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

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This version: October 2018.

Abstract

The interplay of equity market and banking integration is of first-order importance for risk sharing in the EMU. While EMU created an integrated interbank market, "direct" banking integration (in terms of direct cross-border bank-to-real sector flows or cross-border banking-consolidation) and equity market integration remained limited. We find that direct banking integration is associated with more risk sharing, while interbank integration is not. Further, interbank 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, 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 we examine which channels were fragile and which were resilient during the crisis. From the insights of this exercise, as well as from the historical pattern of risk sharing between U.S. 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 make use of the accounting 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 pro-cyclical saving ("consumption 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)). Income smoothing through cross-border ownership of assets also allows to share permanent idiosyncratic shocks while consumption smoothing does not (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 pro-cyclical saving. Income smoothing improved somewhat, but the cross-border ownership of equity that is needed to underpin it remained low. Unsurprisingly, EU institutions provided little risk sharing because there are almost no fiscal transfer mechanisms between eurozone members. The pattern of risk sharing in the pre-crisis eurozone was 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 pro-cyclical savings are unsuited for absorbtion of 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 the nature of banking integration in the eurozone is of first-order importance for understanding channels of risk sharing in the EMU during our sample period. 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 credit default swaps 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] 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 (2011), 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, during our sample period, interbank and direct cross-border lending were very different in their implications for risk sharing in the eurozone. We find that direct cross-border lending had risk sharing benefits similar to the those from cross-border ownership of equity. Direct banking integration seems to be associated with a shift of risk sharing patterns towards more income smoothing. This feature means that it was more resilient during the global financial crisis and its aftermath, because during the crisis, it was consumption smoothing that collapsed very strongly. 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 this explains why risk sharing virtually dried up during the eurozone sovereign debt crisis. Hence, the lack of direct 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. Firms have to pre-finance wage payments and investment using either long-term bank loans or using more expensive short-term finance from other sources. Importantly, the model features two sources of bank finance for firms and consumers: direct cross-border loans from a pan-European integrated bank and loans from local banks. Local banks refinance themselves through the interbank market. In the model, there are two sources of uncertainty: idiosyncratic TFP shocks and idiosyncratic shocks to the balance sheet of the local banking sector.

This setup allows us to explain the patterns we observe in the data. Consider the drop in consumption smoothing during the crisis: in the model, the local banking sector shock amounts to a hike in the

[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.

refinancing rate for local banks which leads to a drop in interbank lending. Since the increase in the interest rate falls entirely on the local consumer—as can be seen from the consumption Euler equation—we see a large idiosyncratic drop in consumption. The more direct banking integration there is, the more the consumer will be shielded from this interest interest rate increase. Because local banking sector shocks likely were more important than TFP shocks during the crisis period, and because direct banking integration was low, this can explain why consumption smoothing declined so sharply.

Further, consider our finding that direct banking integration shifts risk sharing patterns towards more income smoothing. In our model, direct banking integration enables firms and consumers to by-pass local banks and gives them access to the EMU-wide borrowing rate. Hence, firms and households effectively take out insurance against shocks to the local banking sector. By insulating the firm from country-specific variation in lending rates, direct banking integration mitigates the real impact of local banking sector shocks on output and thus on dividend and labor income. This contributes to smoothing consumers' income and thus lowers the need for consumption smoothing *ceteris paribus*. Importantly, by insulating the the economy from local banking sector shocks, direct banking integration also provides more stable risk sharing than interbank integration in times of crisis.

A key prediction of our model is that direct banking integration and equity market integration are complementary. By giving firms access to the EMU-wide borrowing rate—which is generally lower and always less volatile than the local lending rate—direct banking integration acts like a positive lending supply shock that allows firms to increase leverage. In the model, higher firm debt levels are desirable because internal finance is very costly. Because current wage payments and investment are financed from fresh loans while the repayment of past loans is pre-determined, the conditional volatility and procyclicality of firm profits (dividends) after a country-specific productivity shock rise with firm leverage. For a given level of equity diversification, more direct banking integration therefore increases the contribution of income smoothing to overall risk sharing. Thus, the model can also explain why banking integration leads to more income smoothing in tranquil times, such as the period before 2008, when idiosyncratic productivity (as opposed to local banking) shocks are likely to have prevailed in the data. At the same time, direct banking integration strengthens the case for more equity diversification in the model.

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. In a separate subsection, we zoom in on why risk sharing during the crisis collapsed and discuss the roles of fiscal austerity, emergency liqudity assistance by the European Central Bank, and widening TARGET2 positions. 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. 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 (2011) 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 (2011) show that, prior to banking deregulation and similar to what we find for Europe today, 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 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. As in Hoffmann et al. (2017), our model further 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

[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.

lending leads to a decline in consumption smoothing.

An important corollary insight from our model is that direct banking integration and equity market integration complement each other if direct banking integration also alleviates firms' financing constraints. This complementarity arises because bank lending allows firms to finance labor and investment from loans rather than current cash flow from revenue. Thus, banking integration partially breaks the negative correlation between dividend and labor income that provides a fundamental rationale for home bias in models with capital, as pointed out by Heathcote and Perri (2013). This decoupling also contributes to making labor income less sensitive to country-specific shocks, thus improving risk sharing by alleviating that part of income risk (associated with labor income) that is not internationally tradable.

Our analysis also relates to Martin and Philippon (2017), who use a stylized model of the Eurozone to disentangle the relative contributions of credit cycles, excessive government spending, and sudden stops to the dynamics of Eurozone economies before and after the financial crisis. Like theirs, our model features local banking sector shocks as exogenous increases in the borrowing costs of individual economies. Our model abstracts from the role of government spending but, differently from Martin and Philippon (2017), it features a very detailed financial market structure, which allows us to study the different mechanisms through which banking and equity market integration affect risk sharing.

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 largely 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 is one where "idiosyncratic" (deviation from aggregate) consumption growth rates are not affected by other idiosyncratic shocks such as changes in income or output (see, e.g., Cochrane (1991)). 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" (deflated gross domestic product) per head and the asterisk denotes the aggregate per capita value of the respective variable. The terms τ_{Ut}, δ_U^k, and ε_{Ut}^k are time- and country-fixed effects and an error term, respectively. Under full risk sharing, β_U is zero. If β_U is not zero, the value can be interpreted as the share idiosyncratic output risk that is "not shared" by the average country in our sample. In empirical data, the estimated value of β_U is regularly between 0 ("full risk sharing") and unity ("no risk sharing"). $1 - \beta_U$ can then 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, depreciation smoothing (of little interest because depreciation is mainly imputed), international transfers smoothing, 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

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

where $\widetilde{gdp}$, $\widetilde{gni}$, $\widetilde{nni}$, and $\widetilde{nndi}$ denote the logarithms of gross domestic 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 refer to observed GDP growth-rates as "shocks" and their variation as "risk"; and we discuss the other variables 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. 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

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

The five coefficients β_I, β_D, β_F, β_C, and β_U can be interpreted as a decomposition of the cross-sectional variance of country-specific output growth. The coefficient β_U is the same as in the basic regression (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 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 net factor income flows and β_I measures to what extent these cross-country income flows buffer a country's income against fluctuations in its output.

The difference between gross national income and net national income is capital depreciation, whereas the wedge between net national income and disposable net national income represents international net transfers[4]. The coefficients β_D and β_F therefore indicate to what extent capital depreciation and interna-

[4]We include this channel for the completeness of variance decomposition, but will skip them in our analysis due to the

tional transfers help smooth disposable income after a shock to output.

Finally, country's residents or its government may save or dissave after observing disposable income. We refer to this 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 ($\boldsymbol{\beta}= [\beta_I, \beta_D, \beta_F, \beta_C, \beta_U]$) can easily be estimated from the five regressions

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

where the coefficients δ_X^k and τ_{Xt} capture country-specific and time 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. In a 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. Specifically, we parametrize $\boldsymbol{\beta}$ as a function of variables that measure different aspects of financial integration for each country. We start with total cross-border lending so that

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

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. For completeness, we further decompose the consumption smoothing channel—which is positive when savings are pro-cyclical—into the contributions from government and private saving. In order to do so, we follow Kalemli-Ozcan et al. (2014) and linearize $\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k \approx \Delta\widetilde{\left(\frac{S}{C}\right)}$. Because this expression is linear in savings, one can trivially break it up into government and private savings components and, as the OLS-coefficient to GDP is linear in the dependent variable, break up the amount of consumption smoothing into the parts that result from government and private saving, respectively.

We perform a similar analysis using the sub-components of total bank lending—bank-to-bank cross-border lending ($B2B$) and bank-to-nonbank cross-border lending ($B2N$)—and equity (E), all normalized with GDP.

focus on the financial markets channels.

3.2 Data

We use quarterly data for gross domestic product, gross national income, net national income, 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.[5] As a control group, we use non-EMU countries that are members of the EU. We calculate real per capita values of $\widetilde{gdp}$, $\widetilde{gni}$, $\widetilde{nni}$, $\widetilde{nndi}$ and $\widetilde{c}$ by deflating with the respective national harmonized index of consumer prices (HICP) and using population data published by Eurostat. Because quarterly data can be noisy, we study annual growth rates of these variables by taking differences between quarter t and $t-4$, so that $\Delta x = log\left(X_t/X_{t-4}\right)$ for $x = \left[\widetilde{gdp}, \widetilde{gni}, \widetilde{nni}, \widetilde{nndi}, \widetilde{c}\right]$ throughout the paper. Public savings are net savings of general government provided by the OECD. We calculate total savings as the difference between net national disposable income and consumption and we calculate private savings as the difference between total savings and public savings.

