, and receive dividends (profits) from the firms and banks they own. They maximize their lifetime utility, given by:

$$\max_{\{C_t,\ N_t,\ D_t\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{{C_t}^{1-\sigma} - 1}{1-\sigma} - \Psi \frac{N_t^{1+\psi}}{1+\psi} \right) \right],$$

where β is the discount factor, σ is the coefficient of risk aversion, ψ is the inverse of Frisch elasticity, and Ψ is the weight of labor disutility. Total labor, supplied by the household, is denoted by N_t and is immobile across country borders, while C_t represents consumption of the (tradeable) good. We assume that the international cross-ownership of firms is captured by a parameter, λ, which measures an exogenously given degree of capital market integration between the home and the foreign country. Specifically, $(1-\lambda)$ measures the exposure to the home firms productive process, and $\mu = \frac{\lambda Y}{\lambda Y + \lambda^* Y^*}$ is the ratio of shares that the home household owns in a world mutual fund. There will be home bias, if the share λ is lower than the country's share of production.

The household's flow budget constraint is given by

[15] As shown by Shin (2012), VaR constraints have the reduced form implication that a risk-neutral, profit-maximizing bank will seek to implement a constant risk weighted leverage ratio.

$$C_t + D_t = W_t N_t + D_{t-1}(1 + r^d_{t-1}) + \widetilde{L}_t \iota$$
$$+ (1-\lambda)\text{DIV}_t + \mu(\lambda \text{DIV}_t + \lambda^* \text{DIV}^*_t) + \text{DIV}^{\text{LB}}_t + \mu^{\text{GB}} \text{DIV}^{\text{GB}}_t,$$

where $D_t = D^{\text{LB}}_t$ is the holding of household deposits earning net interest r^d_t, $W_t N_t$ is the total wage received by the household, μ^{GB} is the share of the global bank owned by the home household, and $\widetilde{L}_t \iota$ the interest on providing within-period non-bank financing to the firm (taken as given).

Market clearing Goods markets in each country clear according to:

$$Y_t = C_t + I_t + \Gamma_t + NX_t,$$

where Γ_t is total net costs present in the model, which therefore can be thought of as part of gross real investment.[16] Here, NX_t is total net exports of each country, such that the market clearing condition for the whole world requires:

$$NX_t + NX^*_t = B_{t-1}(1 + r^b_t) - B_t,$$

i.e., the sum of net exports of the both countries has to be equal to the net capital flows to the rest of the world, intermediated by the global bank.

Further definitions Aggregate GDP in the model is $\text{GDP}_t = Y_t$. The current account of each country is given by $CA_t = -\left(\Delta M_t + \Delta L^{\text{GB}}_t\right) + \mu^{\text{GB}} \Delta E_t$, such that $CA_t + CA^*_t = -\Delta B_t$.

Given these definitions, and realizing that the difference between the current account and the net exports is equal to the net interest payments from abroad, the gross national income (GNI) is defined as $\text{GNI}_t = \text{GDP}_t + CA_t - NX_t$. The net national income (NNI) is then defined as the GNI net of depreciation of capital stock, namely $\text{NNI}_t = \text{GNI}_t - \delta_t K_{t-1}$. Absent fiscal transfers in our model, NNI coincides with net national disposable income (NNDI). To reproduce empirical results, we also introduce a proxy for the cross-border ownership of foreign assets by defining $E^{ex}_t = \mu \lambda^* K^*_{t-1}/12$, i.e., the proportion of the foreign capital that the home country owns through the world mutual fund, divided by twelve.[17]

Calibration We calibrate our model to replicate the channels of risk sharing regressions in Table 1. Details of the calibration are available in the technical appendix. We then ask if our model is able to quantitatively reproduce the cross-sectional link between international equity and banking positions and risk sharing that we have documented in Tables 2 and 3.

5 Quantitative results from the model

To show how well our model calibration matches the data, we run the channels decomposition reported in Table 1 on model-generated data. The results are presented in Table 6. To match the drop in consumption

[16] In our model, Γ_t is composed of intermediation costs for credit, implicit borrowing costs $\left(L^{\text{GB}}_t + L^{\text{LB}}_t - L_t\right)$, and all adjustment costs.

[17] The scaling is inessential for model dynamics, but allows us to match the mean of the model variable E^{ex}_t to its empirical counterpart.

smoothing that we find in the data and in Figure 1, our model requires an increase in financial frictions during the crisis period over and above the drop in global liquidity. In our calibration, we achieve this by assuming that deposit adjustments costs in the crisis period are higher than in the precrisis-period. Otherwise, the calibration of the model is the same across periods. Comparing Table 6 to Table 1 shows that we match the risk sharing patterns in the EMU very closely. Table 6 reports the model generated estimates of income smoothing, consumption smoothing, and fraction not smoothed. In tranquil times, see the row labeled 1998-2008, 8% of shocks are smoothed by international income flows, 49% are smoothed via countercyclical saving, and 43% are unsmoothed. This pattern of risk sharing is very similar to the empirical estimates found for the EMU10 prior to the crisis. During crisis times, as reported in Table 6 in the row labeled 2009-2013, income smoothing collapses to zero, while consumption smoothing drops sharply to 30%, leaving 80% of shocks unsmoothed—these results are also very similar to those obtained in EMU10 during the crisis.

Table 7 display regressions on model generated data allowing for interactions with international bank-to-bank lending and bank-to-nonbank lending in Panel A, with an interaction for equity market integration added in Panel B. To the extent that the regressions on model generated data match the results in Tables 2 and 3, in which risk sharing patterns vary as a function of banking and equity positions, the model provides an interpretation of the empirical results. The results in Table 7 show that our model can indeed explain the empirical findings. From the first columns of Panel A, we see that total banking integration is not associated with more risk sharing and, from the next set of regressions, neither is bank-to-bank lending. Bank-to-nonbank lending is, as in the data, associated with significantly more income smoothing. As in the data, the point estimate on consumption smoothing is negative (though insignificant). This partly reflects that the coefficients sum to unity (when depreciation is included). When income is more smoothed there is less scope for smoothing of consumption (all relative to GDP).[18] The salient feature of our empirical results was that direct banking integration impacts risk sharing in an equity-like manner by leading to more income smoothing. Indeed, this is also what we find in the model-generated data for the pre-crisis period: direct banking integration increases income smoothing, as does equity market integration. Conversely, interbank positions are not strongly linked to risk sharing.

