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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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Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?*

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This version: May 2019.

Abstract

We study channels of risk sharing in the EMU before and after 2008, when the Great Recession started. Empirically, higher cross-border equity holdings and more direct bank-to-nonbank lending are associated with more risk sharing while interbank integration is not. Equity market integration in the EMU remains limited while banking integration is dominated by interbank integration. Further, interbank integration proved to be highly procyclical, which contributed to a freeze in risk sharing after 2008. Based on this evidence, and results from simulations of a stylized DSGE model, we discuss implications for banking union. Our results show that direct banking integration and capital market integration are complements and that robust risk sharing in the EMU requires integration on both fronts.

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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 between eurozone countries 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 achieved 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 patterns 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.

Following a large academic literature in macroeconomics, we define "risk sharing" as the ability of a country to insulate its consumption from shocks to its own output, after controlling for the component of output growth that is common across countries. Based on this definition, Asdrubali et al. (1996) 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 (such as dividends and interest) 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. We organize our empirical analysis following this approach and we study the behavior of these risk sharing channels in simulated data from a DSGE model, which has not been done previously in the literature.

The inception of the euro led to increased risk sharing between eurozone countries, but from a low level and mainly through pro-cyclical saving. Income smoothing improved somewhat, see Kalemli-Ozcan et al. (2005), but remained low, mainly reflecting that cross-border ownership of equity remained low. EU institutions provide 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.

The main contributions of this paper are, first, to update previous work on risk sharing in the eurozone to the first 20 years of the euro; second, to construct a DSGE model which makes precise the interpretations of the risk sharing channels and; third, to demonstrate that the nature of banking integration in the eurozone is important for understanding channels of risk sharing in the EMU during our sample period; and, fourth, to study different scenarios for equity and banking market integration using our model. Simulations of the model suggest that equity (or capital market) union and banking union are complementary.

Figure 1 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 cross-border lending to the non-bank sector was more muted before 2008, it was stable throughout the crisis. Our empirical results suggest that direct cross-border lending had risk sharing benefits similar to the those resulting from cross-border ownership of equity, while interbank lending had little impact on risk sharing.

While interbank lending appeared to be 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 sovereign debt crisis. Direct banking integration, by contrast, is associated with better income risk sharing in the data. Income smoothing also proved to be the more resilient risk sharing channel during the crisis. We argue that 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.

Our DSGE model assumes that firms and banks face financial frictions and profits of firms are shared internationally in proportion to the degree of international equity market integration. We keep the model simple by assuming that, among others, equity market integration is exogenous, because our focus is on the mapping of financial and banking integration to risk sharing. In the model, firms have to pre-finance wage payments and investment using either long-term bank loans or 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 three sources of uncertainty: shocks to idiosyncratic total factor productivity (TFP), funding shocks for a global bank, and spread shocks for local banks. This setup allows us to explain the patterns observed in the data. As direct banking integration increases, consumers will be better shielded from idiosyncratic interest rate fluctuations caused by (global or local) shocks hitting local banks. Because 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.

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—in effect, firms and households 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 of consumers' income and thus lowers the need for consumption smoothing *ceteris paribus*. This corresponds to our empirical finding that direct bank-to-nonbank integration shifts risk sharing patterns towards more income smoothing.Importantly, by insulating the economy from local banking sector shocks, direct banking integration also provides more stable risk sharing than interbank integration in times of crisis.

An important question for the future design of the European banking union is to what extent the drop in risk sharing in Europe was caused by global banking sector shocks (that played out in heterogeneous ways because countries had different degrees of exposure to them) or by local banking sector shocks. Our model can provide insights on this issue. As discussed above, the data suggest a general drop in consumption smoothing in the eurozone during the crisis. However, among northern member countries, this drop in consumption smoothing is partially offset by better income smoothing while income smoothing declines among southern members. Our model can encompass these differential risk sharing patterns once we assume that banking shocks in the north were predominantly of a global nature, whereas in the south there was an important local component.

The pattern of cross-country banking integration in the eurozone prior to the crisis is reminiscent of the nature of interstate banking integration in the United States prior to state-level banking deregulation. In spite of there being a well-integrated interbank market among U.S. federal states, prior to deregulation banks were generally not allowed to enter markets outside the state in which they were headquartered. 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 1, cross-border interbank flows grew very fast. But even though entry into other markets in the eurozone was formally allowed, 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] In the United States, banks consolidated across state borders following deregulation and started to operate internal (within-bank) capital markets. Morgan et al. (2004) show that this contributed to lower business cycle volatility across U.S. states because local banking sector shocks could more easily be dampened by inter-state banking flows. Demyanyk et al. (2007) and Hoffmann and Shcherbakova-Stewen (2011) study risk sharing following U.S. banking integration and show, using reduced form regressions, that banking integration contributed to more income smoothing and made risk sharing more resilient in recessions when it is most needed. We believe 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.

The accounting framework of Asdrubali et al. (1996) has been widely used, starting with Sørensen and Yosha (1998), who study risk sharing among OECD and EU countries. These studies suggest that the main reason for the lack of international risk sharing is the almost complete absence of cross-border income flows. The lack of international income smoothing correlates closely with the home bias in cross-border asset holdings, see Sørensen et al. (2007), in particular at longer horizons, see Artis and Hoffmann (2011). It also explains why U.S. states are better at sharing permanent idiosyncratic shocks with each other, see Becker and Hoffmann (2006).[2] An important contribution of this paper is that it provides a quantitative-theoretical underpinning of the decomposition suggested by Asdrubali et al. (1996) in the form of a DSGE model.

To our knowledge, ours is also the first paper to draw attention to the role of banking integration (as opposed to equity and general credit or bond market integration) for consumption risk sharing in the EMU. Kalemli-Ozcan et al. (2010) study the determinants of banking integration in the EU (and its impact on output synchronization) and find that regulatory harmonization caused higher banking integration in the EU and that the stabilization of exchange rates in itself was a main determinant of financial integration. Their results point to the important role of banking integration in the eurozone but their focus is not on consumption risk sharing.

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

[2]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). 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 markets), 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), Coeurdacier et al. (2015), and many others. This large body of work has delivered many theoretical insights.

Kalemli-Ozcan et al. (2013) study the role of banks in the transmission of international business cycles, and they interpret their results by constructing a simple DSGE model, much as we do. As in Kalemli-Ozcan et al. (2013), our model incorporates global and local banks but as in Hoffmann et al. (2017), we further allow local banks to borrow from a global bank delivering a distinction between direct and 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 interbank 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. This complementarity arises because bank lending allows firms to finance labor and investment from loans rather than other expensive (intraperiod) funds. 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 the part of income risk (associated with labor income) that is not internationally tradeable.

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 it has a more detailed financial market structure than their model. This 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).

The outline of the remainder of the paper is as follows: we first document how the patterns of risk sharing evolved prior to and after the onset of the Great Recession. 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 liquidity 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 channels of 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 Channels of Risk Sharing in the Eurozone

2.1 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.[3] 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, as consumption only covaries with aggregate output. If β_U is not zero, the value can be interpreted as the share of 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 want to know *through which channels* risk sharing is achieved. Sørensen 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

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

where $\widetilde{gdp}$, $\widetilde{gni}$, $\widetilde{nni}$, and $\widetilde{nndi}$ denote the logarithms of gross domestic product, gross national income (GNI), net national income (NNI), and net national disposable income (NNDI) of each country, divided by the aggregate value of the group of countries studied, respectively. We focus on the idiosyncratic, country-specific component of all 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, dividing by the variance of $\Delta \widetilde{gdp}_t^k$, and rearranging, we get

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

[3] As a technical aside, we define "aggregate" to mean aggregated over the countries in our sample (so we do not study if these countries share risk with, say, the United States). Time-fixed effect absorb any aggregate variation, so the normalization with the starred variables is redundant in this regression, but it plays a role in regressions with time varying coefficients that we discuss below.

where

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

The five coefficients β_I, β_D, β_F, β_C, and β_U are the coefficients from OLS regressions on GDP growth and are 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. The coefficients β_D and β_F therefore indicate to what extent capital depreciation and international transfers help smooth disposable income after a shock to output.[4]

Finally, a 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 period-by-period, or panel, 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 (for $X = I, D, F, C, U$, respectively).[5] Note that the last equation is just the basic risk sharing regression (1). Each of the channels can be estimated separately by least squares with the same results as a system regression because the

[4] We include these channels for the completeness of variance decomposition, but will skip them in our analysis which is focused on the financial markets channels.

[5] The decomposition of shocks to output is cross-sectional, but Asdrubali et al. (1996) show that the coefficients from the panel regressions are weighted averages of cross-sectional regressions when a time-fixed effect is included.

equations constitute a "seemingly unrelated regression system" with identical regressors.

The set of regressions (2) assumes that $\boldsymbol{\beta}_X$ 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 parameterize $\boldsymbol{\beta}_X$ as a function of variables that measure different aspects of financial integration for each country. We start with total cross-border lending so that

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

where TB^k_{t-1} measures total cross-border lending in country k at time $t-1$ (relative to GDP) and $\overline{TB}_{t-1}$ is the average across countries of TB^k_{t-1} at time $t-1$. The interaction terms are lagged one period in order to be predetermined in period t. The pattern of risk sharing is allowed to vary freely with cross-border bank lending. For example, $a_I + b_I \times \left(TB^k_{t-1} - \overline{TB}_{t-1}\right)$ measures the amount of income smoothing obtained by country k in period t with total cross-border lending TB^k_{t-1}. The parameter b_I measures how much higher-than-average bank lending increases the amount of income smoothing obtained. Technically, the first term in (3) is found as the coefficient to output while the second term is found as the coefficient to output (normalized by aggregate output) and the term $\left(TB^k_{t-1} - \overline{TB}_{t-1}\right)$.

For completeness, we further decompose the consumption smoothing channel—which is positive when saving is pro-cyclical—into the contributions from government and private saving. We do not model the behavior of governments, but because fluctuations in governments' deficits (negative saving) are very large, it is important to quantify their roles in consumption smoothing. In order to do so, we follow Kalemli-Ozcan et al. (2014) and linearize $\Delta\widetilde{nndi}^k_t - \Delta\widetilde{c}^k_t \approx \Delta\widetilde{\left(\frac{S}{C}\right)}$. Because this expression is linear in saving, one can trivially break it up into government and private saving 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 and bank-to-nonbank cross-border lending—and equity (E), all normalized with GDP.

2.2 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 1999–2013. Our group of countries is limited to 10 long-standing EMU-member countries due to data availability, and we exclude Ireland and Luxembourg because of the particular structure of capital flows in these financial hubs. As a control group, we use non-EMU countries that are members of the EU.[6] 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 saving is net saving of general government provided by the OECD. We calculate total saving as the difference between net national disposable income and consumption and private saving as the difference between total saving and public saving.

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

Our measures of cross-border total lending (TB), interbank lending (bank-to-bank, B2B), and direct lending (bank-to-non-bank, B2N) (from all reporting countries) for each of the countries in the sample are from the locational banking statistics of the Bank for International Settlements (BIS). We normalize the lending data by the GDP of the receiving country. Foreign portfolio equity assets are from the dataset of Lane and Milesi-Ferretti (2007) extended till 2011. An alternative to using the locational statistics might be to use the consolidated statistics available at the BIS. However, we believe that to understand the role of direct and interbank integration for risk sharing in the eurozone, it is important to account for the "double-decker" structure of the global banking system emphasized by Hale and Obstfeld (2014) and Bruno and Shin (2015). So the locational banking statistics are preferable for our purpose.[7]

2.3 Empirical results

Table 1 displays the results from estimating the channels decomposition (2), for EMU and, for a comparison, non-EMU countries. The first line presents results for the entire sample period 1999–2013. From column (5), β_U is estimated at 0.81 for EMU countries, and our interpretation is that 81 percent of shocks to output remain uninsured across these countries. From column (1), β_I is estimated at 0.09, implying that cross-country factor income flows contribute 9 percent to cross-country risk sharing. In column (4), β_C is estimated at 0.25, with the interpretation that saving and dissaving smooth 25 percent of shocks. International transfers play a very limited role over the entire sample period, see column (3). The depreciation coefficient β_D is large at negative 15 percent—as can be seen from the second and third rows, this is driven by the post 2008 data but because depreciation is mainly imputed, we do not explore this variable in detail. The "non-EMU Europe" sample is not a focus here but the results show that both income smoothing, see column (6), and consumption risk sharing, see column (9), are insignificant during this period. Sørensen and Yosha (1998) and Sørensen et al. (2007) found no income risk sharing in the OECD outside of the EU before the EMU and the significant amount of income risk sharing in the EMU following 1999 is presumably due to increased financial integration in the euro area.