Our measures of cross-border total (TB), bank-to-bank ($B2B$), and bank-to-non-bank ($B2N$) 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. Foreign portfolio equity assets are from the dataset of Lane and Milesi-Ferretti (2007) extended till 2011.

3.3 Empirical results

Table 1 displays the results from estimating 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 7% to cross-country risk sharing, savings and dissavings smooth 23% of shocks. International transfers play a very limited role over the entire sample period, as does depreciation. Note that in the "non-EMU Europe" sample, there is almost no risk sharing 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, but after 2008 this less than 20% of risk was shared. Turning to the channels that drive this freeze in risk sharing, we find that, in percentage points, the drop in consumption smoothing accounts for almost 20 percentage points of this decline. Again, we find the international transfer channel to be essentially dormant in both subperiods, while the depreciation channel accounts for most the remaining decline in risk sharing.[6] 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.

In summary, Table 1 reveals a clear drop in international risk sharing among EMU countries after the crisis, associated in particular with a considerable decline of consumption smoothing. This pattern is

[5]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.

[6]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.

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 (2011) for the United States. It is, however, 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. This shift of risk sharing patterns towards more income smoothing as a consequence of banking integration is a key stylized fact that we will explain using our quantitative-theoretical model below.

The second and third blocks of channel regressions (columns 4-6 and 7-9, respectively) provide similar results, breaking 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 $B2N$-lending 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 consumption smoothing channel turns negative.

Panel B of Table 2 provides the results for the period 2009–13. 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. In regressions on simulated data from our model calibrated to the post-2008 period, we verify that the regressions with interaction terms deliver much weaker results due to the simultaneous occurence of banking sector crises in several EMU countries which implies that most variation in the data is dominated by aggregate factors.

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, is 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.[7] 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 there is an important common component driving the cross-sectional heterogeneity in these two variables. This could suggest a complementarity between the two forms of integration. We explore this issue in our DSGE model below.

3.4 Understanding the collapse in risk sharing during the crisis

Our results so far suggest that direct banking integration was associated with a shift towards more income smoothing while the drop in risk sharing during the crisis mainly happened through a collapse of the consumption smoothing channel. In this subsection, we examine the sources of this collapse in more detail.

In Table 4, we estimate the decomposition of risk sharing on two subgroups of countries: the "southern" EMU countries (Greece, Italy, Portugal, and Spain) that were hit hardest by the crisis and and the remaining "northern" EMU countries in our sample. In addition to our baseline channel decomposition, we further decompose the consumption smoothing channel, β_C, into two separate components: private consumption smoothing and government saving. As before, we abstract from the channels of international transfers and depreciation.[8]

The results in Table 4 confirm, and even strengthen, our previous findings: before the crisis, risk sharing for the south predominantly happened through consumption smoothing, whereas income smoothing was almost inexistent. Quite differently for the northern countries. These have high levels of income smoothing, consistent with high gross international equity positions. Income smoothing for the northern countries remains stable during the crisis, as one would expect for risk sharing from ownership diversification, while consumption smoothing collapses in both groups. Zooming in on the composition of consumption smooth-

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

[8]We regress the logarithm of one plus the ratio of the private (public) saving on the growth rate of GDP allowing for time-fixed effects. As shown in Kalemli-Ozcan et al. (2014), this method is based on a linearization and delivers two coefficients that approximately add up to the estimated amount of consumption smoothing and therefore provides a decomposition of consumption smoothing into the parts originating from government and private saving.

ing in terms of private smoothing and government saving, we find that private consumption smoothing drops for both groups, while the drop for the southern countries is exacerbated by a collapse of smoothing through government saving. This pattern corroborates and extends (on a longer post-crisis sample) the findings by Kalemli-Ozcan et al. (2014), who argue that the southern EMU members had very little fiscal space in the boom years prior to the crisis, which implied that they had to curtail government expenditure very quickly during the crisis because public saving could go no further negative. Fiscal consolidation resulted in countercyclical increases in government saving, worsening the asymmetric impact of the crisis on consumption in the southern EMU economies.

An important feature of our results is that both consumption smoothing and interbank positions collapsed rapidly during the crisis. In our regressions for the crisis period in Table 4, interbank lending is consistently associated negatively with consumption smoothing and with risk sharing overall. However, the link is imprecisely estimated. As discussed above, this is likely to be the case due to the dominant aggregate variation in the data. An additional possible reason could be that our data on interbank positions do not include the emergency liqudity assistance (ELA) by the European Central Bank, which at least partially substituted for private interbank lending. This could have mitigated the drop in consumption smoothing after 2008. While it would be interesting to explore this issue empirically, to our knowledge, detailed country-by-country data on the volume of emergency liquidity assistance by the ECB are not publicly available.[9]

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 the banking sector faces exogenous financing 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 substitute between loans provided by local and global banks. Fourth, households have a choice between borrowing from local or global banks while, fifth, local banks face a friction in borrowing from the global bank in interbank markets. 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. Given that our empirical results are obtained from what is necessarily a small cross-section of countries, the regressions in the previous

[9] One may suspect that these emergency flows found their direct reflection in widening TARGET2-positions within the eurozone and, therefore, that TARGET2 positions could be associated with better risk sharing. However, TARGET2 liabilities are at best a very indirect reflection of ELA flows. As shown by Whelan (2014, 2017), widening TARGET2 balances during 2008-2012 mainly reflect the capital flight that plagued countries like Greece, Italy or Portugal during the crisis. If residents of crisis-hit countries transfer funds from their home accounts to core countries like Germany or if they buy German assets, this transfer automatically is registered as a TARGET liability of the crisis country and as a TARGET2 credit for Germany. Clearly, we would not expect capital flight to be associated with better but, if anyting, with worse risk sharing. This is indeed what we find if we include a country's TARGET2 liabilities as an interaction with idiosyncratic GDP in our risk sharing rergressions.

section should not be interpreted in a causal way. Rather, they provide a useful metric against which we will benchmark our model. The model therefore also serves the purpose to identify the causal chain that we believe explains our empirical findings.

Agents and markets

There are two open economies in our model, each populated by a representative household, a firm, and a local bank. The (small) home country represents one of the 10 EMU countries in our sample, while the (large) foreign one represents the "rest of the EMU". Additionally, there is a global bank, which operates in the two countries (EMU) 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:

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

where $\Lambda_{t:t+l}^{firm}$ is the stochastic discount factor (SDF) that the firm uses to discount its future profits (at horizon l). It is a weighted average of the SDFs of the home and the foreign households (as determined by the respective Euler equations).[10] Profits are defined as:

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

where W_t denotes wages, I_t – investment, L_t – total bank borrowing, r_t^l – bank lending rate, $\widetilde{L}_t$ – borrowing from other sources (about which we are not specific), and $\boldsymbol{\iota}$ – the net interest rate (cost) on this borrowing. 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: $Q_t = 1 + \varphi^I \left(\frac{I_t}{K_{t-1}} - \delta \right)$.

A vast empirical corporate finance literature has found that firms do not distribute all of the profits (earnings), but rather smooth dividends over time (see, e.g., Leary and Michaely (2011) for U.S. firms and Javakhadze et al. (2014) for an analysis of international data). For a typical RBC model like ours, this would imply that firm-profits increase household income gradually over time and that dividend payments

[10] In particular, $\Lambda_{t:t+l}^{firm} = (1 - \lambda) \Lambda_{t:t+l} + \lambda \left(\mu \Lambda_{t:t+l} + \mu^* \Lambda_{t:t+l}^* \right)$, where $\Lambda_{t:t+l}$ is the household SDF, a *-superscript denotes the foreign country, λ is the share of foreign equity in the country's equity portfolio, and μ is the relative country size (see more details on these parameters in the subsection introducing households).

[11] We choose a pro-cyclical rate of depreciation, of functional form: $\delta_t = \delta + 0.025 \log \left(\frac{Y_t}{Y} \right)$, for the model to approximately match the amount of risk-sharing achieved by this channel in the data.

are less volatile and more procyclical. This is essential for a model to deliver benefits of international equity-market integration and match the stylized fact that equity integration increases risk-sharing over long horizons (Becker and Hoffmann (2006)). Given this, we introduce the following dividend smoothing rule, in which the parameter ρ^{SOA} denotes speed of adjustment, and lower ρ^{SOA} means smoother dividend payments (DIV_t):

$$\text{DIV}_t = \left(1 - \rho^{SOA}\right) \text{DIV}_{t-1} + \rho^{SOA} \Pi_t.$$

Firms need to borrow in order to finance their operating expenses; i.e., the wage bill and investment. This setup follows Neumeyer and Perri (2005), who rationalize the wage bill pre-financing need of firms through within-period loans by the timing structure of wage contracts and firm production. We extend their argument along two dimensions. First, firms also need to pre-finance investment outlays, and second, loans need to be repaid end-of-priod after dividends habe been distributed. This makes firm loans intertemporal, which matches the timing of consumer and interbank loans in the economy. In addition, we posit that only a fraction of operating expenses, 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 holdings or direct injection of funds by the owner of the firm. In our model here, we assume that the firm mobilizes its own internal cash holdings (e.g., by using cash holding or equity repurchases due to a buffer stock of profits that have not been disbursed as dividends) at an exogenous penalty rate of interest ι that is strictly 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 $\widetilde{L}_t = (1 - \phi) \left(W_t N_t + I_t\right)$. We interprete ϕ as a proxy for firm leverage, such that higher ϕ leads to overall lower cost of funds (given high ι), but also higher exposure of firms to shocks in the banking sector. Banking integration (direct and indirect) implies a rise in this parameter.