In Panel B, we see in the first column that income risk sharing is increasing in equity holdings with high statistical significance: cross-ownership of assets is, as in the basic theoretical models the vehicle of income smoothing (although interest payments also provides income flows across countries). Bank-to-bank lending still has little impact on risk sharing, in the second block of columns, while bank-to-nonbank lending, in the third block of columns, is correlated with equity risk sharing, so that the coefficient on the later declines when the bank-to-nonbank interaction is included. In the last block of regressions, we add equity to bank-nonbank-lending as in the empirical regressions, and as for this interacted regressor, we obtain a more precisely estimated coefficient as with the data, although the value of 36% is slightly lower than the corresponding coefficient estimated from the data.

For the crisis period, we also re-estimated the regressions in Tables 2 and 3, but we do not tabulate the

[18]This finding of a negative coefficient of direct banking integration on consumption smoothing mirrors the findings in Hoffmann and Shcherbakova-Stewen (2011b), who also document a shift from consumption smoothing towards income smoothing following state-level banking deregulation in the United States. While they do not find that consumption risk sharing increases overall, they argue that it becomes more resilient against aggregate downturns – exactly because of the shift towards more income smoothing.

results, which mimic those in panel B of Table 2 in that the coefficients are much smaller and insignificant. In our model, this can be explained by the large global liquidity shock which is common across countries and makes a larger share of the variability common to the countries so that it becomes impossible to identify the cross-sectional link between banking positions and risk sharing in the short sample. Hence, the model also allows us to understand why our empirical regressions appear unstable during the crisis period.

Having validated that our model is able to capture the patterns of risk sharing since the inception of the euro, we use it to study how banking and equity market integration interact in providing more risk sharing. Specifically, we ask the following question: having calibrated the model to match the direct banking and equity market integration in the individual EMU-countries, how would the patterns of risk sharing in the eurozone change if we increased (lowered) each country's foreign equity holdings or its level of direct banking integration? The results, presented in Table 8, reveal that in our model banking integration and equity integration are complements. For a given level of equity market integration, increasing direct banking integration from 20 percent below to 20 percent above current levels would increase risk sharing through income smoothing channel. However, the marginal impact of the increase in banking integration increases with the level of equity market integration. The same is true in converse: increasing equity market integration from 50 percent below to 50 percent above current levels has a considerably bigger impact of risk sharing if banking integration is already high.

To understand the mechanism underlying this complementarity more closely, in Figure 3, we inspect the model impulse responses of an idiosyncratic TFP shock to GDP, consumption, dividends, and the ratio of GDP to GNI (i.e. the income smoothing channel) under the four regimes: (1) low banking integration and low equity integration – blue lines with (x); (2) high banking integration and low equity integration (green lines with (*)); (3) low banking integration and high equity integration (red lines with (x)); (4) high banking integration and high equity integration (orange lines with (*)). The foreign country is kept the same in all simulations with $\phi = 0.65$ and $\lambda = 0.45$. The figure shows that the response to GDP is very similar in all four scenarios. However, the consumption responses to this shock are clearly different, with the high-banking/high-equity market integration scenario being the one with the most muted consumption response. The impulse responses of dividends and the income smoothing channel show why this is the case: moving from low to high banking integration makes dividends considerably more volatile, irrespective of the degree of equity market integration. This happens because banking integration in our model essentially reflects a shift from (prohibitively expensive) within-period (i.e. short-term) finance to bank loans with a one-period maturity. Because the firm finances current wages and investment with a one-period loan (and with loan repayments from the last period pre-determined), its dividends become more volatile and more procyclical with banking integration. For a given level of equity integration, higher (idiosyncratic) volatility of dividends implies more risk sharing through the income-smoothing channel. Conversely, as shown by the impulse response of the GDP/GNI ratio, the effect of increasing equity market integration on income smoothing will be higher, the higher the (idiosyncratic) volatility of dividends.

6 Conclusion

EMU was a major step towards deeper financial integration among member states. However, integration did not quite proceed in the way many observers had expected: international diversification of equity portfolios remained limited and did not increase more than in other parts of the world. Bond market integration mainly affected sovereign bond markets and large corporations. We showed that in Europe's bank-based financial system, the nature of banking integration is of first-order importance for understanding the patterns and channels of risk sharing during the Euro's first decade as well as for understanding how well various channels of risk sharing performed during the Eurozone crisis. While EMU was associated with the creation of an integrated interbank market, as witnessed by an explosion in cross-border interbank flows, real banking integration (in terms of bank-to-real sector flows or cross-border consolidation of banks) remained very limited. We find that direct (i.e., bank-to-real sector) integration has significant risk sharing benefits—mainly via its impact on income smoothing—while indirect integration does not. Interbank flows were highly procyclical during the global financial and European sovereign debt crises and we show that the collapse in interbank markets contributed to the breakdown in risk sharing, mainly by making it impossible for households to smooth consumption. The uneven nature of banking integration in the eurozone contributed significantly to the freeze in risk sharing after 2008.

To understand these patterns, we put forward a stylized DSGE model in which firms and banks face financial frictions and where there is incomplete equity market integration. In the model, firms have to pre-finance wage payments and investment using either longer-term bank loans or using costly short-term finance from other sources. Because current wage payments and investments are financed from fresh loans while the repayment of past loans is pre-determined, banking integration increases the volatility and procyclicality of firm profits (dividends) in response to idiosyncratic productivity shocks. Hence, for any given level of international equity portfolio diversification, we then see a bigger relative role for income smoothing. This explains why banking integration leads to more income smoothing in tranquil times, such as the period before 2008, when small idiosyncratic shocks arguably prevailed.