In the second and third lines, we split the sample by periods; namely, the first decade of the euro (1999–2008) and the European sovereign debt crisis and its aftermath (2009–2013) and focus on the EMU countries. A salient feature of the results is a clear drop in risk sharing after 2008. Before 2008, about 62 percent of idiosyncratic output risk was shared as the coefficient for non-smoothed in column (5) is 38 percent, but after 2008 less than 20 percent of risk was shared with 81 percent left unsmoothed. Turning to the channels that drive this freeze in risk sharing, we find that the drop in consumption smoothing,

[7] To see why, consider the example of a U.S. bank lending to a German headquartered bank which then lends the same amount to an Italian non-financial firm. In both the locational and the consolidated statistics, the loan by the American to the German bank would count as an interbank liability of Germany to the United States and the loan to the Italian firm as a direct (B2N) liability of Italy to Germany. If the American bank instead lends to its German subsidiary which then arranges the loan to an Italian firm, the loans would still appear as an interbank liability of Germany and a B2N liability of Italy in the locational data, whereas in the consolidated statistics, the loan would only appear as a direct (B2N) liability of Italy to the United States. Hence, in this case the double-decker structure of banking integration would be lost in the consolidated data, even though the loan is intermediated through Germany by a legally independent subsidiary of a U.S. bank. If, as happens in our model below, refinancing conditions for banks based in Germany worsen during a financial crisis, this will have knock-on effects on lending to southern European countries. Looking at the consolidated statistics would therefore tend to understimate the degree of commonality in cross-border lending into Germany and cross-border lending into southern Europe. On the other hand, we acknowledge that locational statistics might provide a distorted picture of banking integration for some obvious financial centers such as Luxembourg and the UK. These two countries are not included in our sample.

see column (4), accounts for almost 20 percentage points of this decline. Again, we find the international transfer channel to be negligible in both subperiods, while the depreciation channel accounts for most of the remaining decline in risk sharing.[8] There is a drop in income smoothing in column (1), but income smoothing is imprecisely estimated for the individual subperiods.

In summary, the panel regressions in Table 1 reveal 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 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 2: 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 interbank flows. We document the empirical facts here, which we will interpret in a more structural way using the model in the next section. 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.

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 using time-varying coefficients, confer regression (3). The key innovation relative to earlier studies is that we look at the risk sharing implications of international bank lending and, in particular, at the distinction between direct (bank-to-nonbank) and indirect cross-border (interbank) lending. We display only the important coefficients that are interpreted as income smoothing, consumption smoothing, and total fraction unsmoothed. For the regressions with interaction terms, such as (3), we show results only for the pre-crisis subsample. Post-2008 results for these regressions are much weaker and we provide them in an appendix. 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 occurrence of banking sector crises in several EMU countries.

The regressions presented in the first three columns of Table 2 consider the role of total banking positions (relative to GDP). The first result is that higher cross-border banking liabilities relative to GDP are not associated with significantly higher risk sharing. The second block of regressions in columns (4)-(6) provides similar results when we consider the role of bank-to-bank liabilities. Because bank-to-bank positions are larger than bank-to-nonbank flows these results are very similar to those obtained for the total lending. Columns (7)-(9) display results when the risk sharing coefficient is allowed to vary with bank-to-nonbank liabilities. We observe a significant positive impact of income smoothing with more direct banking integration, while the impacts on the other risk sharing components are not significant, although the coefficient to consumption smoothing is negative. This reflects that all coefficients measure risk sharing as a fraction of GDP-shocks and if income is more smooth relative to GDP there is less of a role for further smoothing. The last block of channels regressions, columns (10)-(12), considers B2B and B2N lending in a single regression. Here, the role of cross-border liabilities is even more significant for income smoothing and

[8] In the remaining empirical analysis as well as in our theoretical model, we abstain from examining these channels 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.

B2N lending significantly affects the total amount of shocks not smoothed (β_U), although the very large effect on amount not smoothed is sensitive to the inclusion of B2B-lending and therefore may be somewhat affected by multicollinearity. The role of B2B lending remains insignificantly related to risk sharing when we control for direct B2N lending so this effect is robustly estimated. Interestingly, cross-border bank liabilities impact risk sharing primarily via the income smoothing channel, not via consumption smoothing, in line with the findings in Demyanyk et al. (2007) and Hoffmann and Shcherbakova-Stewen (2011) for the United States. This suggests that the conventional interpretation of the income and consumption smoothing channels as being associated with capital and credit markets, respectively, needs elaboration and we will provide an interpretation using our quantitative-theoretical model.

The quantitative impact of direct banking integration on risk sharing implied by our estimates in Table 2 is considerable. In our pre-2008 sample, Italy has an average ratio of direct cross-border lending to GDP of around 0.1, whereas for the Netherlands this average is 0.76. The estimated coefficient on B2N interaction term in column (10) of Table 2 is 0.55. This implies that a change from the level of direct banking integration in Italy to the level in the Netherlands would increase income smoothing in Italy by 35 percentage points ($(0.76 - 0.1) \times 0.55 = 0.35$).

The upshot of the results in Table 2 is that the risk sharing benefits from cross-border banking liabilities are mainly associated with direct B2N lending, at least during the pre-crisis period. Once direct B2N lending is controlled for, interbank B2B 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 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 of Table 3 confirm the intuition that countries with higher equity (portfolio) claims relative to GDP indeed experience more risk sharing and, specifically, more income smoothing, as indicated by the coefficient to equity interacted with output in column (2).[9] When we add bank-to-bank liabilities into the regression in columns (4)-(6), the coefficient to the equity interaction becomes larger but more imprecisely estimated and the impact of equity on overall risk sharing is strongly positive, according to the second line of column (6). Bank-to-bank liabilities correlate with a higher amount of shocks unsmoothed; i.e., with less risk sharing. When we include both equity and direct cross-border bank-to-nonbank positions into the risk sharing regressions, the equity interactions are insignificant as is the interaction with B2N lending (except for the amount left unsmoothed). This happens because of collinearity between equity assets and direct banking liabilities. We therefore run a fourth set of regressions, in which we include the sum of equity claims and bank-to-nonbank liabilities. In this regression, the combined term has a significant positive impact on income smoothing, see column (9), last line and a positive (though insignificant) effect on overall risk sharing as witnessed by the negative coefficient to the amount unsmoothed in column (11). We interpret these regressions as evidence that there is an important common component driving the cross-sectional heterogeneity in these two variables. We explore this issue with our DSGE model below.

The estimates in Table 3 imply economically important effects of banking and equity market integration

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

on risk sharing. Pre-2008 equity holdings as a fraction of GDP in Italy averaged around 20 percent, whereas for the Netherlands the corresponding number was 60 percent. Taking the numbers for pre-2008 average B2N liabilities as a fraction of GDP from our discussion of Table 2 above, we get that the sum of equity positions and B2N liabilities was around 1.35 times GDP in the Netherlands and 0.4 times GDP in Italy. According to the estimated coefficients in the last row of columns (10) and (12) of Table 3, a change of equity and banking integration from the level of Italy to the level of the Netherlands would result in an increase in income smoothing of 36 percentage points and an increase in overall risk sharing of 26 percentage points ($(1.35 - 0.4) \times 0.38 = 0.36$ and $(1.35 - 0.4) \times 0.28 = 0.26$), respectively.

2.4 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 decompose the consumption smoothing channel, β_C, into two separate components: private consumption smoothing and government saving. As before, we do not display results for the channels of international transfers and depreciation.[10]

The results in Table 4 show that, before the crisis, the estimated value of 8 percent for β_I in column (1) implies that income smoothing was limited in the South. Quite differently for the northern countries, the estimated value of β_I is 24 percent, implying a high level of income smoothing, consistent with high gross international equity positions. From the second row in the table, income smoothing for the northern countries remained stable during the crisis, as one would expect for risk sharing from ownership diversification, while it went to 0 (with a negative point estimate) for the southern countries. Overall consumption smoothing in the South was at 37 percent before 2009 as calculated from the sum of the coefficients in columns (2) and (3), while the corresponding number for the North was 56 percent. However, consumption smoothing dropped steeply in both groups after 2008, to a level of virtually zero in the South and 26 percent in the North.

Zooming in on the composition of consumption smoothing in terms of private smoothing and government saving, we find that private consumption smoothing dropped for both groups, see columns (3) and (7), where the drop is from 12 percent to –4 percent for the South and from 28 percent to 3 percent for the North (although these coefficient are all insignificant). For the southern countries, the decline in risk sharing was exacerbated by a collapse of smoothing through government saving, with the coefficients in column (2) implying that governments in the South went from absorbing 25 percent of shocks to absorbing 5 percent, while the corresponding drop in the North was an economically insignificant drop from 28 to 23 percent (cf. column (6)). While the coefficients are not statistically significant due to the small sample,

[10] 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.

this pattern corroborates and extends (on a longer post-crisis sample) the findings of 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, and 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. Overall, the large decrease in overall risk sharing after 2008 found in Table 1 is mechanically explained by the severe drop in risk sharing in the southern economics (column (4)), while the drop in the northern economies is only 8 percent according to the point estimates in column (8).

Comparing the temporal patterns in Figures 1 and 2, it is apparent that both interbank positions and risk sharing collapsed rapidly during the crisis. This suggests that the two phenomena might be linked. In our regressions for the crisis period reported in the appendix, the link between cross-border bank positions and risk sharing is imprecisely estimated, though. As discussed above, this is likely to the dominant aggregate variation in the data during the crisis period. An additional reason could be that our data on interbank positions do not include the emergency liquidity assistance (ELA) from the European Central Bank (ECB), which at least partially substituted for private interbank lending. This could have mitigated the drop in consumption smoothing after 2008, at least in the short-run. 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 from the ECB are not publicly available.[11]

From these considerations, it is not surprising that we are unable to identify significant cross-sectional links between cross-border lending and risk sharing during the crisis using relatively high-frequency (i.e., quarterly) data. In order to illustrate the relations between risk sharing and banking integration during the crisis years with our data, we take a simple approach and focus on longer-term changes in risk sharing and bank positions. To this end, we obtain estimates of the drop of risk sharing for individual countries using a panel regression of the form

$$\Delta\tilde{c}_t^k = \beta_U^k \times \mathbf{1}^k \times \Delta\widetilde{gdp}_t^k + \gamma_U^k \times post2008 \times \mathbf{1}^k \times \Delta\widetilde{gdp}_t^k + \tau_{Ut} + \delta_U^k + \varepsilon_{Ut}^k,$$

where $\mathbf{1}^k$ is a country-dummy for country k and $post2008$ is a dummy indicating the crisis period from 2009–2013. We estimate this regression for our entire sample 1999–2013. In this specification, the coefficient γ_U^k can be interpreted as the change in total risk sharing of country k between the pre-2008 and post-2008 periods. A high (low) value of γ_U^k will signal a large (small) increase in the unsmoothed component; i.e., a drop (increase) in risk sharing for the respective country. For each country in our sample, Figure 3 plots our estimates of γ_U^k against the change in the pre- and the post-2008 average of a country's B2N and B2B positions respectively (with each mean taken relative to the cross-country average position during the respective period). The figure reveals that regressions that include interactions with banking

[11] 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) and Whelan (2017) widening TARGET2 balances during 2008-2012 mainly reflected the capital flight that plagued countries like Greece, Italy, and 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. We would not expect capital flight to be correlated with better but, if anything, with worse risk sharing, because it is endogenous to crisis conditions and this is indeed what we find if we include a country's TARGET2 liabilities as an interaction with idiosyncratic GDP in our risk sharing regressions.

integration are unlikely to give statistically significant results because the decline in our measures of banking integration are quite similar across countries, making it hard to identify effects. However, from the figure we can still observe a negative cross-sectional relation between γ_U^k and changes in the B2B position, whereas there does not appear to be a link between changes in B2N and changes in the unsmoothed component. These findings are tentative, due to the limitations of the data, but they support our conjecture that the drop in interbank positions is an important factor behind the decline in risk sharing after 2008.

3 A Theoretical Model

We construct a model which provides an explicit interpretation of our results. The study of risk sharing channels has been motivated by economic intuition in the literature, but here we document how a model can explain the patterns—in particular, we highlight the interactions between equity market integration and banking integration in the form of either bank-to-bank or bank-to-real sector, which are less obvious to interpret without a model. 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, and we assume that 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 a 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 banks and a global bank. Fourth, households have a choice between borrowing from local or global banks and, fifth, local banks face frictions 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 channels of risk sharing identified from our empirical regressions. The regressions in the previous section should not be interpreted in a causal way, but they provide statistics that we will attempt match with the To the extent that we can successfully do that, the model will provide a causal interpretation of our empirical results.