Firms obtain bank loans from global and local banks, while they cannot substitute one source of bank credit for the other in response to exogenous shocks. 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.[12] For tractability, we assume that up to a fraction τ of total loan demand can be satisfied by loans from the global bank, while the rest has to be financed locally: $L_t^{\text{GB}} = \tau L_t$ and $L_t^{\text{LB}} = (1 - \tau) L_t$. This setup implies that an effective interest rate that firms pay on their total bank loans (L_t) is a weighted average of the interest rates demanded by global ($r_t^{l,\text{GB}}$) and local ($r_t^{l,\text{LB}}$) banks: $r_t^l = \tau r_t^{l,\text{GB}} + (1 - \tau) r_t^{l,\text{LB}}$. Direct banking integration—an increase in loans from global banks—manifests itself in an increase in τ and thus a shift of the composition of loans from local banks to global banks and a higher weight for the EMU-wide interest rate in firms' bank loans (i.e, a lower

[12]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—about 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.

role for the idiosyncratic fluctuations in domestic lending rates). The opposite holds for indirect banking integration, which partially increases the supply of loans from the local bank.

Banks In each country, there is a local (domestic) bank. Additionally, local households own a constant fraction of the global bank. Local banks fund themselves by borrowing from global banks, 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* extends loans to firms, L_t^{LB}, and to households, H_t^{LB}, and raises funds in the interbank market, M_t. Its balance sheet identity is correspondingly given by:

$$L_t^{\mathrm{LB}} + H_t^{\mathrm{LB}} = M_t.$$

The local bank is owned by domestic households and maximizes expected discounted profits. Given an intratemporal nature of the problem, its objective can be reformulated as maximizing next-period profits (Π_t^{LB}):

$$\max_{L_t^{\mathrm{LB}},\ H_t^{\mathrm{LB}},\ M_t} \quad L_t^{\mathrm{LB}} r_t^{l,\mathrm{LB}} + H_t^{\mathrm{LB}} r_t^{h,\mathrm{LB}} - M_t r_t^m - \varphi_t^{\mathrm{LB}},$$

where $r_t^{l,\mathrm{LB}}$ and $r_t^{h,\mathrm{LB}}$ denote interest rates on local bank loans, extended to firms and households, respectively. The last term, φ_t^{LB}, is a quadratic "adjustment cost" in interbank markets, modeled as a function of the relative deviation of B2B loans from their long-run value, namely, $\varphi_t^{\mathrm{LB}} = \frac{1}{2}\varphi^{\mathrm{LB}} \left(\frac{M_t - M}{M}\right)^2$. This term reflects the difficulty for banks to undergo short-term changes in their funding structure though international interbank markets. In the presence of asymmetric shocks to loan demand and/or supply, these adjustment costs lead to different borrowing costs between the two countries. From the point of view of the households, this drives a wedge between their respective borrowing rates and hence, stochastic discount factors and expected consumption growth paths, and therefore prevents a nearly perfect risk-sharing through international interbank markets. Additionally, this formulation prevents a unit-root dynamics in interbank loans, known to be otherwise a feature of this type of models (Schmitt-Grohé and Uribe (2003)).

The *global bank* in our model provides funds to firms, L_t^{GB}, and households, H_t^{GB}, in both countries and additionally lends in the interbank market, M_t. It refinances itself through wholesale funding in the global interbank market, B_t, such that its balance sheet is given by:

$$L_t^{\mathrm{GB}} + L_t^{\mathrm{GB}^*} + H_t^{\mathrm{GB}} + H_t^{\mathrm{GB}^*} + M_t + M_t^* = B_t,$$

where an asterisk (*) indicates the foreign country. Its objective is to maximize total expected discounted profits, or simply, next-period profits (Π_t^{GB}):

$$\max_{L_t^{\mathrm{GB}},\ L_t^{\mathrm{GB}^*}, H_t^{\mathrm{GB}},\ H_t^{\mathrm{GB}^*}\ M,\ M_t^*,\ B_t} \quad \left(L_t^{\mathrm{GB}} + L_t^{\mathrm{GB}^*}\right) r_t^{l,\mathrm{GB}} + \left(H_t^{\mathrm{GB}} + H_t^{\mathrm{GB}^*}\right) r_t^{h,\mathrm{GB}} + \left(M_t + M_t^*\right) r_t^m - B_t r_t^b,$$

where $r_t^{l,\mathrm{GB}}$ and $r_t^{h,\mathrm{GB}}$ denote interest rates on global bank loans, extended to firms and households, respectively, r_t^m is the interbank lending rate, and r_t^b is the cost of financing in the global interbank market. Because the global bank is owned in constant proportions by the home and foreign households, total profits Π_t^{GB} are disbursed to households in both countries based on ownership shares μ^{GB} and $\mu^{\mathrm{GB}*} = 1 - \mu^{\mathrm{GB}}$.[13]

The global bank is exposed to lending conditions in the rest of the world through exogenous fluctuations in the supply of funds offered in the U.S. money markets, B_t. In particular, a drop in B_t raises the global interest rate r_t^b, which transmits to lending conditions to firms and households in both countries. The two countries effectively share the consequences of this shock through the internal capital markets of the global bank; i.e., through the change in the composition of L_t^{GB}, H_t^{GB} and M_t between the countries.

Both global and local banks possess market power, as credit is extended to firms in a monopolistic competition environment. We do not explicitely model the microeconomic mechanism behind it and refer the reader to any model, in which a Dixit–Stiglitz framework is applied to the bank loan market; e.g., Gerali et al. (2010). The implication of market power is that banks set mark-ups on their cost of funds when they extend credit to firms and households. Because firms are subject to stronger relationship lending than households and because most household borrowing is secured (mortgages), we assume that the mark-ups on loans to firms are higher than mark-ups on loans to households. This allows for a negative transmission of banking sector shocks to the productive side of the economy.[14] In particular, the optimal supply of credit, arising from local and global bank optimization problems given the monopolistic competition set-up is the following:

$$r_t^{l,\mathrm{GB}} = MU^{\mathrm{GB}} r_t^b,$$

$$r_t^{h,\mathrm{GB}} = MU^{HH} r_t^b,$$

$$r_t^m = r_t^b,$$

$$r_t^{l,\mathrm{LB}} = MU^{\mathrm{LB}} \left(r_t^m + lbs_t + \varphi^{\mathrm{LB}} \frac{M_t - M}{M} \right),$$

$$r_t^{h,\mathrm{LB}} = MU^{HH} \left(r_t^m + lbs_t + \varphi^{\mathrm{LB}} \frac{M_t - M}{M} \right),$$

where MU^{GB} and MU^{LB} denote mark-ups set by global and local banks for firms, respectively, with the latter being larger, because local banks exhibit more market power due to reasons explained above, MU^{HH} denotes mark-ups set by both banks on loans to households, and lbs_t is local banking shocks. From the optimality conditions above, it can be seen why the friction in interbank loan-intermediation leads to a wedge between home and foreign discount rates. Given equal r_t^b and r_t^m across countries, it introduces a positive slope to the optimal supply of credit to firms and, importantly, households. The latter therefore are not exposed to the same borrowing rates and may have diverging consumption growth

[13] These ownership shares are calculated as long-run shares of revenues that the global bank earns in a respective country, e.g., $\mu^{\mathrm{GB}} = \frac{L r^{l,\mathrm{GB}} + M r^m}{\left(L^{\mathrm{GB}} + L^{\mathrm{GB}*}\right) r^{l,\mathrm{GB}} + \left(H^{\mathrm{GB}} + H^{\mathrm{GB}*}\right) r^{h,\mathrm{GB}} + (M + M^*) r^m}$.

[14] Because firms are owned by the households, the effective friction from having to pre-finance the wage bill and investment arises as a spread betwen the effective cost of external financing and the borrowing rate faced by the households.

paths. Finally, we incorporate local banking shocks directly into the optimality condition by imposing a country-specific wedge on the equilibrium interbank loan rates, demanded by the global bank. These shocks are mean-zero and idiosyncratic across countries, and shift a respective loans supply schedules up. In particular, a positive local banking shock would result in local bank demanding higher interest rates from its borrowers, as its own cost of funds rises. Due to a positive mark-up spread ($MU^{\mathrm{LB}} > MU^{HH}$), the effective spread for the firms rises and they cut on production, employment, investment and credit. Obviously, the real effects of the local banking shocks are most pronounced in countries, in which firms and households are particularly dependent on credit from local bank (low B2N).

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

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

where β is the discount factor, σ is the coefficient of risk aversion, ψ is the inverse 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 (homogeneous 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

$$C_t + H_{t-1}\left(1 + r_{t-1}^h\right) = W_t N_t + (1-\lambda)\mathrm{DIV}_t + \mu(\lambda \mathrm{DIV}_t + \lambda^* \mathrm{DIV}_t^*) + \Pi_{t-1}^{\mathrm{LB}} + \mu^{\mathrm{GB}} \Pi_{t-1}^{\mathrm{GB}} + H_t,$$

where on the right-hand side total income is split between the total payroll, $W_t N_t$, dividend payments from directly owning the home firm, $(1-\lambda)\mathrm{DIV}_t$, dividend payments from holding the diversified portfolio of firms, $\mu(\lambda \mathrm{DIV}_t + \lambda^* \mathrm{DIV}_t^*)$, and total profits from local and global banks, $\Pi_{t-1}^{\mathrm{LB}} + \mu^{\mathrm{GB}} \Pi_{t-1}^{\mathrm{GB}}$. The household can smooth consumption over time by taking loans from global and local banks: $H_t = H_t^{\mathrm{GB}} + H_t^{\mathrm{LB}}$.