We argue that, during the crisis period after 2008, the data were dominated by a global banking shock that lead to a breakdown in interbank markets. In our model, a global shock to interbank markets hits local banks which try to substitute wholesale funding for deposits. This drives up domestic interest rates, making *ex post* consumption smoothing very expensive for households. It is this feature of our model that drives the breakdown in risk sharing during a crisis, again consistent with the data.

Our theoretical framework features an important interaction between capital (equity) market and banking integration that has, to our knowledge, not been discussed in the previous literature. Specifically, the model and our empirical findings suggest that capital market union and banking union are complements and that for further integration of the eurozone to be successful, both unions need to be completed. At the same time, the model and the data illustrate that the risk sharing benefits from banking integration are only robust to large global financial shocks if banking integration is sufficiently deep; i.e., focused on cross-border lending between banks and the real sector (or on cross-border bank consolidation) and not predominantly on cross-border interbank lending.

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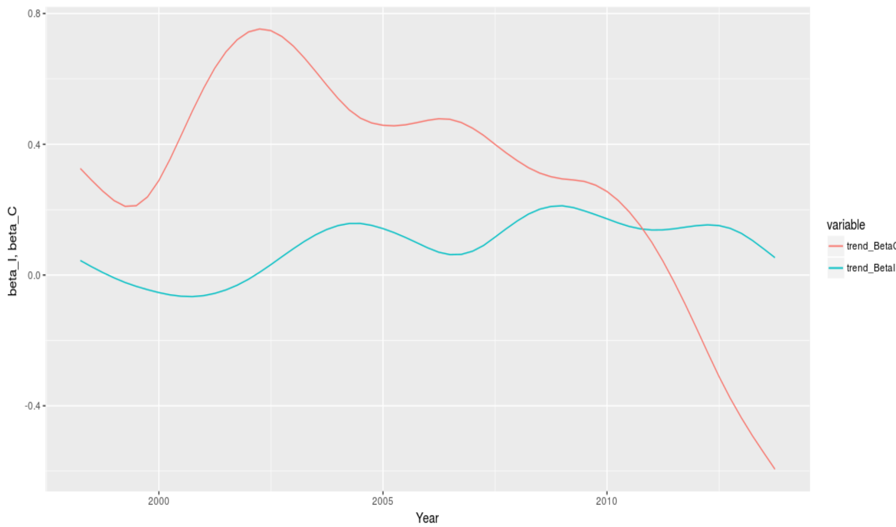
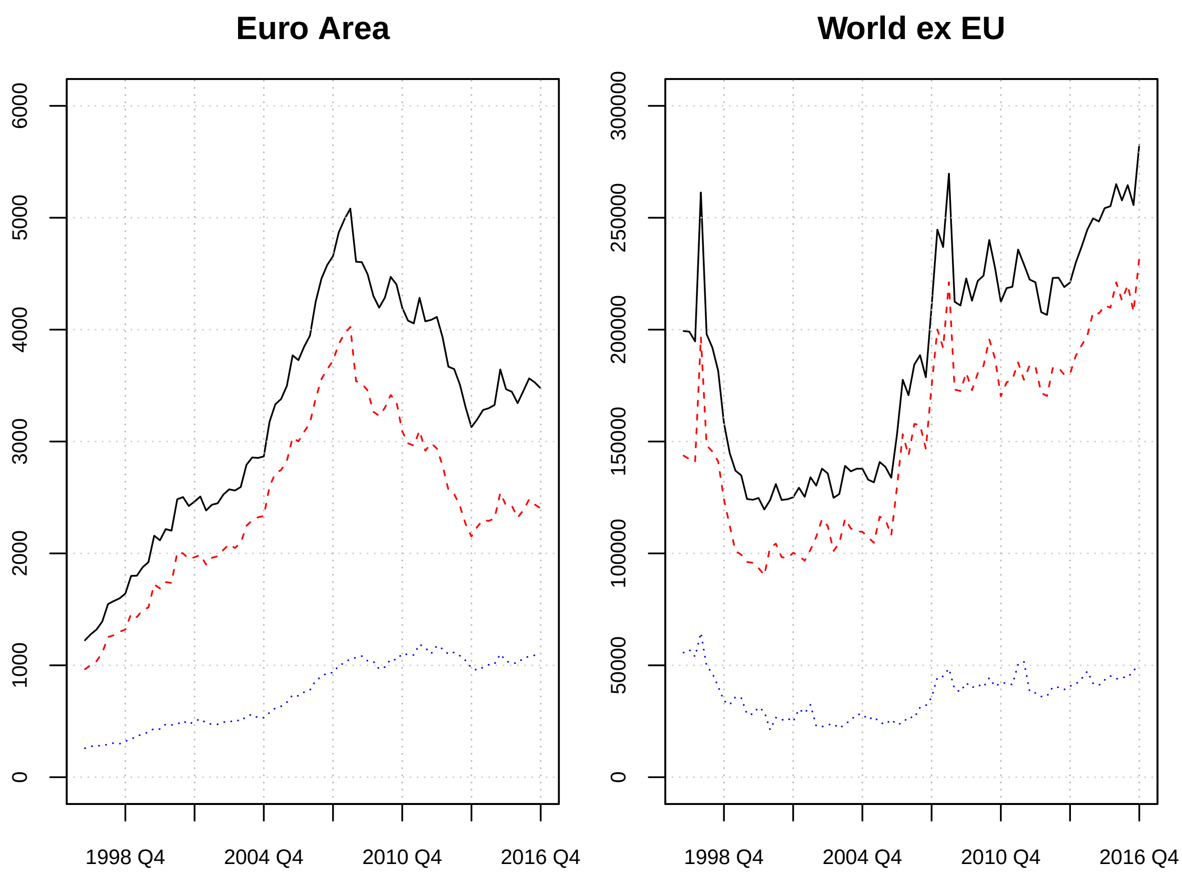
Figure 1: Income and Consumption Smoothing, 1998-2013