Agents and markets

Figure 4 provides a stylized outline of our model. There are two open economies, each populated by a representative household H, a firm F, and a local bank LB. The (small) home country represents one of the 10 EMU countries in our sample, while the (large) foreign country represents the "rest of the EMU." Additionally, there is a global bank, GB, which operates in the two countries (EMU) and has access to wholesale funding B from the rest of the world. The global bank lends to local banks through the EMU-wide interbank market (B2B) and it lends directly to firms in each country (B2N). Local banks use funds obtained through the interbank market to lend to households and firms in their country of residence only. Households own shares in firms in both countries; i.e., equity markets are (partially) integrated. Firms are subject to shocks to TFP, the global bank is subject to funding shocks, and local banks a subject to "intermediation shocks."

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, TFP, 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 dividends:

$$\max_{\{N_{t+s},\ K_{t+s},\ I_{t+s},\ L_{t+s}\}_{s=0}^{\infty}} \mathbb{E}_t \left[\sum_{s=0}^{\infty} \Lambda_{t:t+s}^{firm} \text{DIV}_{t+s} \right],$$

where $\Lambda_{t:t+s}^{firm}$ is the stochastic discount factor (SDF) that the firm uses to discount its future profits (at horizon s). It is a weighted average of the SDFs of the home and the foreign households (as determined by the respective Euler equations).[12] Dividends are defined as:

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

where W_t is wages, I_t is investment, L_t is total bank borrowing, r_t^l is the bank lending rate, F_t denotes funds raised within the period from other domestic sources (about which we are not specific), $\boldsymbol{\iota}$ is the net interest rate (cost) on this borrowing, and φ_t^I is a quadratic adjustment cost in investment; i.e., $\varphi_t^I = \frac{1}{2}\varphi^I K_{t-1}\left(\frac{I_t}{K_{t-1}} - \delta\right)^2$. 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.[13]

Firms need to borrow in order to finance their operating expenses; i.e., the wage bill and investment. Firms can satisfy a fraction ϕ of their financing needs using one-period bank loans. The rest of their financing needs has to be satisfied with within-period (i.e., short-term) finance as in Neumeyer and Perri (2005). The identity for external finance is thus

$$L_t + F_t = W_t N_t + I_t,$$

where $L_t = \phi\,(W_t N_t + I_t)$ are one-period bank loans and $F_t = (1-\phi)\,(W_t N_t + I_t)$ are short-term funds. Short-term funds are raised from an un-modeled non-bank financial sector which we assume is competitive but inefficient so that non-bank intermediation costs ι are so high that firms will always prefer to borrow from banks. Thus, a higher ϕ leads to overall lower cost of funds for the firm and a larger share of firm finance coming from banks, so firms' exposure to banking sector shocks increases directly with ϕ.

Firms obtain bank loans from global and local banks and they cannot substitute one source of bank credit for another in response to exogenous shocks. This reflects 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.[14] For tractability, we assume that a fixed fraction τ of total loan

[12] In particular, $\Lambda_{t:t+s}^{firm} = (1-\lambda)\Lambda_{t:t+s} + \lambda\left(\mu\Lambda_{t:t+s} + \mu^*\Lambda_{t:t+s}^*\right)$, where $\Lambda_{t:t+s}$ 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).

[13] We choose a pro-cyclical rate of depreciation, of functional form: $\delta_t = \delta + 0.023 \log\left(\frac{Y_t}{Y}\right)$, for the model to approximately match the amount of risk sharing achieved by this channel in the data (in pre-crisis times).

[14] 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 percent on average,

demand is satisfied by loans from the global bank, while the rest has to be financed locally: $L_t^{\mathrm{GB}} = \tau L_t$ and $L_t^{\mathrm{LB}} = (1-\tau) L_t$. 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 ($r_t^{l,\mathrm{GB}}$) and local ($r_t^{l,\mathrm{LB}}$) banks: $r_t^l = \tau r_t^{l,\mathrm{GB}} + (1-\tau) r_t^{l,\mathrm{LB}}$. Direct banking integration manifests itself in an increase in τ and thus a shift of the composition of loans from local banks to the global bank and a higher weight for the EMU-wide interest rate in bank loans to firms (i.e, a lower role for the idiosyncratic fluctuations in domestic lending rates). The opposite holds for indirect banking integration, which increases the supply of loans from the local bank.

Banks In each country, there is a local (domestic) bank and local households own a constant fraction of the global bank. Local banks fund themselves by borrowing from the global bank while the global bank hasaccess 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 global northern European banks. Some authors, such as Kalemli-Ozcan et al. (2013), allow for local banks (which only service one sector) and global banks (which service a separate sector) in each country. Our assumptions, however, capture the particular structure of lending in the eurozone and allow our model to predict how different types of international bank lending affects channels of risk sharing.

The *local bank* provides 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 the 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 $r_t^{h,\mathrm{LB}}$ is the interest rates on local bank loans to households. 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 undertake short-term changes in their funding structure through international interbank markets. In the presence of asymmetric shocks to loan demand and/or supply, adjustment costs lead to different borrowing costs in the two countries. From the point of view of the households, this drives a wedge between their respective borrowing rates, and hence their stochastic discount factors. This implies that their expected consumption

measured by value added. Long-term relationships with local banks allow firms to borrow even in circumstances in which arm's-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.

growth paths deviates which we measure as a decline in consumption smoothing. Additionally, this formulation prevents unreasonable 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* 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}):

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

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 $\mu^{\mathrm{GB}*} = 1 - \mu^{\mathrm{GB}}$.[15]

The global bank is exposed to lending conditions in the rest of the world through exogenous fluctuations in the supply of funds, B_t, offered in the global money market. In particular, a drop in the global supply of money market funds raises the interest rate r_t^b until demand equals supply, 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 countries.

Both global and local banks possess market power, as credit is extended to firms in a monopolistic competition environment. We do not explicitly 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.[16]

The model implies that interest rates are as follows:

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

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

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

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

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

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

$$r_t^{h,\mathrm{LB}} = r_t^m + lbs_t + \varphi^{\mathrm{LB}} \frac{M_t - M}{M}.$$

MU^{GB} and MU^{LB} denote firm-loan mark-ups set by global and local banks, respectively, with the latter being larger because local banks have more market power for the reasons outlined above, and lbs_t is a local banking shock which acts as a country-specific "wedge" between the interbank rate and the household lending rate. This shock is mean-zero and idiosyncratic across countries and shifts the respective loans supply schedules. In particular, a positive local banking shock would result in local banks demanding higher interest rates as their cost of funds rises. Due to the mark-up ($MU^{\mathrm{LB}} > 1$), the effective spread for firms would rise and they would cut back on production, employment, investment, and credit. The real effects of local banking shocks are most pronounced in countries in which firms and households are particularly dependent on credit from local banks (low B2N). As a result of the frictions, households in different countries are not exposed to the same borrowing rates and therefore have diverging consumption growth paths.

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

$$\max_{\{C_{t+s},\ N_{t+s},\ H_{t+s}\}_{s=0}^{\infty}} \mathbb{E}_t \left[\sum_{s=0}^{\infty} \beta^s \left(\frac{{C_{t+s}}^{1-\sigma} - 1}{1-\sigma} - \Psi \frac{N_{t+s}^{1+\psi}}{1+\psi} \right) \right],$$

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 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: $H_t = H_t^{\mathrm{GB}} + H_t^{\mathrm{LB}}$.

We assume that households, similarly to the firms, will satisfy a fixed fraction, κ, of their total loan demand by taking a loan from the global bank, $H_t^{\mathrm{GB}} = \kappa H_t$, and satisfy 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 global lending rates, $r_t^{h,\mathrm{GB}}$, and local lending rates, $r_t^{h,\mathrm{LB}}$: $r_t^h = \kappa r_t^{h,\mathrm{GB}} + (1-\kappa) r_t^{h,\mathrm{LB}}$. The parameter κ 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 implies 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 implied 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 empirically consistent negative responses 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 can be thought of as part of gross real investment.[17] NX_t is total net exports of each country, such that the market clearing condition 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 is the sum of loans from the global bank offered to firms and households: $\text{B2N}_t = L_t^{\text{GB}} + H_t^{\text{GB}}$, while bank-to-bank cross-border bank flows is $\text{B2B}_t = M_t = L_t^{\text{LB}} + H_t^{\text{LB}}$. The current account of each country is therefore defined as $CA_t = -\left(\Delta M_t + \Delta L_t^{\text{GB}} + \Delta H_t^{\text{GB}}\right) = -\left(\Delta\text{B2B}_t + \Delta\text{B2N}_t\right)$, and $CA_t + CA_t^* = -\Delta B_t$.

Aggregate GDP in the model is denoted by Y_t. The difference between the current account and net exports is equal to net interest payments from abroad, so gross national income, GNI, is defined as $\text{GNI}_t = Y_t + CA_t - NX_t$. Net national income, NNI, is defined as GNI net of depreciation of capital stock, namely $\text{NNI}_t = \text{GNI}_t - \delta_t K_{t-1}$. Because of the absence of fiscal transfers in our model, NNI coincides with net national disposable income, NNDI.

To reproduce the empirical results, we also introduce a proxy for cross-border ownership of foreign assets by defining the equity-to-GDP ratio $EQ_t = \mu \frac{\lambda^* K_{t-1}^*}{Y_t} \times const \approx \lambda \nu^E \frac{K_{t-1}^*}{K^*}$, where the approximation arises from the fact that the "home" country is much smaller than the "foreign" country and scaling (through a constant and ultimately, parameter ν^E) reflects that cross-border holding of equity is only a fraction of the foreign firm's assets.

[17] In our model, Γ_t is composed of the within-period funding cost of the firm, $F_t\iota$, and all (second-order) adjustment costs.

Mapping the data to the model

We calibrate our model to replicate the channels of risk sharing regressions as estimated in Table 1.

Forcing variables There are three major sources of shocks in our setup: shocks to total factor productivity, shocks to local banks, and shocks to the global bank. The TFP processes for home and foreign countries are given by:

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

$$\log \theta_t^* = \rho^\theta \log \theta_{t-1}^* + \frac{\sigma^\theta}{\sqrt{Y^*/Y}} \eta_t^*.$$

Similarly, the local banking shocks are as follows:

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

$$lbs_t^* = \rho^{lbs} lbs_{t-1}^* + \frac{\sigma^{lbs}}{\sqrt{Y^*/Y}} \eta_t^{lbs*}.$$

The stochastic process for the global banking shock has the same realization in 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. Scaling of the variance of the shocks hitting the foreign country results from the assumption that they represent a linear combination of mutually uncorrelated shocks to individual countries.

Calibration We calibrate the baseline model at the quarterly frequency using the 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-lagged-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.

The size of each "home" economy is normalized to one, while the size of the "foreign" country is normalized to nine, the number of countries in the sample minus one, because it represents the "rest of the EMU." Regarding the parameters which are common for all countries, some of them are standard in the literature and have been accordingly chosen. Households are net borrowers and their discount factor β is set to 0.99, to match the steady-state quarterly interest rate relevant to the households of 1 percent. 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 4 to match the relative volatility of HP-filtered investment with respect to GDP in the baseline. The cost of alternative sources of finance to firms (ι) is set to 4 percent, 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. The index of real wage rigidities, γ, is set to 0.80, which is consistent with Blanchard and Galí (2007) and allows us to match the relative standard deviation of hours worked. We choose mark-ups of 3.5 and 2 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 the global bank 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 heterogeneity across simulations (for the 10 EMU countries in the sample) comes from choosing the degrees of capital market integration (EQ), direct banking integration (B2N) and interbank integration (B2B)—all steady-state values in proportion to GDP—from the data, as showed in Table 6. These variables implicitly pin down the following deep model parameters. EQ determines λ from the long-run relation $EQ = \frac{E}{Y} \approx \nu^E \times \lambda$, where ν^E is a scaling constant, whose value is set to 0.60, to ensure that the calibrated values of λ fall in range (0, 1) for all countries. ($B2N$, $B2B$) in turn determine the deep model parameters (τ, κ, ϕ). In the model, we define B2N as a sum of loans from the global bank to firms and households, $B2N = L^{\mathrm{GB}} + H^{\mathrm{GB}}$, and B2B as interbank loans or the 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 $\tau = 0.40$ and $\kappa = 0.15$ for the EMU as a whole. 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 available to firms in the countries in our sample is approximately equal to $0.60 = 1 - 0.40$. The value of the parameter κ has been chosen 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.[18]

We assume the variance and persistence of TFP shocks are $\sigma^\theta = 0.0077$ and $\rho^\theta = 0.95$. The persistence parameter is standard in the literature, while the standard deviation has been set to match the standard deviation of model generated HP-filtered GDP to that of the data (1.43 percent). To further match the volatility of the net exports-to-lagged-GDP ratio (1.13 percent in the data), we assume small but non-negligible innovations to local and global banking shocks in the baseline, equal to 0.0022 (both σ^{lbs} and σ^{gbs}). The persistence of the global banking shock is assumed the same as of the TFP process; i.e., $\rho^{gbs} = 0.95$. We set the autocorrelation coefficient for the local banking shock (an interest rate) to 0.40 in order to achieve a similar response of consumption to GDP on impact as the response of the same ratio

[18] These are strict restrictions, which do not leave us with many degrees of freedom in choosing this parameter; in fact, there is no guarantee for such a value of κ to exist.

resulting from the global banking shock (a response three times that of GDP).