Similar to the firm loans framework, we assume that households can satisfy up to a fraction (κ) of their total loan demand by taking a loan from the global bank, $H_t^{\mathrm{GB}} = \kappa H_t$, and have to finance the rest by loans from local banks, $H_t^{\mathrm{LB}} = (1-\kappa) H_t$. The effective household borrowing rate (r_t^h) thus arises as a weighted average of the lending rates offered by global ($r_t^{h,\mathrm{GB}}$) and local ($r_t^{h,\mathrm{LB}}$) banks, respectively: $r_t^h = \kappa r_t^{h,\mathrm{GB}} + (1-\kappa) r_t^{h,\mathrm{LB}}$. The parameter κ thus measures the integration of consumer retail loan markets and increases with direct cross-border lending and decreases with indirect cross-border lending. A higher value of κ means that households are less exposed to domestic lending conditions through a better access to an EMU-wide interest rate, which shields them from idiosyncratic banking shocks and domestic interest rate variability due to frictions in interbank loan markets.

Models without additional frictions are known to produce positive responses of employment and output to interest rate shocks, as a negative shock to discount factors leads to a decrease in discounted lifetime wealth. An optimizing household responds by expanding its labor supply to compensate for an increase in the marginal cost of consumption, such that in equilibrium employment rises on impact, as does output, while wages plummet. To counteract this mechanism, we introduce real wage rigidities in a reduced form as proposed by Blanchard and Galí (2007), as follows:

$$\log W_t = \gamma \log W_{t-1} + (1-\gamma) \log MRS_t,$$

where MRS_t is the impied marginal rate of substitution, arising from optimal choice of labor by the household; i.e., $MRS_t = \Psi N_t^{\psi} C_t^{-\sigma}$, and γ is the persistence parameter, which can be interpreted as an index of real rigidities. This rigidity in real wages prevents an over-reaction of wages and employment and achieves an empirically consistent negative response of labor and output to an interest rate shock.

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.[15] Here, NX_t is total net exports of each country, such that the market clearing condition for the whole world requires:

$$NX_t + NX_t^* = B_{t-1}(1 + r_{t-1}^b) - B_t;$$

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 Bank-to-real sector cross-border banking flows in the model arise as a sum of loans from global banks offered to firms and households: $\text{B2N}_t = L_t^{\text{GB}} + H_t^{\text{GB}}$, while bank-to-bank cross-border bank flows are $\text{B2B}_t = M_t = L_t^{\text{LB}} + H_t^{\text{LB}}$. The current account of each country is therefore given by $CA_t = -\left(\Delta M_t + \Delta L_t^{\text{GB}} + \Delta H_t^{\text{GB}}\right) = -\left(\Delta \text{B2B}_t + \Delta \text{B2N}_t\right)$, and $CA_t + CA_t^* = -\Delta B_t$.

Aggregate GDP in the model is $\text{GDP}_t = Y_t$. Realizing that the difference between the current account and the net exports is equal to the net interest payments from abroad, gross national income (GNI) is defined as $\text{GNI}_t = \text{GDP}_t + CA_t - NX_t$. Net national income (NNI) is then defined as 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 $E_t = \lambda Y \nu^E \frac{K_{t-1}^*}{Y^*}$; i.e., the proportion of the scaled foreign capital that the home country owns through the world mutual fund. This approximation arises as a result of assuming an infinitely large foreign country, and we use the parameter ν^E to match the magnitude in the of E_t in the model and data, as firms are leveraged to the extent that the market value of equity is a fraction of the market value of firm capital.

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. The model is solved by log-linearizing

[15] In our model, Γ_t is composed of internal funding cost of the firm, $\widetilde{L_t \iota}$, and all (second-order) adjustment costs.

around the deterministic steady-state. 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 Model results

5.1 Understanding risk-sharing mechanisms

Before we move on to study its quantitative implications, in this subsection we present a stylized version of of our model in order to build intuition on how the different forms of financial integration—equity market integration, direct, and interbank integration—map into our decomposition of risk sharing channels. To this end, we focus on the optimal consumption decision by the household in a simple case with log-utility. Combining the consumption Euler equation with the budget constraint, we can approximate the consumption-income ratio as

$$\frac{C_t}{\textsc{inc}_t} = (1-\beta)\left(-\frac{H_{t-1}}{\textsc{inc}_t}\left(1+r^h_{t-1}\right)+\sum_{s=0}^{\infty}\mathbb{E}_t\left[\frac{\textsc{inc}_{t+s}}{\textsc{inc}_t}\times\prod_{j=1}^{s}\left(1+r^h_{t+j-1}\right)^{-1}\right]\right) \tag{4}$$

where $\textsc{inc}$ denotes household income and is defined as follows:

$$\textsc{inc}_t = \textsc{labinc}_t + (1-\lambda)\textsc{div}_t + \mu(\lambda\textsc{div}_t + \lambda^*\textsc{div}^*_t) + \textsc{bankinc}_t, \tag{5}$$

with $\textsc{labinc}_t \equiv W_t N_t$ denoting labor income and $\textsc{bankinc}_t \equiv \Pi^{\mathrm{LB}}_{t-1} + \mu^{\mathrm{GB}}\Pi^{\mathrm{GB}}_{t-1}$ income from bank profits.

Equation 4 states that, for a given expected path of discount rates, r^h_{t+j-1}, fluctuations in income over time will map into fluctuations in the consumption-income ratio as the consumer tries to smooth consumption over time. This is the classical permanent income result that is familiar from this type of model and it provides a natural starting point for our discussion of risk sharing channels. Note that variation in the discount rate faced by the household, r^h_{t+j}, will lead the household to adjust consumption *given* income. This feature of the permanent-income model is also sometimes refered to as consumption-tilting.

In our model, local banking shocks–which we assume only occur in crisis times—translate into counter-cyclical variation in the interest rate faced by consumers. This induces the consumer to make consumption less smooth than it would otherwise be. Specifically, the less direct banking integration there is in consumer lending (i.e., the lower κ), the more the household will be exposed to the variation in interest rates offered by the local bank. In the limit, if there is no direct banking integration in consumer lending at all, the household can smooth consumption only by taking out loans from or by depositing funds in the local bank. Then, given income, local banking sector shocks will force the household to smooth consumption less, exactly as we observed during the crisis.

Importantly, direct banking integration also affects income, very much as equity market integration does. To see why, note that both direct banking integration for firms and equity integration impact current and future income on the right hand side of (4). However, while both equity and direct banking integration affect income, they do so in different ways.

Increased equity market integration provides risk sharing by decoupling a country's current and future income from its output by diversifying dividend income internationally. For given fluctuations in output, this leads to income movements that are less correlated with local output. In our metric this shows up as income smoothing.

Income smoothing, however, can also happen through direct banking integration. Differently from equity integration, in our model this occurs because banking integration affects the stochastic structure of dividend and labor income. To see this, note that both dividend and labor income are functions of the effective interest rate at which the firm can refinance itself which we can write as the weighted average of the lending rate of the global and local banks, $r_t^l = \tau \times r_t^{l,\mathrm{GB}} + (1-\tau) \times r_t^{l,\mathrm{LB}}$, where τ is the parameter measuring direct banking integration for firms. Specifically, the asymmetric response of output, labor income, and dividends to a local banking shock will be muted by direct banking integration, because it insulates the firm from variation in local lending rates. Thus, income is effectively smoothed by shielding firm's activities from variation in the lending rate of the local banks.

In the model, direct banking integration also affects income smoothing after an idiosyncratic productivity shock. An increase in direct banking integration is not only a substitution of credit away from local banks, it also amounts to an increase in the total amount of credit available to firms. If the share of the firms' expenses that can be prefinanced through loans increases, this dampens the need to smooth dividends by cutting down on wage and investment expenses after a negative productivity shock. This increases the conditional correlation between labor and dividend income and because both labor and dividends now comove more strongly in the same direction, there is a stronger idiosyncratic movement in output. For a given level of equity diversification, this implies that a larger share of the variance of country-specific GDP movements gets smoothed via cross-border dividend income flows.We expect this mechanism to be particularly important in tranquil times, when TFP shocks drive the variation the data. While banking and equity market integration are exogenous in our model, this mechanism also suggests that there is a potentially important complementarity between equity market and banking integration: if agents were allowed to choose optimal levels of banking and equity market integration (subject to some cost), then we would expect direct banking integration and equity market integration to be strongly correlated in the cross-section. This could explain our findings in Table 3, where equity and direct cross-border lending appear collinear but, jointly, have a very strong impact on income smoothing.

Finally, consider the role of interbank integration for risk sharing. Interbank integration allows the local bank to elastically accomodate fluctuations in credit demand by households and firms. In our model, such fluctuations in credit demand arises as a consequence of TFP shocks. Because interbank integration allows local banks to access the EMU-wide interbank rate in response to such shocks, it has risk sharing benefits similar to those resulting from direct banking integration in tranquil times, when TFP shocks dominate the data. However, interbank integration will not be able to shield firms and households from the fallout of local banking sector instability itself. Thus, the risk sharing benefits from direct as opposed to interbank integration are particularly relevant in times of crisis: because direct banking integration insures firms against fluctuations in borrowing rates, income reacts less to the local banking crisis, and because it insulates households from countercyclical fluctuations in local bank's lending rates, consumption smoothing also drops less.