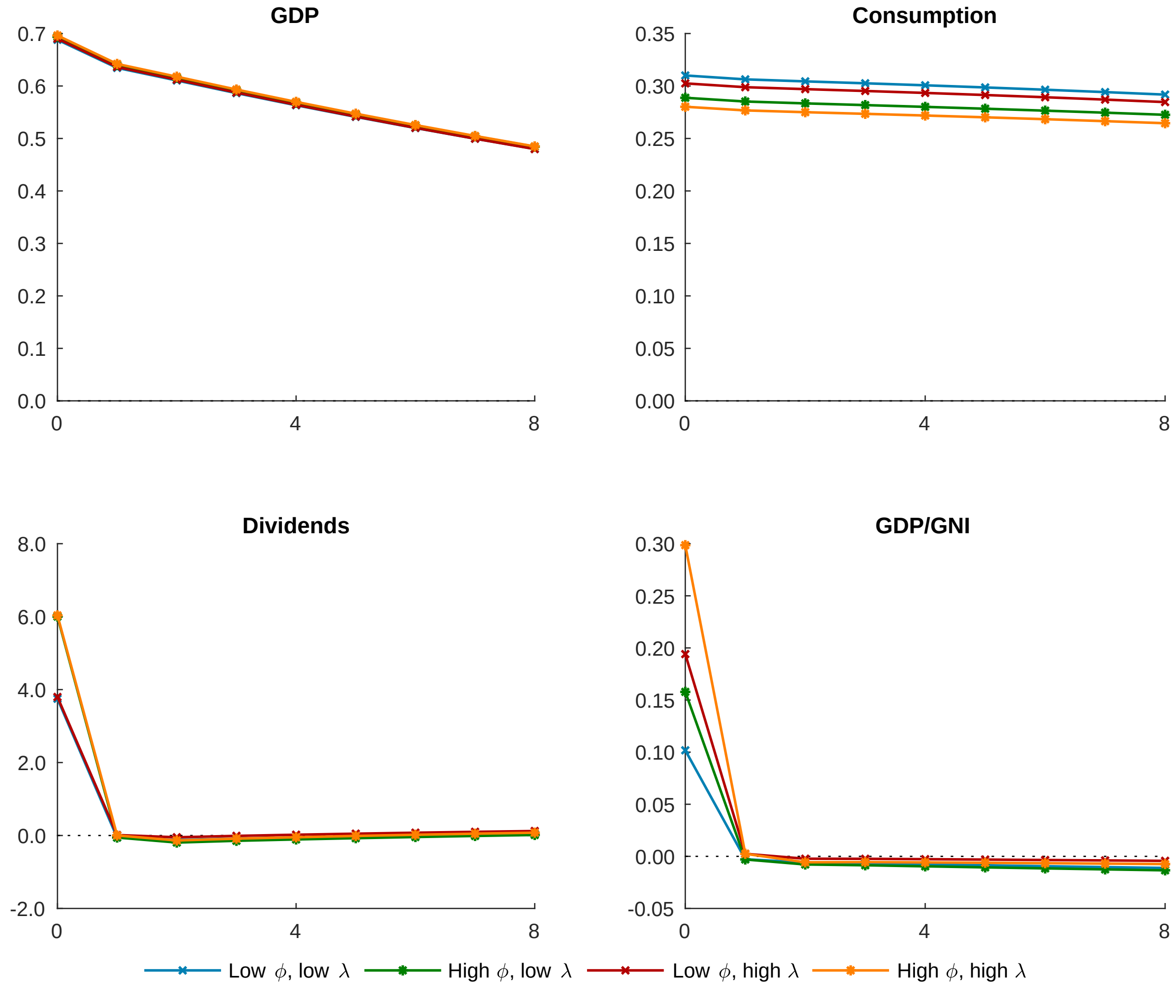
NOTES: The figure plots the degree of income smoothing ($\beta_I(t)$, green line) and consumption smoothing ($\beta_C(t)$, red line). The coefficients $\beta_I(t)$ and $\beta_C(t)$ are estimated from cross-sectional regressions $\Delta \widetilde{gdp_t^k} - \Delta \widetilde{gni_t^k} = \beta_I(t)\Delta \widetilde{gdp_t^k} + \tau_t + \epsilon_t^k$ and $\Delta \widetilde{nndi_t^k} - \Delta \widetilde{c_t^k} = \beta_C(t)\Delta \widetilde{gdp_t^k} + \tau_t + \epsilon_t^k$ for each quarter from $t = 1996Q1 \ldots 2013Q4$, where $\widetilde{\ }$ denotes idiosyncratic component of growth in gross domestic product, gdp, gross national income, gni, net national disposable income, $nndi$, and consumption, c. The coefficient β_I yields the fraction of output risk shared via net income flows ($\Delta \widetilde{gdp_t^k} - \Delta \widetilde{gni_t^k}$) and represents income smoothing via cross-border ownership. Coefficient β_C yields the amount of output risk captured by savings ($\Delta \widetilde{nndi_t^k} - \Delta \widetilde{c_t^k}$) and corresponds to consumption smoothing via borrowing and lending. The estimates of $\beta_I(t)$ and $\beta_C(t)$ have been smoothed using the trend component of a HP-filter with smoothing parameter of 250.

Figure 2: Cross-border bank lending in the eurozone and other advanced countries



NOTES: The figure plots cross-border lending by foreign banks to the eurozone (Belgium, Germany, Finland, Ireland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal) and some other advanced world economies outside the European Union (Australia, Canada, Switzerland, Japan, South Korea, Norway, New Zealand, and United States). The black solid line shows total lending, the red dashed line shows lending by foreign banks to domestic banks, and the blue dotted line shows lending by foreign banks to the domestic non-bank sector (including governments). All values are in billion Euros. The source is BIS locational banking statistics database.