The only difference between *crisis and normal times* is that we assume that the standard deviation of banking shocks is higher in crisis times. In particular, we calibrate it such that the fall in consumption smoothing in crisis times relative to normal times is the same as we observe in the data; i.e., from 0.50 to 0.31. This is achieved by increasing both σ^{lbs} and σ^{gbs} from 0.0022 in normal times to 0.015 in crisis times.

4 Model results

4.1 Understanding the risk sharing mechanisms

Before we move on to study our model's quantitative implications, we present a stylized version 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 can approximate the consumption-income ratio as

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

where INC denotes household income and is defined as follows:

$$\text{INC}_t = \text{LABINC}_t + (1-\lambda)\text{DIV}_t + \mu(\lambda\text{DIV}_t + \lambda^*\text{DIV}^*_t) + \text{BANKINC}_t, \tag{5}$$

with $\text{LABINC}_t \equiv W_t N_t$ denoting labor income and $\text{BANKINC}_t \equiv \Pi^{\text{LB}}_{t-1} + \mu^{\text{GB}}\Pi^{\text{GB}}_{t-1}$ income from bank profits.[19]

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 referred to as consumption-tilting.

In our model, local banking shocks—which we assume rise dramatically in crisis times—translate into countercyclical variation in the interest rate faced by consumers. This induces households 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 households will be exposed to the variation in interest rates offered by the local bank. In the absence of direct cross-border lending, households can smooth consumption only by borrowing from local banks which makes consumption smoothing sensitive to local banking sector shocks, as we observed during the crisis.

[19] To derive this formula, one can take a first order Taylor series approximation of the $\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}$ term around $\mathbb{E}_t\left[\frac{C_{t+1}}{C_t}\right]$ in the household's Euler equation, combine the latter with the household's life-time budget constraint and assume log-utility ($\sigma = 1$). The argument holds also for a more general case with a CRRA utility and higher order approximations. A more general case would imply a time-varying propensity to consume out of total wealth (e.g., due to precautionary saving and income/substitution effects), which is constant $(1-\beta)$ in the simple case presented here.

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, $r_t^l = \tau \times r_t^{l,\text{GB}} + (1 - \tau) \times r_t^{l,\text{LB}}$, 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. Holding the amount of credit by local banks constant, an increase in direct banking integration, τ, also amounts to an increase in the total amount of bank credit available to firms (an increase in ϕ). If the share of firms' expenses that can be prefinanced through loans increases, the conditional correlation between labor and dividend income increases as well. Because labor and dividends now co-move 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 in the data.

Thus, during tranquil times, the risk sharing benefits of equity and direct banking market seem to reinforce each other, which hints at a potentially important complementarity between equity market and direct banking integration. It is interesting to observe that, in our data, equity and direct banking integration are highly correlated in the cross-section, with a correlation coefficient of 0.67. Making direct banking and equity market integration endogenous is clearly beyond the scope of this paper but one can speculate that endogenizing them would generate a positive correlation between the two forms of integration. This complementarity could then also help 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 accommodate fluctuations in credit demand by households and firms. In our model, such fluctuations in credit demand arise as a consequence of TFP shocks and 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.

4.2 Quantitative results from the model

The model is solved by log-linearizing around the deterministic steady-state and we examine its fit by repeating the empirical regressions using simulated data. We first run the channels decomposition that corresponds to the empirical results 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. Results for the tranquil times calibration are displayed in the row labeled 1999–2008 while results for the crisis calibration are displayed in the row labeled 2009–2013. According to columns (1)-(3) in that order, 10 percent of shocks are smoothed by international income flows, 50 percent are smoothed via procyclical saving, and 41 percent are unsmoothed in tranquil times. This pattern of risk sharing is very similar to the empirical estimates found for the EMU prior to the crisis where the corresponding percentages are 14, 50, and 38, as reported in Table 1. During crisis times, income smoothing is 8 percent, consumption smoothing is 31 percent, leaving 62 percent of shocks unsmoothed. The results are also quite similar to the empirical results found for the 2009–2013 period, where the corresponding percentages are 3, 31, and 81. The model clearly captures the drops in both income and consumption smoothing, although income smoothing in the model is higher, although not significant, during the crisis period. Consumption smoothing is at 31 percent, as in the data, while the amount unsmoothed is larger in the data than in the model, but not significantly so. Overall, the model does a good job of replicating the channels of risk sharing and the decline in the recession.

In Table 9, we display regressions on model-generated data allowing for interactions with international bank-to-bank lending and bank-to-nonbank lending. The results match those of the corresponding empirical regressions well. The main terms in the top line of the table show results that are stable and very similar to those of the top line of the empirical Table 2. According to Table 9, column (1), total banking integration in the second line is associated with more income smoothing with a coefficient of 13 percent which is close to the empirical value of 9 percent in Table 2. The economic interpretation of this coefficient (and similarly for the other interactions) is that an increase in total banking assets of a magnitude similar to the value of GDP, will increase income smoothing by 13 percentage points. The coefficient is negative 15 percent for consumption risk sharing, which is also similar to the corresponding empirical coefficient, while the net effect on risk sharing in column (3) is negative at –3 percent, and clearly insignificant as it is in the empirical table.

Columns (4)-(6) focus on bank-to-bank lending, captured by the estimated interaction terms in the third line. The pattern is very similar to that found for total bank lending which reflects the that B2B lending flows are larger than B2N lending flows. The third block of results in columns (7)-(9) shows that bank-to-nonbank lending is associated with significantly more income smoothing and, as in the data, the point estimate on consumption smoothing is negative (albeit the coefficients are numerically larger in the model-based regressions). This partly reflects that the coefficients sum to unity (when depreciation is included) so when income is smoothed more, there is less scope for smoothing of consumption.[20] In columns (10)-(12) of Table 9, we include interactions for both bank-to-bank and bank-to-nonbank lending. While we are not able to quantitatively match all the coefficients of the empirical regressions—the effect on overall risk sharing in column (12) is much smaller than the empirical counterpart in Table 2—the main qualitative message is similar to that of the empirical regressions: a robust positive effect of bank-to-nonbank lending on income smoothing and a negative effect on consumption smoothing in both the empirical and the model-based regressions. The results for bank-to-bank integration are fairly robust to the inclusion of bank-to-nonbank integration (and therefore similar to those of the previous block of regressions), while this is less so in the data. Overall, the data cannot fully separate the effects of B2B- and B2N-lending on total amount smoothed; however, the role of bank-to-nonbank lending on income smoothing appears to be a robust feature of model and data.

In Table 10, an interaction for equity market integration is added. From column (1), second row, income risk sharing is increasing in equity holdings—a coefficient of 88 percent—with high statistical significance: cross-ownership of assets is a key vehicle for income smoothing as in the bare-bones Arrow-Debreu model, and as is apparent from the results in the second row, income risk sharing robustly substitutes for consumption smoothing when foreign equity holdings are high. In columns (4)-(6), we add B2B lending, but we find no significant impact of B2B lending on risk sharing when equity interaction is included. In columns (7)-(9), we find that B2N lending has a positive impact on income smoothing (off-set by consumption smoothing), but the coefficient is no longer significant because B2N lending is correlated with equity risk sharing. This correlation implies that the coefficient to equity market interaction declines to 67 percent, although it is still highly significant. In columns (10)-(12), we use as an interaction the sum of equity and B2N lending, and drop the individual interactions for these variables. We obtain a coefficient to this interaction that is very similar to the corresponding coefficient in the empirical regressions, but the coefficient is less significant than the one on equity interaction alone. Our interpretation is that both B2N- and equity market integration matter separately, but due to noise in the data, the sum comes through more significantly in the empirical regressions.

For the crisis period, we re-estimated the regressions in Tables A1 and A2. The results are in the appendix (Tables A3 and A4) and the coefficients to the interaction terms are insignificant. In our model, this can be explained by the large global liquidity shock which implies that the common variability in 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.

Global or local banking shocks? In our model, risk sharing declines during financial crises because of shocks to local and global banks. However, our results in Table 4 and Figure 3 suggest that the decline in risk sharing was heterogeneous across countries. We therefore further explore the role of global versus local banking shocks. We re-run a version of our model, in which we assume that during the crisis the volatility

[20] 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.

of global banking sector shocks increased and local banking sector volatility increased in the South but not in the North. We run the model equivalent of the empirical regression in Table 4, except that we do not model the government sector, for the two subgroups of countries. The results are displayed in Table 11. The first row displays the pre-crisis results and from columns (1) (South) and (4) (North), the model captures that income smoothing was important in the North (15 percent) while insignificant (2 percent) in the South, which line up well with the empirical results (although income risk sharing in Table 4 is slightly larger). In the model, income risk sharing in the crisis, see the second row of Table 11, increased in the North and remained insignificant in the South with a negative point estimate. All of these features were found in the empirical estimations. In columns (2) and (4), the corresponding results for consumption smoothing are displayed. The amount of consumption smoothing in the model is somewhat larger than the estimated amount of risk sharing from private saving in the empirical table and the model somewhat misses the sharp drop in consumption smoothing in southern Europe but nonetheless it partly captures the declining consumption smoothing that was observed in both the North and the South. Considering the host of upheavals that took place during the Great Recession and their impacts on consumer finances and psychology, which we do not model, the model may well capture the decline in consumption smoothing that was due to declining inter-EMU bank lending. From columns (3) and (6), which display the amount of risk not shared, we observe that the model overall matches the large decline in risk sharing in the South at the same time as risk sharing in the North changed little.

Are equity market and banking integration complements? Having ascertained that the model captures the main features of the data, we can use the model to estimate the sensitivity of the model economy to different forms of financial integration. How would the pattern of risk sharing change if foreign equity holdings and/or direct banking integration changed? In Table 12, we show results for the four potential combination or high/low equity market integration and high/low direct banking integration. The results reveal that banking integration and equity integration are complements in their impact on income smoothing: at a low level of equity market integration, increasing direct banking integration increases risk sharing through the income smoothing channel by 3 percentage points—compare columns (1) (low B2N) and (4) (high B2N) in the row labeled "Low" for equity market integration). However, at a high level of equity market integration, the same change in direct banking integration increases income risk sharing by 10 percentage points (compare columns (1) and (4) in the row labeled "High" for equity market integration). Equity market integration is intuitively important for risk sharing, but banking market integration is also important because it can facilitate smoothing of labor income, which typically infeasible through equity markets, and banking and equity-market integration may reinforce each other—a potentially important finding that has not been previously identified. Our interpretation of this finding is that direct banking integration increases the procyclicality in dividends, as we further explain in the next paragraph, increasing the important of equity market integration.

In Figure 5, we plot the model-generated impulse responses of GDP, consumption, dividends, and GNI to an idiosyncratic TFP shock. The time dimension of our data is too short to estimate impulse responses from the data, but the impulse response functions from the model help us understand its properties better. We plot the impulse response functions for three regimes: (1) the baseline specification, in which a hypothetical country is calibrated to a sample-average country in terms for all parameters, including direct and indirect banking integration; (2) a case with high direct banking integration (high B2N), in which we increase this country's B2N measure to the upper range value of 0.76; and (3) a case with high interbank integration (high B2B), in which we increase this country's B2B measure to the upper range value of 2.76. The foreign country (rest of the EMU) is kept the same across all scenarios.

The figure shows that the response of GDP to TFP shocks is very similar in all scenarios. However, the consumption responses to a domestic TFP shock varies: high B2N integration and high B2B integration lead to more muted consumption responses in line with our findings that banking integration has risk sharing benefits. In tranquil times (when TFP shocks dominate) B2N and B2B integration are qualitatively similar in their impact on risk sharing and 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 short-term finance to bank loans with a one-period maturity. Because the firm finances current wages and investment with 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 less sensitive to TFP shocks when banking integration is high.

In Figure 6, we show the responses of GDP, consumption, dividends, and GNI to a negative local banking shock. Again, we report results for the baseline, high B2N, and high B2B scenarios. Now, the high B2N and B2B cases differ considerably. First, the impact of the local banking sector shock on output is mitigated with high B2N, while it is amplified (relative to the baseline case) with high B2B. The same ranking is apparent for the overall impact on consumption, with high B2N providing better consumption smoothing than both the baseline and, in particular, the high B2B 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.