5.2 Quantitative results from the model

We run the channels decomposition reported in Table 1 on model-generated data calibrated to tranquil times (the benchmark) and crisis times. The results are presented in Table 8, which reports the model-generated estimates of income smoothing, consumption smoothing, and fraction not smoothed. The model is able to match the risk sharing patterns in the EMU-data closely: in tranquil times, see the row labeled 1998–2008, 7% of shocks are smoothed by international income flows, 47% are smoothed via procyclical saving, and 45% are unsmoothed. This pattern of risk sharing is very similar to the empirical estimates found for the EMU prior to the crisis. During crisis times, as reported in the row labeled 2009–2013, income smoothing is 10%, while consumption smoothing drops sharply to 31%, leaving 57% of shocks unsmoothed—these results are also very similar to those found for the EMU for the 2009–2013 period.

Table 9 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. The results in Table 9 match the corresponding empirical regressions well. From the first block (first three columns) of Panel A, total banking integration is strongly associated with more risk sharing and, from the second block of regressions, so is bank-to-bank lending. From the last two blocks of results in columns (7)-(12), bank-to-nonbank lending is associated with significantly more income smoothing and, as in the data, the point estimate on consumption smoothing is negative. This partly reflects that the coefficients sum to unity (when depreciation is included). When income is smoothed more, there is less scope for smoothing of consumption.[16] The salient feature of our empirical results is 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: though both direct and interbank integration appear positively related to risk sharing in tranquil periods, the coefficients on direct integration are generally much bigger than on interbank integration. Hence, it is in particular direct banking integration that increases income smoothing, as does equity market integration. Conversely, interbank positions are not as 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 the key vehicle for income smoothing (interest payments is another source of income flows across countries). Bank-to-bank lending 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 direct lending, and as in the empirical regressions, we obtain a more precisely estimated coefficient for this interacted regressor. Note also, that once we consider both equity and direct banking integration in the regressions, the impact of interbank lending on risk sharing becomes insignificant, as in the data.

For the crisis period, we re-estimated the regressions in Tables 2 and 3, but we do not tabulate the results, which mimic those of Panel B in Table 2 in that the coefficients are insignificant. In our model, this can be explained by the large global liquidity shock which impliess that the common variability in

[16]This finding of a negative coefficient to direct banking integration on consumption smoothing mirrors the findings in Hoffmann and Shcherbakova-Stewen (2011), 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.

interbank positions dominates in the data. This makes it hard to identify the cross-sectional link between banking positions and risk sharing. Hence, the model also allows us to understand why our empirical regressions find insignificant interaction terms for the crisis period.

How would the patterns of risk sharing in the eurozone change if we increased (lowered) each country's foreign equity holdings and/or its level of direct banking integration? Using the model, we can evaluate the impact of increasing these variables in tandem. The results, presented in Table 10, reveal that in our model banking integration and equity integration are complements. At a low level of equity market integration, increasing direct banking integration increase risk sharing through the income smoothing channel by 2% (compare columns 1 and 4 in the row labeled "Low" for equity market integration). When the level of equity market integration is high, the same change in direct banking integration increases income risk sharing by 4% (compare columns 1 and 4 in the row labeled "High" for equity market integration). This implies that banking and equity-market integration are both important. First, labor income can typically not be smoothed through equity markets, leaving a role for other smoothing mechanisms such as banking integration but, second, banking and equity-market integration may reinforce each other—a potentially important finding that has not been previously identified.

To understand the mechanism underlying this complementarity more closely we, in Figure 3, plot the model-generated impulse responses of GDP, consumption, dividends, and GNI to an idiosyncratic TFP shock under three regimes: (1) the baseline specification, in which a hypothetical country is calibrated to a sample-average country in terms of all parameters, including direct and indirect baning integration; (2) high direct banking integration (high B2N), in which we inrease this country's B2N measure to the upper range value of 0.60; and (3) high interbank integration (high B2B), in which we inrease this country's B2B measure to the upper range value of 1.50. The foreign country (rest of the EMU) is kept the same across all scenarios. The figure shows that the response to GDP is very similar in all three scenarios. However, the consumption responses to a domestic TFP shock varies across the scenarios, with the high direct banking integration and the high interbank integration scenarios leading to more muted consumption responses. This is in line with our findings that banking integration has clear risk sharing benefits, and in tranquil times (when TFP shocks dominate) direct and indirect integration are qualitatively similar in their impact on risk sharing. The impulse responses of dividends show why this is the case: moving from baseline levels to high banking integration makes dividends considerably more volatile. This happens because banking integration in our model essentially reflects a shift from (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 loans (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. This is exactly the pattern we see from the response of GNI, which is clearly less senstive to the shock when banking integration is high.

In Figure 4, we show the responses of GDP, consumption, dividends, and GNI to a negative local banking shock. Again, we report results for the baseline, high direct and high interbank integration scenarios. Now, the high direct and interbank integration scenarios differ considerably. First, the impact of the local banking sector shock on output is mitigated under direct integration, while it is amplified (relative to the baseline case) in the high interbank-integrations scenario. The same ranking is apparent for the overall impact on consumption, with direct integration dominating both the baseline and, in particular, the high interbank integration scenario. The responses of dividends and GNI elucidate why direct banking integration provides better risk sharing against the local banking sector shock: direct banking integration leads to a dampening of the countercyclical response of dividends while interbank integration amplifies it.[17] Because direct banking integration increases the procyclicality in dividends, equity market integration has more traction in providing income smoothing, as we wee from the muted response of GNI in the high B2N scenario. This illustrates that the complementarity between equity market and direct banking integration plays out particularly strongly in crisis times.

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 show 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, direct banking integration (in terms of bank-to-real sector flows or cross-border consolidation of banks) remained limited. We find that direct 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 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 country-specific banking shocks that lead to a breakdown in interbank markets. In our model, shocks to the interbank markets hit local banks which try to pass on the increse in their cost of funds to household and firm borrowing rates. This drives up domestic interest rates, making consumption smoothing expensive for households. It is this

[17] Dividends are countercyclical in the crisis, because the banking shock leads to a large drop in firm investment which drives up firm profits.

feature of our model that drives the breakdown in risk sharing during a crisis, 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 national banking-sector 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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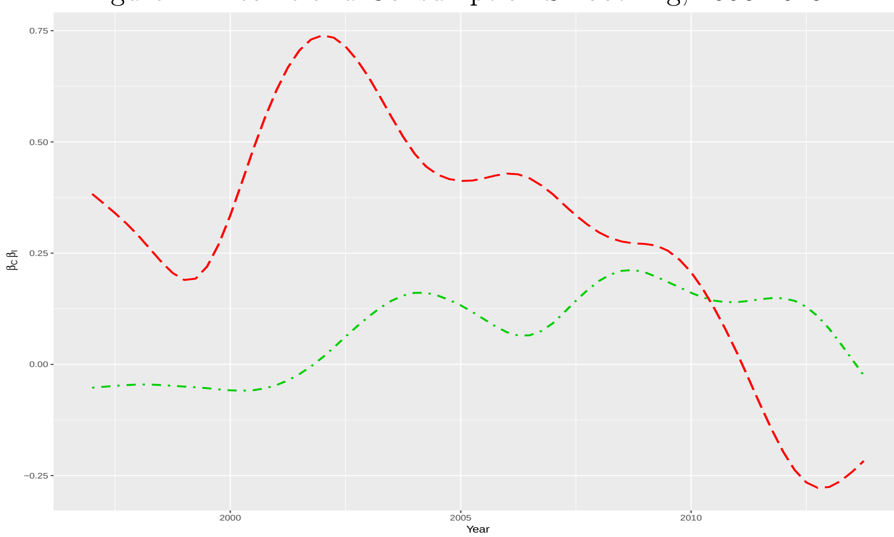
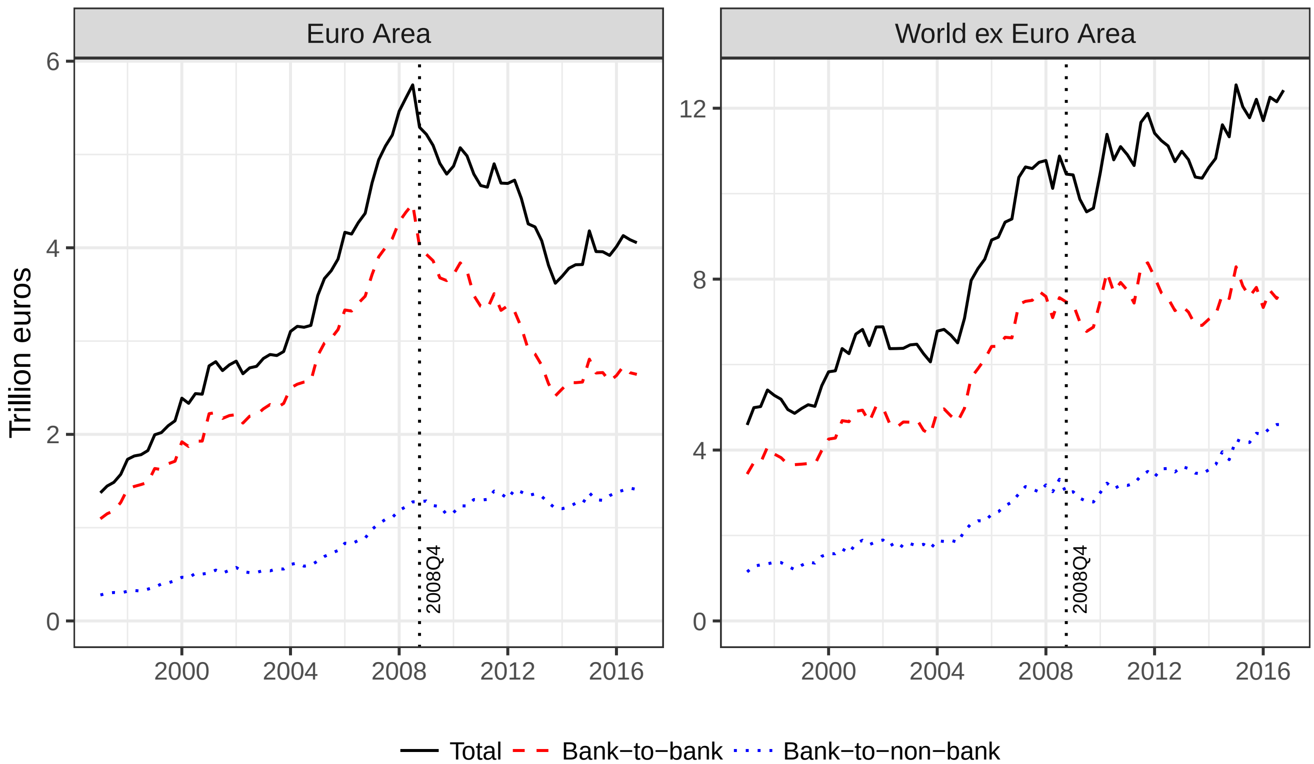
Figure 1: Income and Consumption Smoothing, 1998-2013