Figure 3: Model impulse response functions to a home TFP shock



NOTES: The graph plots the model impulse response functions of home country GDP, consumption, firm dividends and the ration of GDP to GNI (income channel) to the home TFP shock in normal times. Four scenarios are presented: (1) low banking integration (low $\phi = 0.5$) and low equity integration (low $\lambda = 0.3$) – blue lines with (x); (2) high banking integration (high $\phi = 0.8$) and low equity integration (low $\lambda = 0.3$) – green lines with (*); (3) low banking integration (low $\phi = 0.5$) and high equity integration (high $\lambda = 0.6$) – red lines with (x); (4) high banking integration (low $\phi = 0.8$) and high equity integration (high $\lambda = 0.6$) – orange lines with (*). The foreign country is kept the same in all simulations with $\phi = 0.65$ and $\lambda = 0.45$. All impulse responses are percentage deviations from steady state. Number of quarters following the shock is on the x-axis.

Table 1: Basic Risk Sharing

Time span		EMU10					non-EMU				
		β_I	β_D	β_F	β_C	β_U	β_I	β_D	β_F	β_C	β_U
1998-2013	$\Delta\widetilde{gdp}_t^k$	**0.074**	**-0.118**	**0.012**	**0.232**	**0.800**	-0.007	-0.025	0.018	0.024	**0.973**
		(2.627)	(-1.69)	(1.854)	(4.764)	(7.465)	(-0.447)	(-1.086)	(1.429)	(0.592)	(34.270)
1998-2008	$\Delta\widetilde{gdp}_t^k$	0.098	0.034	-0.008	**0.479**	**0.396**	-0.03	-0.012	0.016	0.042	**0.976**
		(1.386)	0.460	(-0.434)	(4.862)	(3.890)	(-1.341)	(-0.665)	(0.771)	(1.087)	(47.007)
2009-2013	$\Delta\widetilde{gdp}_t^k$	0.018	**-0.151**	0.000	**0.317**	**0.816**	0.011	-0.014	0.053	0.13	**0.93**
		(0.204)	(-6.571)	(-0.016)	(4.102)	(5.588)	(0.241)	(-0.436)	(1.520)	(0.916)	(9.609)

The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{gni} - \widetilde{nni}$, $\widetilde{nni} - \widetilde{nndi}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ for I, D, F, C and U respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log\left[X_t^k / X_t^*\right]$. $\boldsymbol{d}_{Xt}^k$ contains time and country fixed effects. Standard errors are clustered by country, and t-statistics are in parentheses.
EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal.
Non-EMU: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Sweden, UK.

Table 2: Risk Sharing and cross-border bank lending

Panel A: 1998-2008

interactions $z_t^k \times \Delta\widetilde{gdp}_t^k$	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U
$1 \times \Delta\widetilde{gdp}_t^k$	0.10	**0.48**	**0.39**	0.11	**0.46**	**0.39**	0.05	**0.49**	**0.42**	0.05	**0.43**	**0.48**
	(1.56)	(4.66)	(4.36)	(1.56)	(4.52)	(4.82)	(1.11)	(4.83)	(4.14)	(1.13)	(3.61)	(7.26)
$\widetilde{\frac{TB_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$	**0.13**	-0.12	0.06									
	(1.83)	(-1.15)	(0.66)									
$\widetilde{\frac{B2B_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$				0.13	-0.16	0.11				0.00	-0.21	0.28
				(1.44)	(-1.53)	(0.94)				(0.01)	(-1.52)	(1.75)
$\widetilde{\frac{B2N_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$							**0.75**	-0.30	-0.29	**0.75**	0.13	**-0.84**
							(3.01)	(-0.53)	(-0.82)	(2.57)	(0.64)	(-2.46)

Panel B: 2009-2013

interactions $z_t^k \times \Delta\widetilde{gdp}_t^k$	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U
$1 \times \Delta\widetilde{gdp}_t^k$	0.01	**0.58**	**0.57**	0.00	**0.59**	**0.56**	0.04	**0.54**	**0.57**	0.01	**0.59**	**0.55**
	(0.04)	(3.05)	(5.35)	(0.02)	(3.14)	(5.37)	(0.38)	(3.03)	(5.80)	(0.09)	(3.18)	(5.61)
$\widetilde{\frac{TB_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$	0.03	-0.21	0.14									
	(0.38)	(-1.34)	(1.40)									
$\widetilde{\frac{B2B_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$				0.03	-0.27	0.18				0.02	-0.24	0.19
				(0.33)	(-1.54)	(1.58)				(0.16)	(-1.36)	(1.53)
$\widetilde{\frac{B2N_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$							0.24	-0.32	0.04	0.13	0.01	-0.11
							(0.83)	(-1.15)	(0.11)	(0.62)	(0.03)	(-0.35)
$\widetilde{\frac{Target2_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$	-0.01	**-0.45**	**0.47**	-0.01	**-0.46**	**0.49**	-0.05	**-0.35**	**0.44**	-0.02	**-0.46**	**0.49**
	(-0.11)	(-2.81)	(4.36)	(-0.11)	(-2.83)	(4.67)	(-0.83)	(-2.33)	(4.22)	(-0.17)	(-2.78)	(4.66)

The table reports the results of the panel OLS regressions $\Delta x_t = \beta_X^k(t)\Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \boldsymbol{c}_X'\boldsymbol{z}_t^k + \varepsilon_{Xt}^k$ with $x_t = \widetilde{gdp}_t^k - \widetilde{gni}_t^k$, $\widetilde{nndi}_t^k - \widetilde{c}_t^k$, $\widetilde{c}_t^k$ for I, C and U respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log\left[X_t^k/X_t^*\right]$. $\beta_X^k(t)$ is defined as $\beta_{Xt}^k = a_X + \boldsymbol{b}_X'\boldsymbol{z}_t^k$. $\boldsymbol{z}_t^k$contains country specific bank lending variables listed in the first column. $\boldsymbol{d}_{Xt}^k$ contains time and country fixed effects. Standard errors are clustered by country and time, and t-statistics are in parentheses.. Standalone coefficients c_X are not reported.
EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal. Time period is specified in the panel headings.