Recall from Table 4 that overall risk sharing among northern eurozone countries was more stable during the crisis because the drop in consumption smoothing was partially offset by an increase in income smoothing. As we show in Table 11, our model can encompass this feature of the data if we assume that banking sector shocks in the North were predominantly global while in the South they also contained an important local component. The differential patterns of risk sharing in the North and in the South can be understood as a direct implication of the complementarity of direct banking integration and equity market integration. In the model, a banking sector shock (global or local) leads to a countercyclical response of domestic dividend payments. If the banking sector shock is local, income smoothing decreases with equity diversification: the countercyclical increase in dividends is shared with the rest of EMU in proportion to the country's equity market integration and if the banking shock is local, there is no concomitant increase in capital income in the rest of the EMU. So, the country affected by the local banking sector shock not only has lower consumption smoothing due to a hike in domestic interest rates, it also obtains little income smoothing. If, however, the banking sector shock is global, dividends also rise in the rest of the EMU and the country benefits from this via better income smoothing. The negative effect of the global banking shock for consumption smoothing is thus partially offset because of equity market integration.

5 Conclusion

EMU was a major step towards deeper financial integration in Europe. However, integration did not 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 while bond market integration mainly involved 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 banking 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 harder 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 with incomplete equity market integration and with financial frictions affecting both firms and banks. In the model, firms have to pre-finance wage payments and investment using either longer-term bank loans or more 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 eurozone was hit by country-specific banking shocks that lead to a breakdown in interbank markets. In our model, shocks to the interbank markets hit local banks who pass on increased cost of funding to households and firms. The higher domestic interest rates make consumption smoothing more expensive for households and this feature of our model drives the breakdown in risk sharing during a crisis, consistent with the data.

Our DSGE model is the first to target the channels of risk sharing identified by Asdrubali et al. (1996) and thereby to underpin their economic interpretation. Furthermore, our framework captures an interaction between capital (equity) market and banking integration that has not been discussed previously. Specifically, our model, and our empirical findings, suggest that both capital market union and banking union are important and that they are complements. Thus, 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 direct cross-border lending from banks to the real sector (or on cross-border bank consolidation) and not predominantly on cross-border interbank lending.

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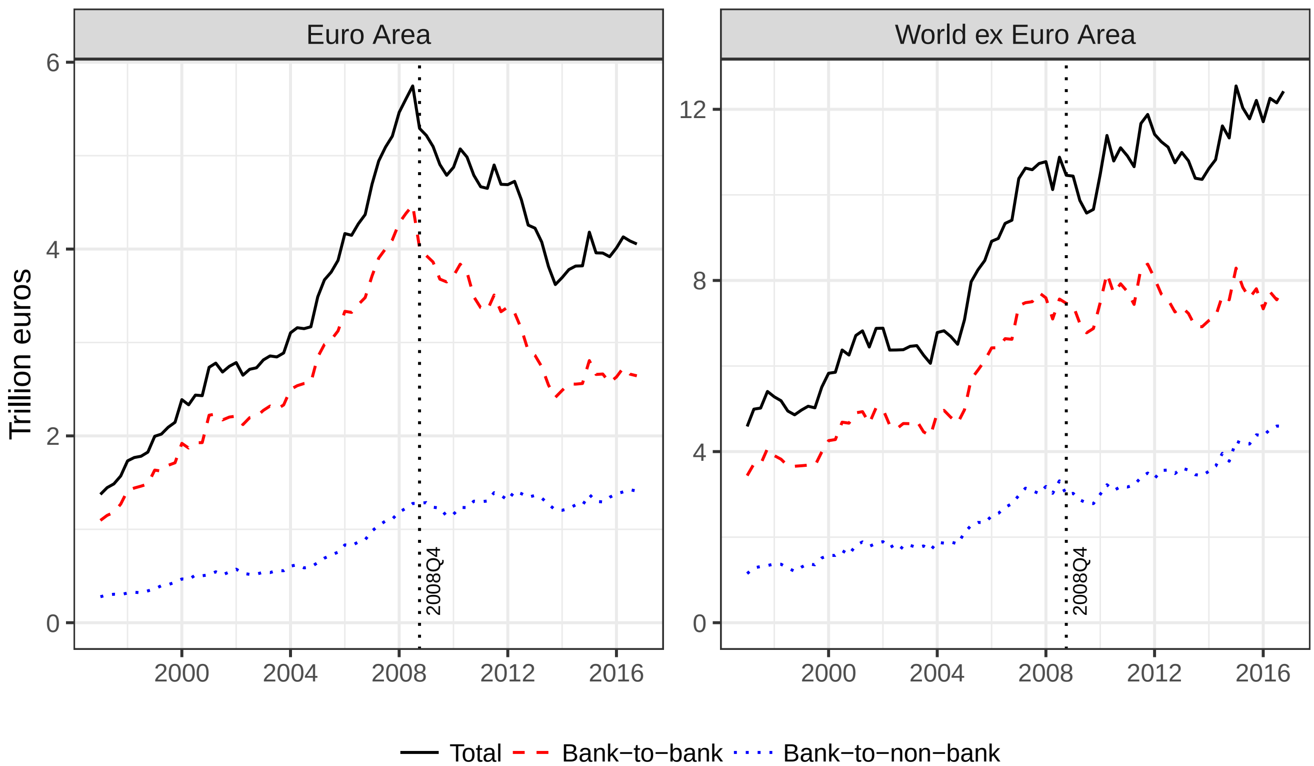
Figure 1: Cross-Border Bank Lending in the Eurozone and Other Advanced Countries

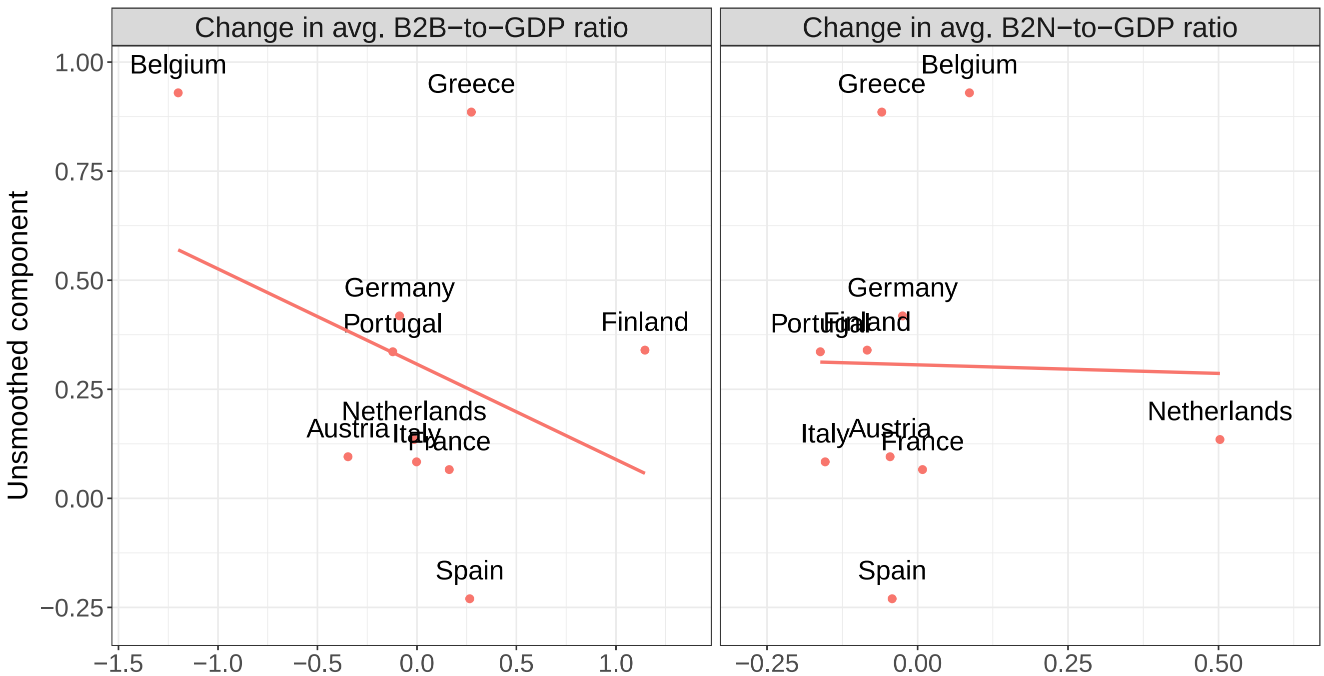


NOTES: The figure plots cross-border lending by foreign banks to 19 eurozone economies ("Euro Area") and a sample of 118 other advanced and developing countries ("World ex Euro Area"). The black solid line shows total lending, the red dashed line shows lending by foreign banks to domestic banks, and 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 the BIS locational banking statistics database.

Figure 2: Income and Consumption Smoothing, 1999–2013

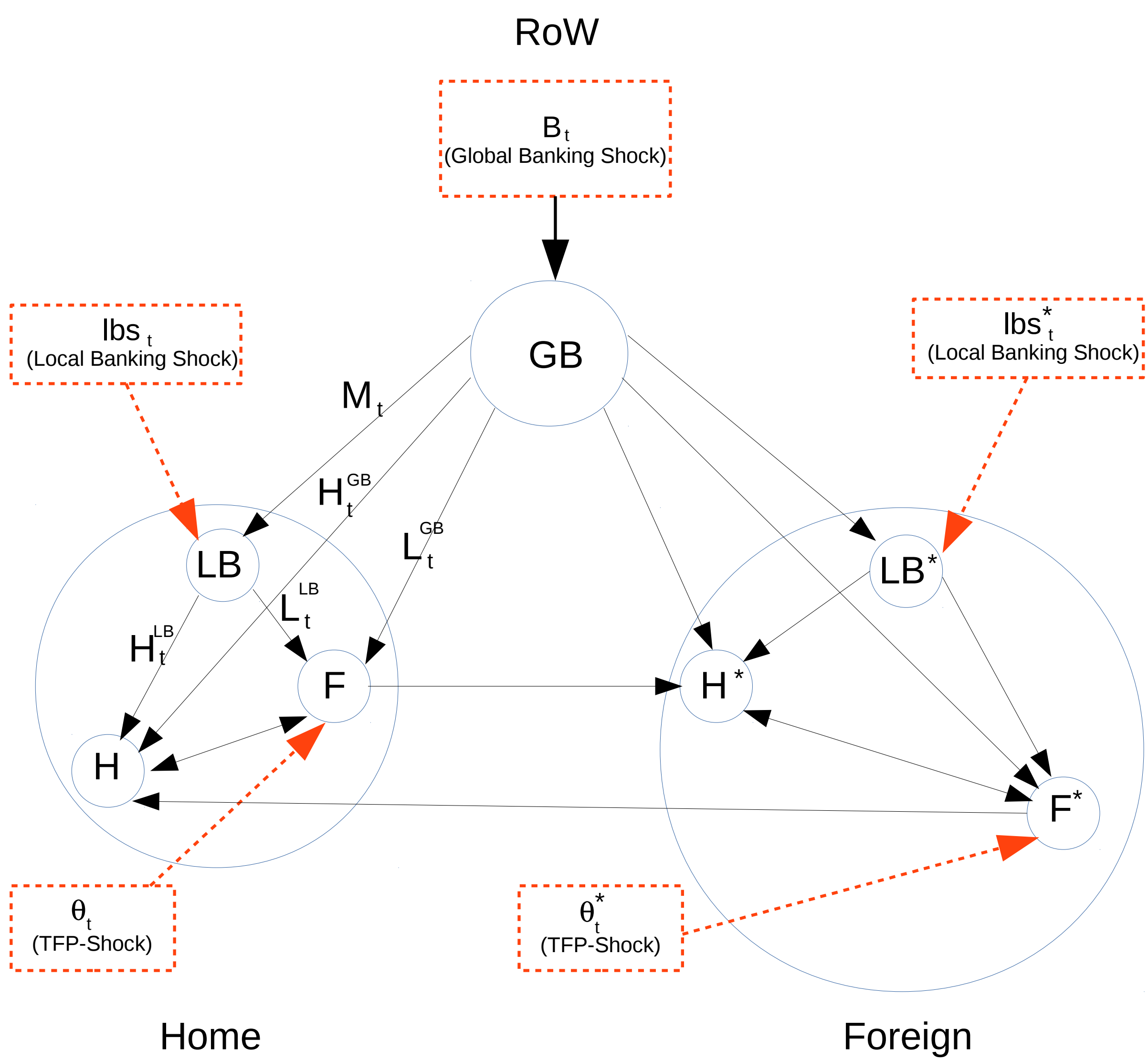
NOTES: The figure plots the degree of income smoothing ($\beta_I(t)$, green dot-dashed line) and consumption smoothing ($\beta_C(t)$, red long-dashed line). The coefficients $\beta_I(t)$ and $\beta_C(t)$ are estimated from cross-sectional regressions $\Delta\widetilde{gdp}_t^k - \Delta\widetilde{gni}_t^k = \beta_I(t)\Delta\widetilde{gdp}_t^k + \tau_t + \epsilon_t^k$ and $\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k = \beta_C(t)\Delta\widetilde{gdp}_t^k + \tau_t + \epsilon_t^k$ for each quarter from $t = 1999Q1 \ldots 2013Q4$, 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 ($\Delta\widetilde{gdp}_t^k - \Delta\widetilde{gni}_t^k$) and represents income smoothing via cross-border ownership. Coefficient β_C yields the amount of output risk captured by savings ($\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k$) and corresponds to consumption smoothing via borrowing and lending. The estimates of $\beta_I(t)$ and $\beta_C(t)$ have been smoothed using the trend component of the HP-filter with smoothing parameter of 250.