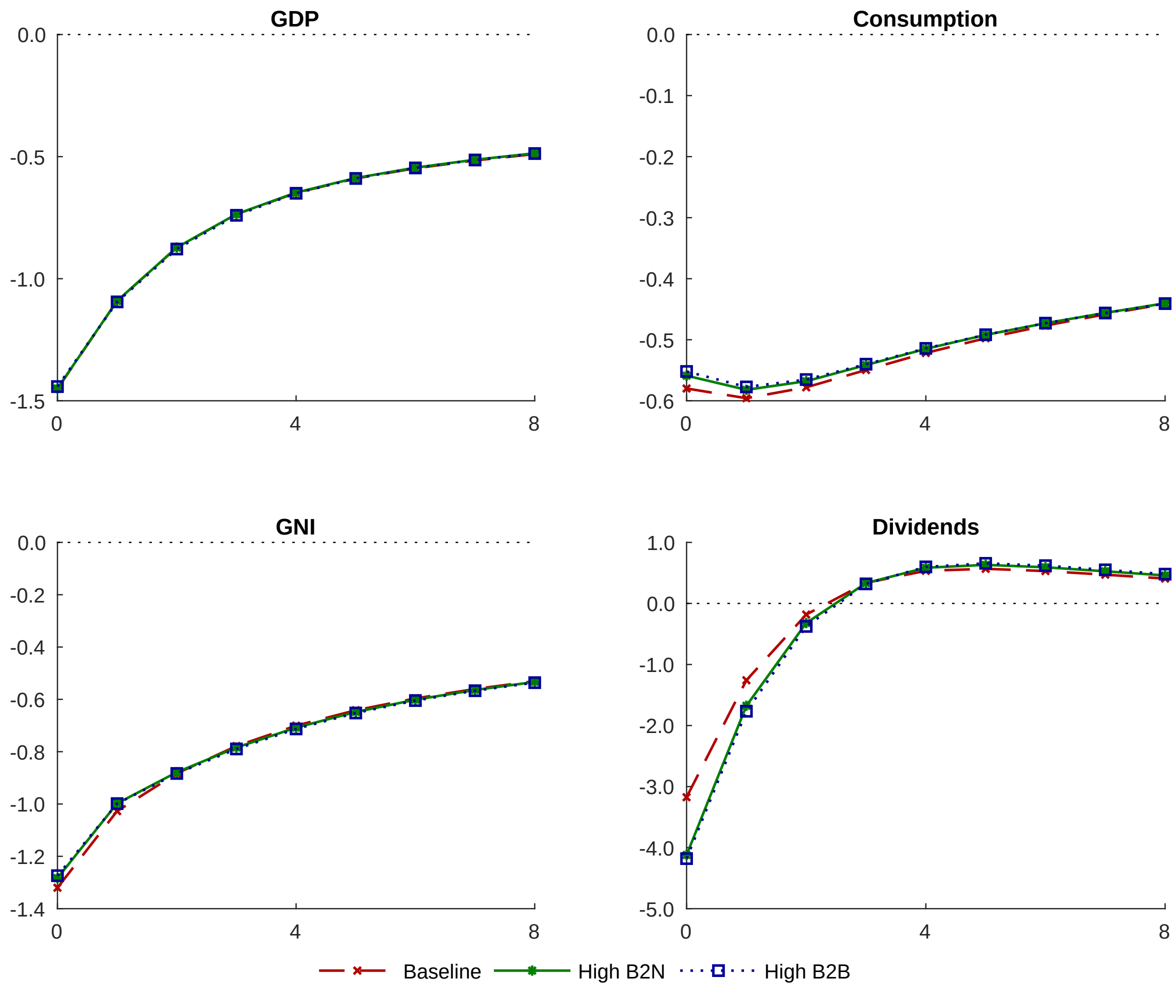
NOTES: The figure plots the degree of income smoothing ($\beta_I(t)$, green dot-dashed line) and consumption smoothing ($\beta_C(t)$, red long-dashed line). The coefficients $\beta_I(t)$ and $\beta_C(t)$ are estimated from cross-sectional regressions $\widetilde{\Delta gdp_t^k} - \widetilde{\Delta gni_t^k} = \beta_I(t)\widetilde{\Delta gdp_t^k} + \tau_t + \epsilon_t^k$ and $\widetilde{\Delta nndi_t^k} - \widetilde{\Delta c_t^k} = \beta_C(t)\widetilde{\Delta gdp_t^k} + \tau_t + \epsilon_t^k$ for each quarter from $t = 1996Q1 \ldots 2013Q4$, where $\tilde{}$ 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 ($\widetilde{\Delta gdp_t^k} - \widetilde{\Delta gni_t^k}$) and represents income smoothing via cross-border ownership. Coefficient β_C yields the amount of output risk captured by savings ($\widetilde{\Delta nndi_t^k} - \widetilde{\Delta c_t^k}$) 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 the HP-filter with smoothing parameter of 250.

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



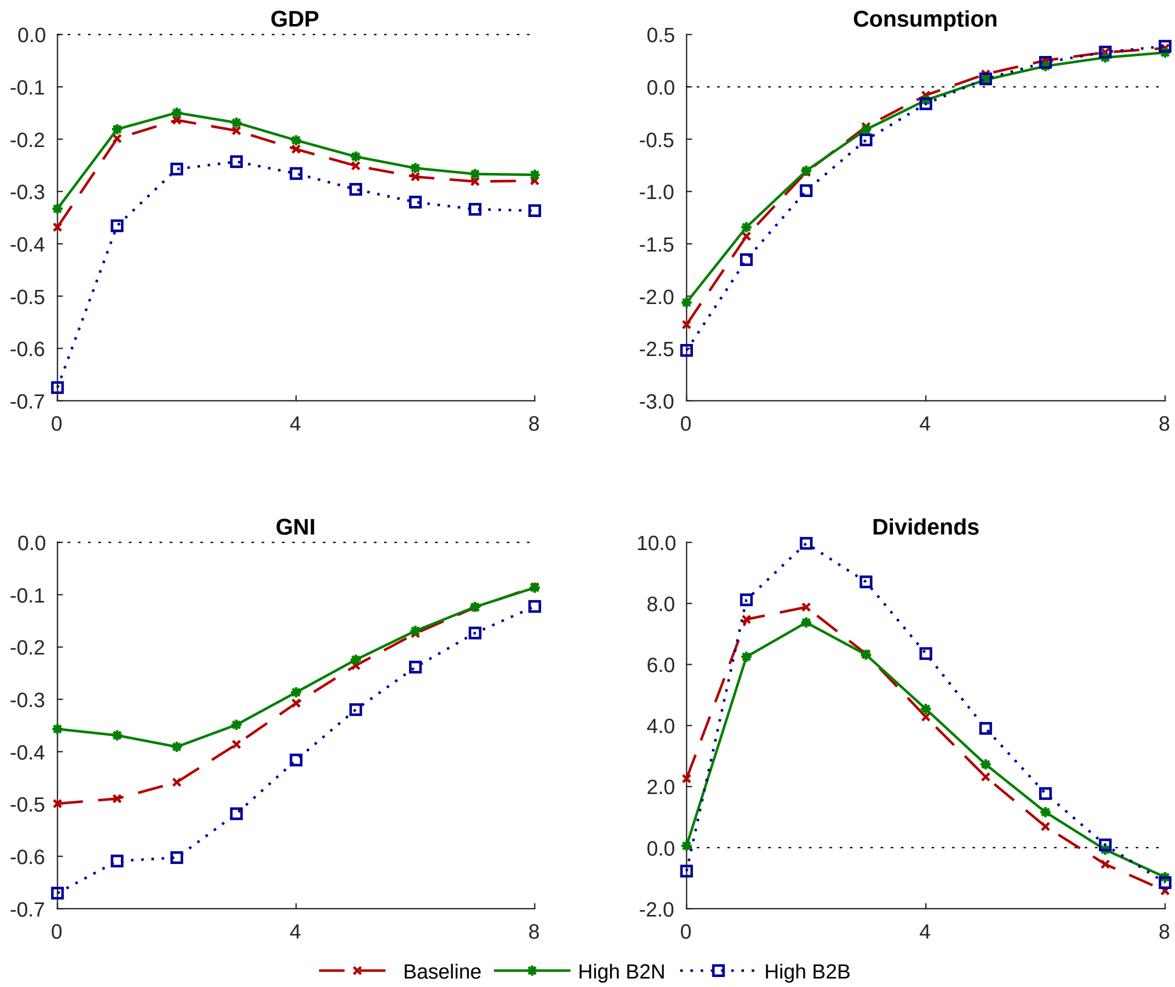
NOTES: The figure plots cross-border lending by foreign banks to 19 eurozone economies ("Euro Area") and a sample of 118 other advanced and developing countries ("World ex Euro Area"). The black solid line shows total lending, the red dashed line shows lending by foreign banks to domestic banks, and the blue dotted line shows lending by foreign banks to the domestic non-bank sector (including governments). All values are in trillion euros. The source is BIS locational banking statistics database.