Table 3: Risk Sharing, cross-border bank lending and equity holdings

	1998-2008											
interactions $z_t^k \times \Delta\widetilde{gdp}_t^k$	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U
$1 \times \Delta\widetilde{gdp}_t^k$	**0.13**	**0.47**	**0.38**	**0.14**	**0.47**	**0.37**	0.09	**0.48**	**0.42**	**0.09**	**0.43**	**0.45**
	(1.86)	(4.00)	(3.55)	(1.85)	(3.82)	(4.53)	(1.50)	(4.62)	(3.70)	(2.42)	(4.42)	(7.80)
$\widetilde{\frac{E_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$	**0.66**	-0.44	-0.14	0.54	0.05	-0.72	0.29	-0.37	0.12			
	(2.07)	(-0.99)	(-0.35)	(1.00)	(0.11)	(-1.53)	(0.60)	(-0.91)	(0.23)			
$\widetilde{\frac{B2B_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$				0.04	**-0.17**	**0.22**				-0.04	**-0.21**	**0.33**
				(0.31)	(-1.79)	(1.75)				(-0.40)	(-1.76)	(2.70)
$\widetilde{\frac{B2N_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$							**0.54**	-0.15	-0.31			
							(1.72)	(-0.38)	(-0.81)			
$\left(\frac{E_{t-1}^k}{GDP_{t-1}^k} + \frac{B2N_{t-1}^k}{GDP_{t-1}^k}\right) \times \Delta\widetilde{gdp}_t^k$										**0.55**	0.10	**-0.66**
										(2.61)	(-0.25)	(-2.31)

The table reports the results of the panel OLS regressions $\Delta x_t = \beta_X^k(t)\Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \boldsymbol{c}_X^{\prime}\boldsymbol{z}_t^k + \varepsilon_{Xt}^k$ with $x_t = \widetilde{gdp}_t^k - \widetilde{gni}_t^k, \widetilde{nndi}_t^k - \widetilde{c}_t^k, \widetilde{c}_t^k$ for I, C and U respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log\left[X_t^k / X_t^*\right]$. $\beta_X^k(t)$ is defined as $\beta_{Xt}^k = a_X + \boldsymbol{b}_X^{\prime}\boldsymbol{z}_t^k$. $\boldsymbol{z}_t^k$contains country specific bank lending variables listed in the first column. $\boldsymbol{d}_{Xt}^k$ contains time and country fixed effects. Standard errors are clustered by country and time, and t-statistics are in parentheses.. Standalone coefficients c_X are not reported.
EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal. Time period is specified in the panel headings.

Table 4: Model calibration

Parameter	Description	Value
β	Households' discount factor	0.99
ψ	Inverse of Frisch elasticity	2
σ	Households' risk aversion	1
α	Capital intensity in firms production function	0.35
φ^I	Investment adjustment cost parameter	10
δ	Capital depreciation in steady-state	0.025
τ	Firms' preference towards loans from GB	0.40
ν	Firms' elasticity of substitution between GB and LB loans	1
r^b	Steady-state cost of wholesale funds	0.005
ι	Cost of alternative sources of funds to firms	0.04
κ^E	Ratio of total bank equity to risk-weighted assets (VaR constraint)	0.08
γ^L	Risk weight on credit to real sector	0.75
γ^M	Risk weight on credit to banks	0.35
$\varphi^{D'}$	LB deposits intermediation cost (first order)	0
φ	LB deposits adjustment cost parameter - tranquil (crisis)	10^{-4}
		(0.1)
$\varphi^{E''}$	GB equity adjustment cost parameter	1
ρ^θ	TFP shocks autocorrelation coefficient	0.95
ρ^b	Global banking shock autocorrelation coefficient	0.95
$\rho^\dagger$	International correlation of TFP shocks	0.25
σ^θ	Standard deviation of TFP shocks	0.007
σ^b	Standard deviation of the GB wholesale funding shock	0.03

NOTES: The GDP of the home country is normalized to one, and that of the foreign country to nine (number of countries in the sample minus one). Additionally, we calibrate home and foreign nominal λ, ϕ and κ – degrees of capital market integration, real banking integration, and the integration in interbank credit. The values of other model parameters Ψ, $\varphi^{E'}$, μ and μ^{GB} are derived from steady-state restrictions.

Table 5: Calibration of B2B, B2N and cross-border equity holdings for EMU countries

	B2B	B2N	Equity
Austria	0.92	0.22	0.19
Belgium	2.80	0.47	0.51
Finland	0.60	0.30	0.24
France	1.19	0.27	0.20
Germany	0.94	0.23	0.25
Greece	0.43	0.46	0.03
Italy	0.74	0.10	0.22
Netherlands	2.32	0.79	0.65
Portugal	2.16	0.36	0.10
Spain	0.78	0.17	0.11
EMU	1.29	0.34	0.25

NOTES: All values are relative to GDP and constructed as pre-2008, within-country averages. The EMU values are averages of respective country values.

Table 6: Basic Risk Sharing: Model

		β_I	β_C	β_U
1998–2008	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.08***	0.49***	0.43***
		(9.39)	(11.32)	(101.71)
2009–2013	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.02	0.30***	0.80***
		(0.77)	(3.43)	(17.03)

NOTES: The table reports the model simulation results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nni} - \widetilde{c}$, $\widetilde{c}$ for I, C and U, respectively. The results for the depreciation channel are not reported. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log\left[X_t^k/X_t^*\right]$. $\boldsymbol{d}_{Xt}^k$ contains time and country fixed effects. T-statistics are in parentheses, calculated from 1000 model simulations from the distribution of the respective coefficient. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal.