Figure 3: Change in Country-Specific Risk Sharing vs. Change in Banking Integration



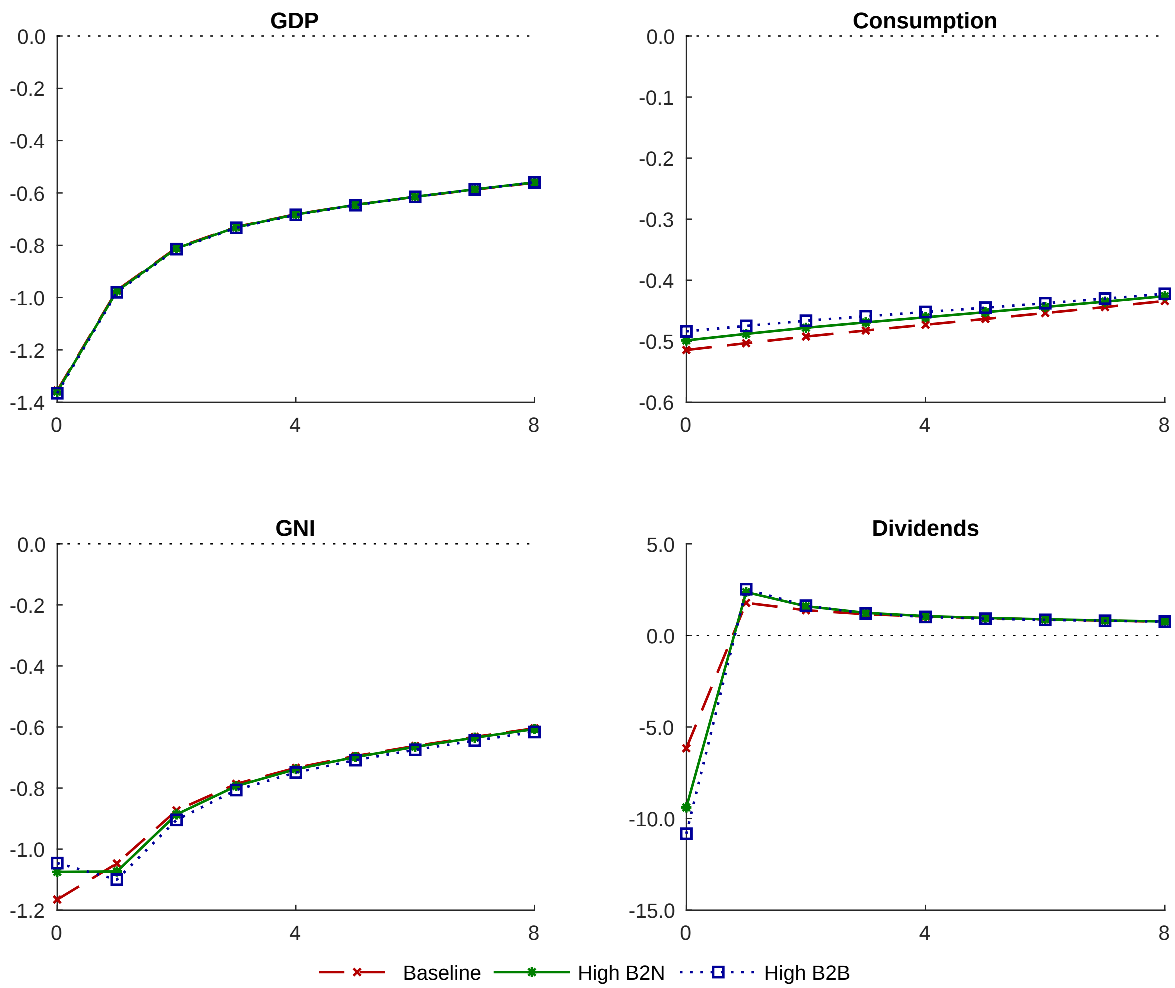
NOTES: The figure displays on the y-axis the post-2008 minus the pre-2008 coefficient to consumption growth in a regression on GDP growth, controlling for time fixed effects, interpreted as the amount of GDP shocks not smoothed (the fraction of risk not shared) estimated country-by-country—see the main text for the exact implementation of the regressions. On the x-axis in the left panel, we display the change post-2008 minus the pre-2008 average international interbank liabilities by country. On the x-axis in the right panel, we display the change post-2008 minus the pre-2008 average internationaldirect non-bank sector banking liabilities by country.

Figure 4: Model Economy



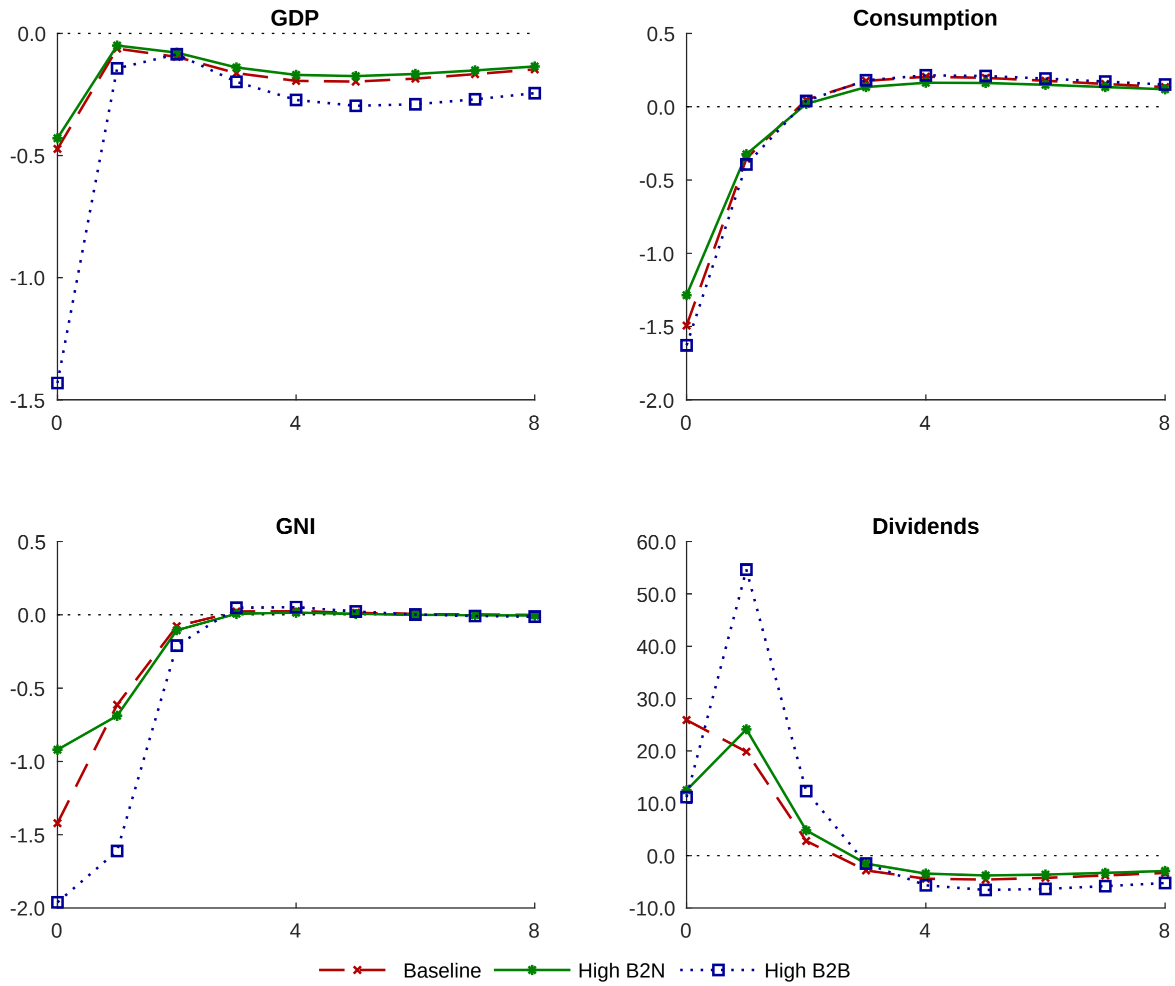
NOTES: The figure outlines the structure of our model. GB refers to global banks. The circle to the left is the domestic economy while the larger circle to the right is the rest of the eurozone. Apart from size, the foreign and the domestic economies are symmetric. LB denotes local banks, H denotes households, and F denotes firms. L denotes loans from the banks indicated by the superscript, while H with LB and GB superscript denote loans to households from local and global banks, respectively. The arrows from firms to households indicate dividend flows and the arrows from households to firms indicate labor supply. The shocks to the economies are indicated in the red boxes framed by broken lines and take the form of global funding shocks B to the global bank, productivity shocks θ to the firms, and intermediation shocks LBS to local banks.

Figure 5: Model Impulse Response Functions to a Domestic TFP Shock



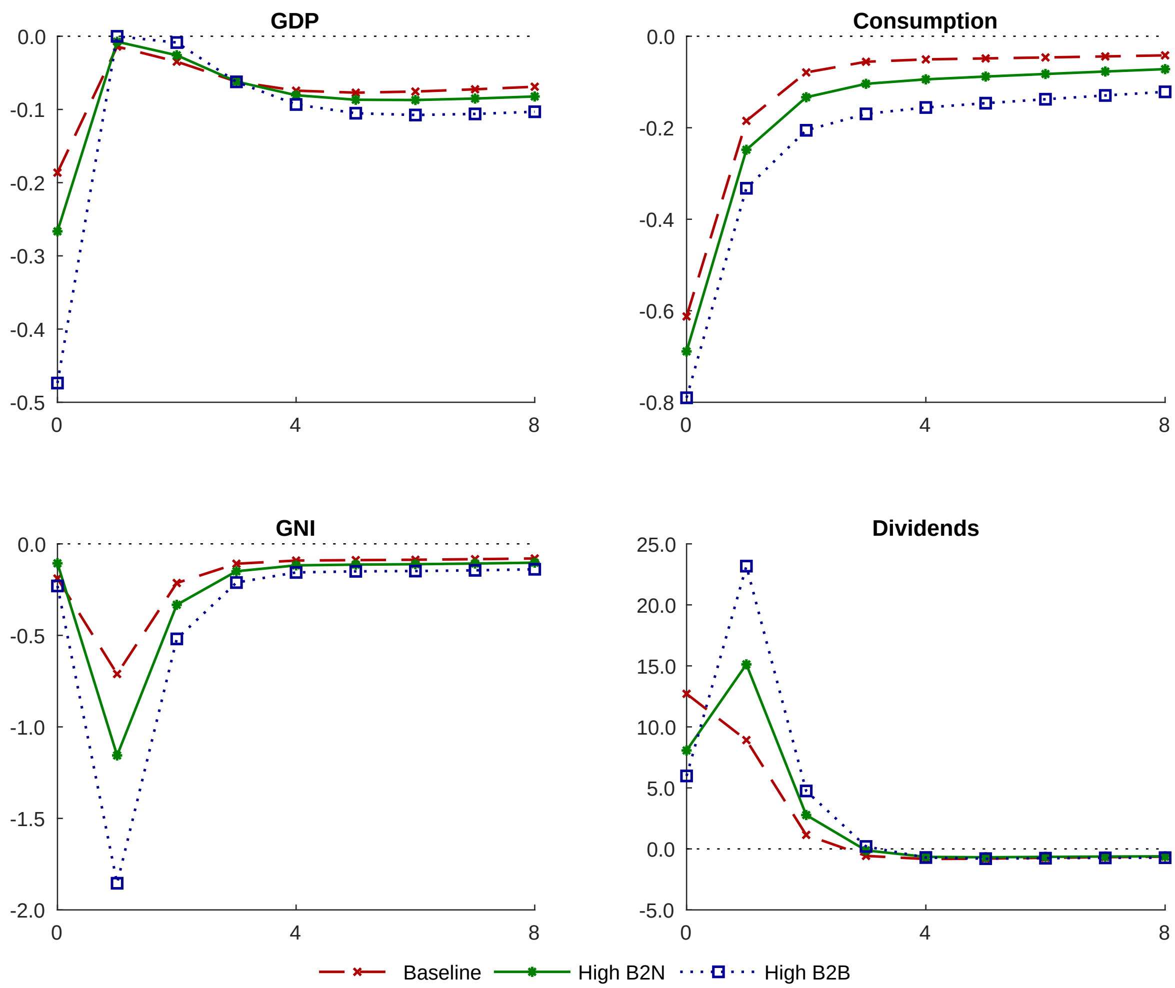
NOTES: The figure plots the model impulse response functions for GDP, Consumption, GNI, and firm dividends to a domestic TFP shock. Three scenarios are presented: (1) Baseline, in which all variables are set to average values: dashed red line with (*); (2) High B2N, in which direct bank-to-nonbank lending is set to the upper range value of 0.76: solid green line with (*); and (3) High B2B, in which interbank lending is set to the upper range value of 2.76: dotted blue line with (*). The foreign country is calibrated from the baseline values in all scenarios. Baseline values are: for Equity: 0.22; B2B: 1.25; B2N: 0.33. All impulse responses are percentage deviations from steady state. Number of quarters following the shock is on the x-axes.