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



NOTES: The figure plots the model impulse response functions of home country GDP, Consumption, GNI and firm dividends to the home TFP shock. Three scenarios are presented: (1) Baseline, in which all variables are set to average values: dashed red line with (*); (2) High B2N scenario, in which B2N is set to the upper range value of 0.60: solid green line with (*); and (3) High B2B scenario, in which B2B is set to the upper range value of 1.50: dotted blue line with (*). The foreign country is calibrated from the baseline values in both scenarios. Baseline values are: for EQ: 0.30; B2B: 1.00; B2N: 0.30 . All impulse responses are percentage deviations from steady state. Number of quarters following the shock is on the x-axis.

Figure 4: Model impulse response functions to a domestic local banking shock



NOTES: The graph plots the model impulse response functions of home country GDP, Consumption, GNI and firm dividends to the home local banking shock. Three scenarios are presented: (1) Baseline, in which all variables are set to average values: dashed red line with (*); (2) High B2N scenario, in which B2N is set to the upper range value of 0.60: solid green line with (*); and (3) High B2B scenario, in which B2B is set to the upper range value of 1.50: dotted blue line with (*). The foreign country is calibrated from the baseline values in both scenarios. Baseline values are: for EQ: 0.30; B2B: 1.00; B2N: 0.30 . 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 the subscript on β being $X = I$, D, F, C, and U, respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, indicated with a *-superscript, $\Delta x = \Delta log\left[X_t^k / X_t^*\right]$. $\boldsymbol{d}_{Xt}^k$ 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, and Portugal.
Non-EMU: Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Sweden, and the UK.

Table 2: Risk Sharing and cross-border bank lending

Panel A: 1998-2008

interactions with $\Delta\widetilde{gdp}_t^k$	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 with $\Delta\widetilde{gdp}_t^k$	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U	β_I	β_c	β_U
$1 \times \Delta\widetilde{gdp}_t^k$	0.006	**0.328**	**0.821**	0.003	**0.331**	**0.820**	0.030	**0.305**	**0.813**	0.008	**0.331**	**0.819**
	(0.08)	(2.55)	(6.39)	(0.03)	(2.57)	(6.18)	(0.35)	(2.71)	(5.94)	(0.11)	(3.75)	(6.10)
$\widetilde{\frac{TB_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$	0.026	-0.053	-0.002									
	(0.41)	(-0.36)	(-0.02)									
$\widetilde{\frac{B2B_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$				0.032	-0.077	-0.008				0.022	-0.068	0.005
				(0.39)	(-0.48)	(-0.06)				(0.33)	(-0.48)	(0.04)
$\widetilde{\frac{B2N_{t-1}^k}{GDP_{t-1}^k}} \times \Delta\widetilde{gdp}_t^k$							0.180	-0.149	-0.030	0.081	0.006	-0.013
							(0.76)	(-0.43)	(-0.12)	(0.40)	(0.02)	(-0.05)

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 $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ for the subscript on β being $X = I$, C, and U, respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, indicated with a *-superscript, $\Delta x = \Delta log\left[X_t^k / X_t^*\right]$. $\beta_X^k(t)$ 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, and Portugal. Time period is specified in the panel headings.

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

	1998-2008											
interactions with $\Delta\widetilde{gdp}_t^k$	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 $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ for the subscript on β being $X = I$, C, and U, respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, indicated with a *-superscript, $\Delta x = \Delta log\left[X_t^k / X_t^*\right]$. $\beta_X^k(t)$ 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, and Portugal. Time period is specified in the panel headings.

Table 4: Risk sharing and saving components

Time span		*GIPS*				*Non−GIPS*			
		β_I	β_C		β_U	β_I	β_C		β_U
			public	private			public	private	
1998-2008	$\Delta\widetilde{gdp}_t^k$	0.078	0.203	0.148	0.557	0.202	0.238	0.310	0.350
		(2.52)	(0.71)	(0.37)	(4.58)	(1.54)	(2.51)	(0.74)	(3.54)
2009-2013	$\Delta\widetilde{gdp}_t^k$	−0.06	0.038	−0.014	1.190	0.325	0.293	0.008	0.419
		(−0.56)	(0.53)	(−0.08)	(10.13)	(4.50)	(3.56)	(0.03)	(3.42)

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 $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ for the subscript on β being $X = I$, C, and U, respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, indicated with a *-superscript. β_C is decomposed into contributions from public and private savings by performing similar regressions with $\Delta x = \Delta\left(\widetilde{\frac{S_{Public}}{C}}\right)$ or $\Delta x = \Delta\left(\widetilde{\frac{S_{Priv}}{C}}\right)$, where S_{Public} and S_{Priv} are public and private saving, respectively and $S_{Public} + S_{Priv} = S = NNDI - C$. $\boldsymbol{d}_{Xt}^k$ contains country and time fixed effects. Standard errors are in parentheses and clustered by country.

GIPS-countries are Greece, Italy, Spain and Portugal. Non-GIPS-countries are Belgium, Germany, Finland, France, Netherlands, and Austria.

Table 5: Model calibration

Parameter	Description	Value
β	Households' discount factor	0.98
ψ	Inverse of Frisch elasticity	2
σ	Households' risk aversion	1
γ	Index of real wage rigidities	0.80
ρ^{SOA}	Speed of adjustment in dividend smoothing	0.45
α	Capital intensity in firms production function	0.35
φ^{I}	Investment adjustment cost parameter	5
δ	Capital depreciation in steady-state	0.025
ι	Cost of alternative sources of funds to firms	0.04
ν^{E}	Implicit equity-to-capital ratio of firms	0.10
φ^{LB}	Local bank adjustment cost in interbank markets	0.002
MU^{LB}	Mark-up on credit from local banks	3
MU^{GB}	Mark-up on credit from global banks	1.5
MU^{HH}	Mark-up on credit to households (all banks)	1.5
ρ^{θ}	TFP shocks autocorrelation coefficient	0.95
ρ^{gbs}	Global banking shock autocorrelation coefficient	0.95
ρ^{lbs}	Local banking shock autocorrelation coefficient	0.80
σ^{θ}	Standard deviation of TFP shocks	0.007
σ^{gbs}	Standard deviation of global banking shock (in crisis periods, 0 in baseline)	0.03
σ^{lbs}	Standard deviation of local banking shock (in crisis periods, 0 in baseline)	0.008

NOTES: 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). The values for equity and banking market integration, λ, τ, κ, and ϕ (degrees of capital market integration, firm openness to global bank loans, households openness to global bank loans, and integration in interbank credit, resp.), are fixed by the country-specific calibration of equity, B2N and B2B, as well as the following rule for calibrating B2N and B2B: an increase in B2N results in a rise in global bank loans to firms and households in equal proportions without further increasing respective loans from the local bank, while an increase in B2B results in a rise in local bank loans to firms and households in equal proportions without further increasing respective loans from the global bank. The values of other model parameters Ψ, μ and μ^{GB} are derived from steady-state restrictions.

Table 6: Raw values for 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	1.11	0.26	0.25

NOTES: All values are relative to GDP and constructed from real data as pre-2008, within-country averages. The EMU values are averages of respective country values. These values are scaled to the range $0.10 - 0.60$ for B2N, $0.60 - 2.00$ for B2B and $0.10 - 0.60$ for equity in the actual model calibration to deal with the extreme values.

Table 7: Business cycle statistics

	Baseline		High B2N		High B2B		Data	
	St.Dev.	Corr.	St.Dev.	Corr.	St.Dev.	Corr.	St.Dev.	Corr.
GDP	1.57*		1.57*		1.57*		1.45*	
Consumption	0.52	0.87	0.51	0.85	0.51	0.85	0.66	0.73
Investment	2.34	0.65	2.30	0.63	2.38	0.61	2.94	0.84
Employment	0.80	0.91	0.80	0.91	0.80	0.91	0.62	0.75
Net exports	0.90	0.43	1.03	0.38	1.05	0.38	1.43	–0.26

NOTES: The table reports theoretical and empirical standard deviations ("St.Dev.") and correlations ("Corr.") of the variables. The theoretical moments are shown for three scenarios: (1) Baseline, in which all variables are set to average values; (2) High B2N scenario, in which B2N is set to the upper range value of 0.60; and (3) High B2B scenario, in which B2B is set to the upper range value of 1.50. The foreign country is calibrated from the baseline values in both scenarios. Baseline values are: 0.30 for equity, 1.00 for B2B, and 0.30 for B2N. The empirical moments are averages across 10 countries in our sample: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. All statistics are obtained from applying the HP-filter to variables in logarithms. Standard deviations are the ratio of the standard deviation to the standard deviation of GDP (except for net exports, which is the standard deviation of net exports-to-GDP ratio in percentage points).