Table 7: Risk sharing, cross border bank lending and equity holdings: Model

Panel A: Cross-border bank lending

	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$1 \times \Delta\widetilde{\mathrm{gdp}^k_t}$	0.08***	0.48***	0.44***	0.08***	0.48***	0.44***	0.10***	0.43***	0.42***	0.10***	0.41***	0.43***
	(9.01)	(10.53)	(81.82)	(9.03)	(10.54)	(81.58)	(11.88)	(9.34)	(134.39)	(11.67)	(8.72)	(124.44)
$\frac{\widetilde{\mathrm{TB}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$	0.04	–0.10	0.01									
	(0.72)	(–0.46)	(0.33)									
$\frac{\widetilde{\mathrm{B2B}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$				0.03	–0.09	0.01				0.01	–0.06	0.01
				(0.54)	(–0.41)	(0.32)				(0.15)	(–0.23)	(0.39)
$\frac{\widetilde{\mathrm{B2N}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$							0.82**	–1.44	0.02	0.83**	–1.38	0.01
							(2.29)	(–0.84)	(0.19)	(2.07)	(–0.73)	(0.04)

Panel B: Cross-border bank lending and equity holdings

	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$1 \times \Delta\widetilde{\mathrm{gdp}^k_t}$	0.10***	0.42***	0.42***	0.11***	0.36***	0.42***	0.10***	0.40***	0.42***	0.11***	0.37***	0.42***
	(9.45)	(7.49)	(146.51)	(9.30)	(5.71)	(148.03)	(10.88)	(7.46)	(172.02)	(9.24)	(5.72)	(140.43)
$\frac{\widetilde{\mathrm{E}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$	0.48**	–0.95	0.06	0.47**	–0.87	0.07	0.32	–0.65	0.11*			
	(2.24)	(–1.02)	(0.99)	(2.11)	(–0.87)	(0.93)	(1.58)	(–0.57)	(1.66)			
$\frac{\widetilde{\mathrm{B2B}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$				0.02	–0.13	–0.00				0.02	–0.13	–0.00
				(0.42)	(–0.45)	(–0.18)				(0.40)	(–0.46)	(–0.17)
$\frac{\widetilde{\mathrm{B2N}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$							0.46	–0.78	–0.13			
							(1.19)	(–0.36)	(–1.14)			
$\left(\frac{\widetilde{\mathrm{E}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}} + \frac{\widetilde{\mathrm{B2N}^k_{t-1}}}{\mathrm{GDP}^k_{t-1}}\right) \times \Delta\widetilde{\mathrm{gdp}^k_t}$										0.36**	–0.64	0.04
										(2.02)	(–0.86)	(0.69)
N	430	430	430	430	430	430	430	430	430	430	430	430

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t = \beta^k_X(t)\Delta\widetilde{gdp^k_t} + \boldsymbol{d}^{k\prime}_{Xt}\mathbf{1} + \boldsymbol{c}'_X\boldsymbol{z}^k_t + \varepsilon^k_{Xt}$ with $x_t = \widetilde{gdp}^k_t - \widetilde{gni}^k_t, \widetilde{nni}^k_t - \widetilde{c}^k_t, \widetilde{c}^k_t$ for I, C and U respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log\left[X^k_t/X^*_t\right]$. $\beta^k_X(t)$ is defined as $\beta^k_{Xt} = a_X + \boldsymbol{b}'_X\boldsymbol{z}^k_t$. $\boldsymbol{z}^k_t$ contains country specific bank lending variables and/or cross-border equity holdings, as listed in the first column. $\boldsymbol{d}^k_{Xt}$ contains time and country fixed effects. Standalone coefficients c_X are not reported. T-statistics are in parentheses, calculated from 1000 model simulations from the distribution of the respective coefficient. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal. The calibration assumes tranquil times and simulations have been done for 47 quarters, corresponding to pre-crisis period in the data (1997Q1–2008Q3).

Table 8: Risk-sharing in model simulations under different scenarios

	β_I	β_C	β_U
Low equity integration Low banking integration	0.03***	0.54***	0.47***
	(35.30)	(73.01)	(497.78)
Low equity integration High banking integration	0.04***	0.56***	0.43***
	(31.31)	(70.69)	(496.08)
High equity integration Low banking integration	0.10***	0.47***	0.45***
	(50.76)	(52.01)	(502.04)
High equity integration High banking integration	0.14***	0.45***	0.41***
	(47.79)	(44.47)	(505.25)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta \widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime} \mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nni} - \widetilde{c}$, $\widetilde{c}$ for I, C and U, respectively. The results for the depreciation channel are not reported. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log \left[X_t^k / X_t^*\right]$. $\boldsymbol{d}_{Xt}^k$ contains time and country fixed effects. T-statistics are in parentheses, calculated from 1000 model simulations from the distribution of the respective coefficient. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal. Cross-sectional heterogeneity in parameters is preserved from the calibration of parameters κ, ϕ, and λ (see Parametrization section). Given this heterogeneity, low capital integration means a uniform shift of the parameter λ for all countries by 50% down, and high capital integration—by 50% up. Analagously, low banking integration means a uniform shift of the parameter ϕ for all countries by 20% down, and high banking integration—by 20% up. The calibration assumes tranquil times and has been performed using 1000 model simulations, each spanning 1000 quarters.

Appendix: mapping the model to the data

Parametrization We calibrate the baseline model at the quarterly frequency using parameter values displayed in Table 4. The heterogeneity across simulations (for 10 EMU countries in the sample) comes from choosing the degrees of capital market integration (λ), real banking integration (ϕ) and integration in interbank credit markets ($\kappa = \frac{M}{L^{\text{LB}}}$). These values are calibrated by scaling the pre-crisis averages of per capita cross-border equity holdings, bank-to-real sector loans and bank-to-bank loans, showed in Table 5. The scaling is needed to ensure plausible values for the above parameters and is done linearly within the following ranges: $\lambda \in [0.3,\ 0.6]$, $\phi \in [0.5,\ 0.8]$, and $\kappa \in [0.5,\ 0.8]$. Thus, we do not explicitly match the levels of simulated variables to those in the data, but directly calibrate the parameters which determine these ratios in the model. Being simple, this procedure is sufficient to match the cross-sectional correlation in these variables from model simulations to the data. The model is then solved by log-linearizing around the deterministic steady-state.