Figure 6: Model Impulse Response Functions to a Domestic Local Banking Shock



NOTES: The figure plots the model impulse response functions for GDP, Consumption, GNI, and firm dividends to a domestic 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, in which direct bank-to-nonbank lending is set to the upper range value of 0.76: solid green line with (*); and (3) High B2B, in which interbank lending is set to the upper range value of 2.76: dotted blue line with (*). The foreign country is calibrated from the baseline values in all scenarios. Baseline values are: for Equity: 0.22; B2B: 1.25; B2N: 0.33. All impulse responses are percentage deviations from steady state. Number of quarters following the shock is on the x-axes.

Figure 7: Model Impulse Response Functions to a Global Banking Shock



NOTES: The figure plots the model impulse response functions for GDP, Consumption, GNI, and firm dividends to a global banking shock. Three scenarios are presented: (1) Baseline, in which all variables are set to average values: dashed red line with (*); (2) High B2N, in which direct bank-to-nonbank lending is set to the upper range value of 0.76: solid green line with (*); and (3) High B2B, in which interbank lending is set to the upper range value of 2.76: dotted blue line with (*). The foreign country is calibrated from the baseline values in all scenarios. Baseline values are: for Equity: 0.22; B2B: 1.25; B2N: 0.33. All impulse responses are percentage deviations from steady state. Number of quarters following the shock is on the x-axes.

Table 1: Basic Risk Sharing

		EMU10					non–EMU				
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		β_I	β_D	β_F	β_C	β_U	β_I	β_D	β_F	β_C	β_U
1999 – 2013	$\Delta\widetilde{\mathrm{gdp}}_\mathrm{t}^\mathrm{k}$	0.09**	−0.15***	0.01*	0.25***	0.81***	−0.02	−0.03**	0.03**	−0.00	1.02***
		(2.55)	(−3.41)	(1.82)	(5.52)	(7.47)	(−1.35)	(−1.97)	(2.02)	(−0.01)	32.43
1999 – 2008	$\Delta\widetilde{\mathrm{gdp}}_\mathrm{t}^\mathrm{k}$	0.14*	−0.01	−0.01	0.50***	0.38***	−0.03***	−0.03**	0.03	−0.01	1.04***
		(1.84)	(−0.30)	(−0.34)	(4.97)	(3.61)	(−2.63)	(−2.54)	(1.49)	(−0.19)	55.71
2009 – 2013	$\Delta\widetilde{\mathrm{gdp}}_\mathrm{t}^\mathrm{k}$	0.03	−0.15***	0.00	0.31***	0.81***	0.02	−0.01	0.06*	0.05	0.96***
		(0.30)	(−6.75)	(0.03)	(4.03)	(5.44)	(0.44)	(−0.37)	(1.83)	(0.34)	(8.29)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{gni} - \widetilde{nni}$, $\widetilde{nni} - \widetilde{nndi}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ 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, Czech Republic, Denmark, Poland, Romania, Sweden, and the UK.

Table 2: Risk Sharing and Cross-Border Bank Lending, 1999–2008

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}_t^k}$	0.15**	0.49***	0.39***	0.15*	0.47***	0.40***	0.10*	0.53***	0.41***	0.08*	0.49***	0.49***
	(2.21)	(5.88)	(3.85)	(1.86)	(5.29)	(4.39)	(1.66)	(6.26)	(3.79)	(1.66)	(6.79)	(6.40)
$\widetilde{\frac{\mathrm{TB}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.09	−0.13	0.04									
	(1.01)	(−1.61)	(0.45)									
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.07	−0.16	0.11				−0.04	−0.14	0.26*
				(0.71)	(−1.51)	(0.93)				(−0.52)	(−1.18)	(1.86)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.47*	−0.12	−0.54	0.55**	0.11	−0.98***
							(1.68)	(−0.37)	(−1.64)	(2.40)	(0.30)	(−3.62)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ 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 1999Q1-2008Q4.

Table 3: Risk Sharing, Cross-Border Bank Lending and Equity Holdings, 1999–2008

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}_t^k}$	0.13**	0.52***	0.37***	0.12**	0.50***	0.42***	0.11*	0.53***	0.40***	0.10**	0.54***	0.38***
	(2.25)	(5.34)	(3.34)	(2.07)	(5.51)	(4.97)	(1.76)	(5.91)	(3.62)	(2.47)	(6.89)	(3.53)
$\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.76*	−0.59	−0.25	1.13	−0.25	−1.11***	0.54	−0.57	0.07			
	(1.88)	(−1.17)	(−0.62)	(1.52)	(−0.24)	(−2.88)	(0.93)	(−0.93)	(0.15)			
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				−0.13	−0.13	0.31***						
				(−0.84)	(−0.57)	(2.95)						
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.22	0.16	−0.58**			
							(0.48)	(0.41)	(−2.07)			
$\left(\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} + \widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}}\right) \times \Delta\widetilde{\mathrm{gdp}_t^k}$										0.38**	−0.18	−0.28
										(2.19)	(−0.89)	(−1.19)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ 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 $\Delta x = \Delta\big(\widetilde{\frac{S_{Public}}{C}}\big)$ or $\Delta x = \Delta\big(\widetilde{\frac{S_{Priv}}{C}}\big)$, 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.
EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. Time period is 1999Q1-2008Q4.

Table 4: Risk Sharing and Saving Components

		South				North			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		β_I	β_C		β_U	β_I	β_C		β_U
			public	private			public	private	
1999 – 2008	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.08**	0.25	0.12	0.54***	0.24*	0.28**	0.28	0.33***
		(2.37)	(0.80)	(0.34)	(4.59)	(1.89)	(2.34)	(0.97)	(3.09)
2009 – 2013	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	−0.05	0.05	−0.04	1.19***	0.38***	0.23	0.03	0.41***
		(−0.47)	(0.75)	(−0.23)	(9.84)	(4.11)	(1.60)	(0.11)	(3.11)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ 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 saving by performing similar regressions with $\Delta x = \Delta\big(\widetilde{\frac{S_{Public}}{C}}\big)$ or $\Delta x = \Delta\big(\widetilde{\frac{S_{Priv}}{C}}\big)$, 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.
Southern countries are Greece, Italy, Spain, and Portugal. Northern countries are Belgium, Germany, Finland, France, Netherlands, and Austria.

Table 5: Model Calibration I: Common Parameters

Parameter	Description	Value
β	Households' discount factor	0.99
ψ	Inverse of Frisch elasticity	2
σ	Households' risk aversion	1
γ	Index of real wage rigidities	0.80
α	Capital intensity in firms production function	0.35
φ^I	Investment adjustment cost parameter	4
δ	Capital depreciation in steady-state	0.025
ι	Cost of alternative sources of funds to firms	0.04
ν^E	Scaling parameter for cross-border equity holdings	0.60
φ^{LB}	Local bank adjustment cost in interbank markets	0.015
MU^{LB}	Mark-up on credit from local banks	3.5
MU^{GB}	Mark-up on credit from global banks	2.0
ρ^θ	TFP shocks autocorrelation coefficient	0.95
ρ^{gbs}	Global banking shock autocorrelation coefficient	0.95
ρ^{lbs}	Local banking shock autocorrelation coefficient	0.40
σ^θ	Standard deviation of TFP shocks (same in baseline and crisis)	0.0077
σ^{gbs}	Standard deviation of global banking shock: baseline (crisis)	0.0022 (0.015)
σ^{lbs}	Standard deviation of local banking shock: baseline (crisis)	0.0022 (0.015)

NOTES: Country-specific calibration parameters are presented in Table 6.

Table 6: Model Calibration II: Country-Specific Parameters

		Raw values			Deep parameters			
	GDP	B2B	B2N	Equity	τ	κ	ϕ	λ
Austria	1.00	0.92	0.21	0.16	0.37	0.13	0.30	0.27
Belgium	1.00	2.76	0.46	0.46	0.30	0.10	0.80	0.77
Finland	1.00	0.57	0.31	0.21	0.58	0.27	0.28	0.35
France	1.00	1.14	0.26	0.17	0.36	0.13	0.37	0.28
Germany	1.00	0.89	0.23	0.23	0.39	0.15	0.30	0.38
Greece	1.00	0.45	0.45	0.02	0.72	0.40	0.33	0.03
Italy	1.00	0.72	0.10	0.19	0.26	0.08	0.20	0.32
Netherlands	1.00	2.23	0.76	0.59	0.46	0.19	0.85	0.98
Portugal	1.00	2.04	0.35	0.09	0.30	0.10	0.60	0.15
Spain	1.00	0.75	0.17	0.10	0.36	0.13	0.24	0.17
EMU	10.00	1.25	0.33	0.22	0.40	0.15	0.43	0.37

Memorandum items: The values of parameters Ψ, μ and μ^{GB} are derived from steady-state restrictions as follows:

$$\Psi = \frac{W}{N^{\psi} C^{-\sigma}},$$

$$\mu = \frac{\lambda Y}{\lambda Y + \lambda^* Y^*},$$

$$\mu^{\text{GB}} = \frac{L r^{l,\text{GB}} + M r^m}{\left(L^{\text{GB}} + L^{\text{GB}^*}\right) r^{l,\text{GB}} + \left(H^{\text{GB}} + H^{\text{GB}^*}\right) r^{h,\text{GB}} + (M + M^*) r^m}.$$

NOTES: GDP is unity for all countries. B2N, B2B and Equity (raw values) are relative to GDP and constructed from the empirical data as pre-2008, within-country, averages. The EMU values for these parameters are constructed as averages. τ and κ (deep model parameters) are derived from raw values of 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. EMU values for these parameters have been calibrated. Given these parameters, ϕ (deep model parameter) is derived from steady-state restrictions as $\phi = \frac{L}{WN+I}$. λ (deep model parameter) is derived from raw values of Equity using the approximation: $\text{Equity} \approx \nu^E \times \lambda$. The EMU values for these parameters are constructed as averages. All parameters for the foreign country are derived from the values of individual countries, such that the total EMU value (e.g., the average) stays the same for each home-foreign country pair; i.e., $X_c^* = \sum_{j \neq c} \frac{\text{GDP}_j}{\text{GDP}_c^*} \times X_j$, where X_c is one of: B2B_c, B2N_c, τ_c, and κ_c; c is a country index. For equity, we assume $\text{Equity}_c^* = \text{Equity}^{EMU}$.

Table 7: Business Cycle Statistics

	Model		Data	
	St.Dev.	Corr.	St.Dev.	Corr.
GDP	1.43*		1.43*	
Consumption	0.50	0.88	0.63	0.75
Investment	2.62	0.58	2.82	0.81
Employment	0.63	0.85	0.62	0.72
Net exports	1.13	0.39	1.13	–0.24

NOTES: The table reports theoretical and empirical standard deviations ("St.Dev.") and correlations ("Corr.") of the variables. The theoretical moments are shown for an hypothetical country, for which all variables are set to average values; i.e., Equity: 0.22; B2B: 1.25; B2N: 0.33. The same values are used for the foreign country. 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

		(1)	(2)	(3)
		β_I	β_C	β_U
1999–2008	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.10***	0.50***	0.41***
		(3.60)	(17.40)	(22.22)
2009–2013	$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.08	0.31	0.62***
		(0.40)	(1.45)	(5.60)

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 and are calculated as the ratio of the mean to the standard deviation of the estimated coefficients across 1000 model simulations. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal.