Table 8: Basic Risk Sharing: Model

		β_I	β_C	β_U
1998–2008	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.07^{***}	0.47^{***}	0.45^{***}
		(7.62)	(57.21)	(48.50)
2009–2013	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.10	0.31	0.57^{**}
		(1.26)	(1.63)	(2.51)

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 $(\widehat{\beta}_i)$ as $mean(\widehat{\beta}_i)/std(\widehat{\beta}_i)$, where the subscript i denotes the i-th simulation. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal.

Table 9: Risk sharing, cross border bank lending and equity holdings: Model pre-crisis simulations

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
$1 \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.07***	0.48***	0.44***	0.07***	0.48***	0.44***	0.06***	0.47***	0.46***	0.06***	0.48***	0.45***
	(9.99)	(65.34)	(43.06)	(9.70)	(64.29)	(43.07)	(9.96)	(62.87)	(48.64)	(10.80)	(65.00)	(43.84)
$\widetilde{\frac{\mathrm{TB}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.12***	–0.09***	–0.05**									
	(6.62)	(–5.68)	(–2.54)									
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.12***	–0.10***	–0.06**				0.07***	–0.06***	–0.03
				(6.30)	(–5.32)	(–2.45)				(3.40)	(–2.70)	(–0.98)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.78***	–0.84***	–0.16	0.47***	–0.49***	–0.11
							(6.34)	(–5.88)	(–0.91)	(3.22)	(–3.03)	(–0.53)

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
$1 \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.06***	0.47***	0.45***	0.07***	0.48***	0.44***	0.06***	0.47***	0.45***	0.06***	0.48***	0.45***
	(10.95)	(72.75)	(45.54)	(11.13)	(73.70)	(40.16)	(11.50)	(72.19)	(47.03)	(11.08)	(67.54)	(40.55)
$\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.47***	–0.44***	–0.14**	0.39***	–0.42***	–0.07	0.36***	–0.45***	–0.01			
	(8.38)	(–9.27)	(–2.29)	(5.49)	(–6.03)	(–0.64)	(6.86)	(–7.12)	(–0.14)			
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.04**	–0.00	–0.05				0.03	0.00	–0.04
				(2.41)	(–0.09)	(–1.56)				(1.46)	(0.08)	(–1.10)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.27**	–0.17	–0.18			
							(2.41)	(–1.19)	(–0.86)			
$\left(\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} + \widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}}\right) \times \Delta\widetilde{\mathrm{gdp}_t^k}$										0.29***	–0.33***	–0.03
										(4.97)	(–6.20)	(–0.38)
N	440	440	440	440	440	440	440	440	440	440	440	440

NOTES: 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 $x_t = \widetilde{gdp}_t^k - \widetilde{gni}_t^k$, $\widetilde{nni}_t^k - \widetilde{c}_t^k$, $\widetilde{c}_t^k$ 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 and/or cross-border equity holdings, as listed in the first column. $\boldsymbol{d}_{Xt}^k$ 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 $(\widehat{\beta}_i)$ as $mean(\widehat{\beta}_i)/std(\widehat{\beta}_i)$, where the subscript i denotes the i-th simulation. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, Portugal. The calibration assumes tranquil times and simulations have been done for 48 quarters, corresponding to pre-crisis period in the data (1997Q1–2008Q4).

Table 10: Risk-sharing under different scenarios. (Baseline calibration.)

		B2N integrarion					
		Low			High		
		β_I	β_C	β_U	β_I	β_C	β_U
Equity integration	Low	0.01	0.52	0.47	0.03	0.53	0.44
	High	0.14	0.38	0.45	0.18	0.36	0.42

NOTES: The table reports the model 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. All countries are assumed to be identical in the equity and B2N calibration. Low capital integration refers to a scenario in which equity is set to a value 50% below the mean, while high capital integration is set to a value 50% above the mean. Low direct banking integration refers to a scenario in which B2N is set to a value 50% below the mean, while high real banking integration is set to a value 100% above the mean. The calibration assumes tranquil times and the simulations have been performed using 1000 model simulations, each spanning 1000 quarters.

Appendix: mapping the model to the data

Calibration We calibrate the baseline model at the quarterly frequency using parameter values displayed in Table 5. The business cycle properties of the calibrated model are given in Table 7. In particular, we present the standard deviations relative to standard deviation of GDP (except for net exports, which is a standard deviation of net exports-to-GDP ratio in percentage points) and correlation with domestic GDP of consumption, investment, employment, net exports and GDP (absolute standard deviation in percentage points). All statistics are obtained from applying the HP-filter to variables in logarithms.

Because we match per capita moments, the size of each "home" economy is normalized to one. And because the "foreign" country represents "the rest of the EMU," we normalize its size to nine; i.e., the number of countries in the sample minus one. Regarding the parameters which are common for all countries, some of them are standard in the literature and have been accordingly calibrated. Households are net borrowers and their discount factor β is set to 0.98, to match the steady-state quarterly net lending rate of 2%. 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.

The production function is 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 5 to achieve plausible values for the relative volatility of HP-filtered investment with respect to GDP over the whole sample, which is approximately 2.3 in normal times and rises sharply in the crisis. The cost of alternative sources of finance to firms (ι) is set to 4%, which is twice as large as the steady-state consumer loans rate, to ensure that bank credit is preferred to internal funds in normal times. We use a value for the speed of adjustment for dividend smoothing (ρ^{SOA}) of 0.45, which corresponds to the findings in Javakhadze et al. (2014), who report estimates for an international sample, including some European countries. The index of real wage rigidities, γ, is set to 0.80, consistent with Blanchard and Galí (2007). We choose mark-ups of 3 and 1.5 for the loans extended to firms by local (MU^{LB}) and global banks (MU^{GB}), respectively. These values are in line with the estimates in Gerali et al. (2010), while we choose a smaller mark-up for loans from global banks as those are usually applied to credit extended to larger firms and are not subject to the same discretionary price setting as loans to small and medium-sized firms. The markup for loans to households (MU^{HH}) is set to 1.5 for both banks— a relatively low value as households usually engage in a collateralized borrowing (e.g., mortgages) with standardized contract details.

The heterogeneity across simulations (for 10 EMU countries in the sample) comes from choosing the degrees of capital market integration (EQ), direct banking integration (B2N) and bank-to-bank integration (B2B)—all steady-state values in proportion to GDP—from the data, as showed in Table 6. We deal with outliers by linearly scaling the original values such that $B2N \in [0.10,\ 0.60]$, $B2B \in [0.60,\ 2.00]$ and $EQ \in [0.10,\ 0.60]$. These variables implicitely pin down the following deep model parameters. EQ determines λ from the long-run relation $EQ = \frac{E}{Y} = \lambda \nu^E \frac{K^*}{Y^*}$, and $(B2N,\ B2B)$ determines $(\tau,\ \kappa,\ \phi)$. Remember, that in the model we define B2N as a sum of loans from global banks to firms and households, $B2N = L^{\mathrm{GB}} + H^{\mathrm{GB}}$, and B2B as interbank loans or a sum of loans from local banks to firms and households, $B2B = M = L^{\mathrm{LB}} + H^{\mathrm{LB}}$. Given these definitions, we follow the rule, according to which an increase in B2N results in a rise in global bank loans to firms (L^{GB}) and households (H^{GB}) in equal proportions without further increasing respective loans from the local bank (L^{LB} and H^{LB}), while an increase in B2B results in a rise in local bank loans to firms (L^{LB}) and households (H^{LB}) in equal proportions without further increasing respective loans from the global bank (L^{GB} and H^{GB}). In doing this, we choose values for $\tau = 0.30$ and $\kappa = 0.15$ for an hypothetical country with sample mean values of the calibrated parameters B2N and B2B. The value of parameter τ has been chosen based on the data from the BIS Total credit database, which reveals that the average share of home bank credit to total credit availale to firms in the countries in our sample lies between 0.6 and 0.7. Although imprecise (as, e.g., total credit in these data also includes bond financing), it is a good proxy for $1 - \tau$ in our model (and is potentially biased downwards). The value for κ has been chosen such as to guarantee that all deep model parameters for all countries are between zero and one, and all steady-state values of endogenous variables are positive.

The dynamics of interbank loans and consumer credit, and therefore, the degree of risk sharing in normal times (governed by the TFP shocks), is determined by the value of the parameter φ^{LB}. We set it to 0.002, at the value which achives to amount of risk-sharing through consumption smoothing at ca. 0.48—the value we found in the data for the pre-crisis period. By the same token, we set the standard deviation of the local banking shocks to 0.008 and the global banking shocks (exogenous supply of money market funds) to 0.03—in order to achieve the drop in consumption smoothing to ca. 0.32 in the crisis times and to ensure similar response of the real output to both types of banking shocks.

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

$$\log \theta_t = \rho^{\theta} \log \theta_{t-1} + \sigma^{\theta} \eta_t.$$

Similarly, the local banking shocks for both countries are as follows:

$$lbs_t = \rho^{lbs} lbs_{t-1} + \sigma^{lbs} \eta_t^{lbs}.$$

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

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

In the setup above, η_t, η_t^{lbs}, $\eta_t^{gbs} \overset{i.i.d.}{\sim} \mathcal{N}(0,\, 1)$, and correspond, respectively, to idiosyncratic TFP shocks, idiosyncratic local banking shocks, and common global banking shocks. All exogenous processes follow autoregressive dynamics with persistence parameters ρ^{θ} and ρ^{gbs} equal to 0.95, and ρ^{lbs} equal to 0.80. For tractability, we assume zero correlation between all shocks. As expained above, we set the standard deviation of banking shocks in crisis times to 0.008 and 0.03 for local and global banking shocks, respectively. The standard deviation of the TFP shocks is chosen consistent with the previous literature as $\sigma^{\theta} = 0.007$.