Because we match per capita moments, the size of each 'home' economy is normalized to one. And since the 'foreign' country represents "the rest of the EMU", we normalize its size to nine, i.e., number of countries in the sample minus one. Regarding parameters, which are common for all countries, some of them are standard in the literature and have been accordingly calibrated. Households' discount factor β is set to 0.99, to match the steady-state quarterly net deposit rate of 1%. The household's coefficient of relative risk aversion σ is one, such that its instantaneous utility function is logarithmic with respect to the consumption bundle. The inverse of the Frisch elasticity ψ in the utility function is set to 2, while the scale parameter Ψ is calibrated separately for each country, as it depends on the country size (e.g., nominal GDP).

The production functions of large and small firms are Cobb-Douglas with the capital intensity parameter α equal to 0.35, approximately corresponding to long-term share of capital in production in advanced economies. We set the capital depreciation steady-state value δ to 0.025, and the investment adjustment cost parameter φ^I to 10 to lower the investment growth rate volatility in presence of global shocks.

We now explain how we calibrate the parameters that determine the risk-weighted leverage ratio of the global bank. First, we choose the value for the ratio of regulatory capital to risk-weighted assets ($\kappa^E = \frac{E_t}{RWA_t}$) of 8%, which corresponds to the minimal requirement in Basel II rules. Next, we assume that the regulator chooses higher risk weights for credit extended to the real sector, than to interbank loans. Since claims on corporates are associated with risk weights ranging from 20% for firms with AAA to AA- ratings to 100% for unrated firms or those with low rating (BBB+ to BB-), to 150% for firms with ratings below BB-, and depend on a range of additional criteria, including the quality of collateral, we assume that an average loan receives the weight equal to 75%. This value is applied to loans to small businesses within regulatory retail portfolios in Basel II rules, and at the same time lies in the middle field within range of applied weights to rated and unrated corporates as described above. For bank-to-bank credit, we choose the weight 35%, which is a simple average of weights applied to loans to banks with AAA to AA- ratings (20%) and those with A+ to A- ratings (50%), and at the same time is used to weight claims secured by residential property, which was a common way of obtaining interbank liquidity through repo agreements prior to the crisis. It is important to note, however, that for our quantitative results below the precise values attached to the risk weights do not play big role as long as the condition $\gamma^L > \gamma^M$ holds.

Next step in our calibration is choosing values for adjustment cost parameters for deposits and equity. The choice of $\varphi^{E'}$ is implicit in equalizing the steady-state cost of equity to its marginal benefit; it approximately equals 0.18. Given this, the implied risk premium on loans to real sector and local banks are given by ca. 1% and 0.5%, respectively. We then choose $\varphi^{E''} = 1$. The steady-state deposit intermediation costs for local banks ($\varphi^{D,\mathrm{LB}'}$) is for simplicity set to zero. We set the cost of alternative sources of finance to firms (ι) to 4%, such that bank credit is always the preferred type of credit. The dynamics of bank deposits, and therefore, the degree of risk sharing, is determined by the values for the parameter $\varphi^{D,\mathrm{LB}''} \equiv \varphi$, and we calibrate it separately in tranquil and crisis times. In particular, we set it small in normal times ($\varphi = 10^{-4}$) and high in times of global distress ($\varphi = 0.1$) and motivate this choice by observing that the collapse of the interbank market during the crisis is associated with the dry-up in liquidity, which should be reflected in large frictions in finding alternative sources of liquidity in the crisis, as opposed to non-crisis times. The exact values are then chosen such that to approximately match the amount of risk that is shared through credit market prior and during the crisis in the data. We let steady-state interest rate paid on liabilities by the global bank equal 0.5%.

Finally, we set the value for the elasticity of substitution between loans from local and global banks of firms (ν) to 1. The corresponding CES preference parameter τ is chosen such as to match the average of the domestic bank dependence across countries in our sample. We define it as $\mathrm{DBD}_t = \frac{L_t^{\mathrm{LB}}}{L_t^{\mathrm{LB}} + L_t^{\mathrm{GB}}}$ and caculate this ratio for each country using the BIS Total credit database, which is on average (using GDP weights) equal to 0.63. Given $\nu = 1$, it must be that $\tau = 1 - \mathrm{DBD}$, so that after rouding we chose $\tau = 0.40$ for every country.

Forcing variables There are two major sources of shocks in our setup: shocks to the total factor productivity and (in simulations involving crisis times) shocks to the global bank. The TFP processes for both countries (home and foreign) are given by:

$$\log \theta_t = \rho^\theta \log \theta_{t-1} + \sigma^\theta \left(\sqrt{\rho^\dagger} \eta_t^\dagger + \sqrt{1 - \rho^\dagger} \eta_t \right).$$

The stochastic process for the global banking shock has the same realization for every country and is given by

$$\log B_t = (1 - \rho^b) \log B + \rho^b \log B_{t-1} - \sigma^b \eta_t^b.$$

In the setup above: $\eta_t^\dagger,\ \eta_t,\ \eta_t^b \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$, and correspond, respectively, to shocks to global TFP, country TFP, and the global bank balance sheet. All exogenous processes follow autoregressive dynamics with persistence parameters ρ^θ and ρ^r, both equal to 0.95. The correlation between country TFP shocks is $\rho^\dagger = 0.25$. For tractability, we assume zero correlation between TFP shocks and the global banking shock.

The volatility of the exogenous processes above is determined respectively by the parameters σ^θ and σ^b. The standard deviation of the global banking shock is set to 3%, which allows us to match the pre-crisis volatility in the difference in the average growth rates of the bank-to-bank and bank-to-real sector loans, which is approximately equal to 4.7% in the data and 5% in the model. In the quantitative experiments we use a path of the random shocks, which allows us to almost perfectly match the dynamics of this variable in the model. Only in the case, where we examine different scenarios presented in Table 8 and where the number of artificial periods by construction does not match the data sample, do we use standard normal shocks across simulations. Having established this, we select the standard deviation of the TFP shocks of $\sigma^{\theta} = 0.007$, often used in the literature.