Table 9: Risk Sharing and Cross-Border Bank Lending: Model, Pre-Crisis Simulations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}_t^k}$	0.10***	0.50***	0.40***	0.10***	0.50***	0.40***	0.08***	0.51***	0.41***	0.09***	0.51***	0.41***
	(3.64)	(17.74)	(21.56)	(3.64)	(17.65)	(21.65)	(3.71)	(19.88)	(22.75)	(3.72)	(19.42)	(22.25)
$\widetilde{\frac{\mathrm{TB}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.13***	–0.15***	–0.03									
	(2.75)	(–2.91)	(–1.07)									
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.14***	–0.16***	–0.03				0.08*	–0.09	–0.01
				(2.69)	(–2.85)	(–1.03)				(1.66)	(–1.61)	(–0.46)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							1.16***	–1.34***	–0.22	0.73	–0.83	–0.16
							(2.77)	(–2.77)	(–1.03)	(1.50)	(–1.42)	(–0.56)
N	360	360	360	360	360	360	360	360	360	360	360	360

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t = \beta_X^k(t)\Delta\widetilde{gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \boldsymbol{c}_X^{\prime}\boldsymbol{z}_t^k + \varepsilon_{Xt}^k$ 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 $\beta_{Xt}^k = a_X + \boldsymbol{b}_X^{\prime}\boldsymbol{z}_t^k$. $\boldsymbol{z}_t^k$ 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 and are calculated as the ratio of the mean to the standard deviation of the estimated coefficients across 1000 model simulations. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. The calibration assumes tranquil times and simulations have been done for 40 quarters, corresponding to pre-crisis period in the data (1999Q1–2008Q4).

Table 10: Risk Sharing, Cross-Border Bank Lending and Equity Holdings: Model, Pre-Crisis Simulations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}_t^k}$	0.12***	0.48***	0.39***	0.13***	0.46***	0.40***	0.11***	0.50***	0.39***	0.10***	0.49***	0.41***
	(4.41)	(16.99)	(20.85)	(4.77)	(15.47)	(21.69)	(4.34)	(18.46)	(21.24)	(3.43)	(16.26)	(21.78)
$\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.88***	–1.02***	–0.14	0.82***	–1.11***	0.03	0.67***	–0.88***	–0.02			
	(3.39)	(–3.54)	(–1.24)	(2.78)	(–3.39)	(0.16)	(3.23)	(–3.48)	(–0.11)			
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.03	–0.01	–0.03				0.03	–0.01	–0.03
				(0.66)	(–0.20)	(–0.93)				(0.46)	(–0.15)	(–0.70)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.40	–0.24	–0.31			
							(1.07)	(–0.51)	(–1.00)			
$\left(\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} + \widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}}\right) \times \Delta\widetilde{\mathrm{gdp}_t^k}$										0.50*	–0.69**	0.01
										(1.85)	(–2.27)	(0.09)
N	360	360	360	360	360	360	360	360	360	360	360	360

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 and are calculated as the ratio of the mean to the standard deviation of the estimated coefficients across 1000 model simulations. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. The calibration assumes tranquil times and simulations have been done for 40 quarters, corresponding to pre-crisis period in the data (1999Q1–2008Q4).

Table 11: Basic Risk Sharing, North vs. South and Global vs. Local Banking Shocks: Model

		South			North		
		(1)	(2)	(3)	(4)	(5)	(6)
		β_I	β_C	β_U	β_I	β_C	β_U
1999–2008	$\Delta\widetilde{\mathrm{gdp}}_t^k$	0.02	0.60***	0.41***	0.15***	0.43***	0.41***
		(0.90)	(33.92)	(13.50)	(3.42)	(9.48)	(16.71)
2009–2013	$\Delta\widetilde{\mathrm{gdp}}_t^k$	–0.12	0.41**	0.73**	0.36*	0.17	0.39***
		(–0.52)	(2.00)	(2.06)	(1.71)	(0.68)	(9.18)

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 and are calculated as the ratio of the mean to the standard deviation of the estimated coefficients across 1000 model simulations.
Pre-crisis calibration for southern and northern countries is identical. Crisis times assume an increase in the volatility (standard deviations) of local and global banking shocks for the southern countries from 0.0022 to 0.03 and increase in volatility of (only) global banking shocks for the northern countries from 0.0022 to 0.03.
Southern countries are Greece, Italy, Spain and Portugal. Northern countries are Belgium, Germany, Finland, France, Netherlands, and Austria.

Table 12: Risk Sharing under Different Scenarios: Model, Pre-Crisis Simulations

		B2N integrarion					
		Low			High		
		(1)	(2)	(3)	(4)	(5)	(6)
		β_I	β_C	β_U	β_I	β_C	β_U
Equity integration	Low	0.01	0.60	0.42	0.04	0.59	0.38
	High	0.16	0.37	0.45	0.26	0.29	0.40

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 percent below the mean, while high capital integration is set to a value 100 percent above the mean. Low direct banking integration refers to a scenario in which B2N is set to a value 50 percent below the mean, while high real banking integration is set to a value 100 percent above the mean. The calibration assumes tranquil times and the simulations have been performed using 1000 model simulations, each spanning 1000 quarters.

Appendix

Table A1: Risk Sharing and Cross-Border Bank Lending, 2009–2013

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.06	0.27**	0.81***	0.05	0.28**	0.81***	0.06	0.28**	0.79***	0.06	0.28**	0.80***
	(0.92)	(2.37)	(6.49)	(0.79)	(2.47)	(6.18)	(0.71)	(2.37)	(5.88)	(0.93)	(2.13)	(6.04)
$\widetilde{\frac{\mathrm{TB}_{\mathrm{t-1}}^{\mathrm{k}}}{\mathrm{GDP}_{\mathrm{t-1}}^{\mathrm{k}}}} \times \Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$	0.10	−0.12	0.01									
	(0.71)	(−0.59)	(0.05)									
$\widetilde{\frac{\mathrm{B2B}_{\mathrm{t-1}}^{\mathrm{k}}}{\mathrm{GDP}_{\mathrm{t-1}}^{\mathrm{k}}}} \times \Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$				0.11	−0.15	0.02				0.10	−0.16	0.05
				(0.66)	(−0.62)	(0.12)				(0.55)	(−0.57)	(0.36)
$\widetilde{\frac{\mathrm{B2N}_{\mathrm{t-1}}^{\mathrm{k}}}{\mathrm{GDP}_{\mathrm{t-1}}^{\mathrm{k}}}} \times \Delta\widetilde{\mathrm{gdp}}_{\mathrm{t}}^{\mathrm{k}}$							0.36	−0.31	−0.21	0.12	0.06	−0.27
							(0.92)	(−0.59)	(−0.78)	(0.39)	(0.11)	(−1.01)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ 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 2009Q1-2013Q4.

Table A2: Risk Sharing, Cross-Border Bank Lending and Equity Holdings, 2009–2013

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\widetilde{\Delta \mathrm{gdp}_t^k}$	0.24***	0.11	0.69***	0.18**	0.22	0.66***	0.25***	0.09	0.70***	0.18*	0.23**	0.70***
	(3.60)	(0.83)	(5.16)	(2.08)	(1.19)	(4.62)	(3.09)	(0.64)	(5.47)	(1.72)	(2.07)	(6.65)
$\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \widetilde{\Delta \mathrm{gdp}_t^k}$	1.41***	−0.64	−1.39***	0.94***	0.48	−1.84***	1.39***	−0.52	−1.58***			
	(3.93)	(−1.29)	(−3.09)	(6.78)	(0.94)	(−3.53)	(4.44)	(−0.90)	(−3.06)			
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \widetilde{\Delta \mathrm{gdp}_t^k}$				0.01	−0.16	0.11						
				(0.10)	(−0.68)	(1.61)						
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \widetilde{\Delta \mathrm{gdp}_t^k}$							0.03	−0.23	0.35			
							(0.08)	(−0.44)	(1.16)			
$\left(\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} + \widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}}\right) \times \widetilde{\Delta \mathrm{gdp}_t^k}$										0.59	−0.18	−0.58*
										(1.48)	(−0.43)	(−1.85)

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta \widetilde{gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nndi} - \widetilde{c}$, $\widetilde{c}$ 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 $\Delta x = \Delta\big(\widetilde{\frac{S_{Public}}{C}}\big)$ or $\Delta x = \Delta\big(\widetilde{\frac{S_{Priv}}{C}}\big)$, 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.
EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. Time period is 2009Q1-2013Q4.

Table A3: Risk Sharing and Cross-Border Bank Lending: Model, Crisis Simulations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}_t^k}$	0.05	0.39**	0.57***	0.05	0.38**	0.58***	0.06	0.36**	0.59***	0.06	0.38***	0.57***
	(0.36)	(2.46)	(5.21)	(0.35)	(2.37)	(5.35)	(0.50)	(2.49)	(5.06)	(0.55)	(2.81)	(5.55)
$\widetilde{\frac{\mathrm{TB}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	0.11	–0.29	0.17									
	(0.45)	(–1.07)	(1.53)									
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.12	–0.32	0.18				0.02	–0.19	0.19
				(0.50)	(–1.11)	(1.56)				(0.07)	(–0.60)	(1.40)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							1.18	–2.68	1.35	1.33	–1.72	0.01
							(0.59)	(–1.14)	(1.16)	(0.52)	(–0.54)	(0.01)
N	200	200	200	200	200	200	200	200	200	200	200	200

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 and are calculated as a ratio of the mean to the standard deviation of the estimated coefficients across 1000 model simulations. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. The calibration assumes crisis times and the simulations have been done for 40 quarters, corresponding to the crisis period in the data (2009Q1–2013Q4).

Table A4: Risk Sharing, Cross-Border Bank Lending and Equity Holdings: Model, Crisis Simulations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U	β_I	β_C	β_U
$\Delta\widetilde{\mathrm{gdp}^k_t}$	0.11	0.31**	0.57***	0.12	0.30**	0.58***	0.08	0.34**	0.59***	0.00	0.43***	0.59***
	(0.78)	(2.09)	(4.77)	(0.84)	(2.09)	(5.32)	(0.63)	(2.51)	(4.98)	(0.01)	(2.96)	(5.90)
$\widetilde{\frac{\mathrm{E}^k_{t-1}}{\mathrm{GDP}^k_{t-1}}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$	0.95	–1.85	0.74	1.39	–1.79	0.04	0.36	–1.16	0.78			
	(0.80)	(–1.39)	(1.33)	(0.89)	(–1.03)	(0.05)	(0.29)	(–0.77)	(0.92)			
$\widetilde{\frac{\mathrm{B2B}^k_{t-1}}{\mathrm{GDP}^k_{t-1}}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$				–0.11	–0.02	0.17				–0.00	–0.14	0.16
				(–0.36)	(–0.06)	(1.01)				(–0.00)	(–0.37)	(1.04)
$\widetilde{\frac{\mathrm{B2N}^k_{t-1}}{\mathrm{GDP}^k_{t-1}}} \times \Delta\widetilde{\mathrm{gdp}^k_t}$							0.73	–1.09	0.19			
							(0.29)	(–0.36)	(0.10)			
$\left(\widetilde{\frac{\mathrm{E}^k_{t-1}}{\mathrm{GDP}^k_{t-1}}} + \widetilde{\frac{\mathrm{B2N}^k_{t-1}}{\mathrm{GDP}^k_{t-1}}}\right) \times \Delta\widetilde{\mathrm{gdp}^k_t}$										0.50	–0.78	0.14
										(0.46)	(–0.56)	(0.31)
N	200	200	200	200	200	200	200	200	200	200	200	200

NOTES: The table reports the results of the panel OLS regressions $\Delta x_t = \beta^k_X(t)\Delta\widetilde{gdp}^k_t + \boldsymbol{d}^{k\prime}_{Xt}\mathbf{1} + \boldsymbol{c}'_X\boldsymbol{z}^k_t + \varepsilon^k_{Xt}$ with $x_t = \widetilde{gdp}^k_t - \widetilde{gni}^k_t$, $\widetilde{nni}^k_t - \widetilde{c}^k_t$, $\widetilde{c}^k_t$ for I, C and U respectively. The lower-case letters with a tilde denote logarithmic deviations from the sample-wide aggregate, $\Delta x = \Delta log\left[X^k_t/X^*_t\right]$. $\beta^k_X(t)$ is defined as $\beta^k_{Xt} = a_X + \boldsymbol{b}'_X\boldsymbol{z}^k_t$. $\boldsymbol{z}^k_t$ contains country specific bank lending variables and/or cross-border equity holdings, as listed in the first column. $\boldsymbol{d}^k_{Xt}$ contains time and country fixed effects. Standalone coefficients c_X are not reported. t-statistics are in parentheses and are calculated as a ratio of the mean to the standard deviation of the estimated coefficients across 1000 model simulations. EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. The calibration assumes crisis times and the simulations have been done for 40 quarters, corresponding to the crisis period in the data (2009Q1–2013Q4).