Essays in Financial Integration, Firm Dynamics and Risk Sharing

Dissertation
submitted to the
Faculty of Business, Economics and Informatics
of the University of Zurich

to obtain the degree of
Doktor der Wirtschaftswissenschaften, Dr. oec.
(corresponds to Doctor of Philosophy, PhD)

presented by

Egor Maslov
from Russian Federation

approved in October 2020 at the request of

Prof. Dr. Mathias Hoffmann
Prof. Dr. Per Östberg

The Faculty of Business, Economics and Informatics of the University of Zurich hereby authorizes the printing of this dissertation, without indicating an opinion of the views expressed in the work.

Zurich, October 21^{st} 2020

Chairman of the Doctoral Board: Prof. Dr. Steven Ongena

Acknowledgments

This dissertation is the culmination of inspiring and instructive years. Many people guided and supported me during this time and I would like to express my gratitude to them.

First and foremost, I am indebted to my supervisor Mathias Hoffmann, who provided me with continuing guidance and support during all these years. I am grateful for his advice, the affirming and productive environment he created, and the experience that he shared with me. I also thank my co-supervisor Per Östberg for his encouragement, support and timely advice.

Two chapters of this dissertation are joint work with my co-authors. I thank Mathias Hoffmann, Bent Sørensen and Iryna Stewen for their recognition, and for sharing their experience with me. It has been great pleasure to work with you and I am looking forward to our future collaborations.

Countless discussions with colleagues and fellow students have improved the quality of my work and helped me during my time as a PhD student. I am particularly thankful for the companionship of Adrian Bosshard, Lilia Mukhlynina, Alexander Raabe, Lilia Ruslanova, Anastasiia Sokko, Michael Stiefel, Rahel Studer, Vladimil Sulaja, and Adriano Tosi. The administrative staff at the University of Zurich, in particular Cornelia Metzler, Sonja Verel and Sarah Wilkus, provided valuable support.

I want to thank Daniel for his love and patience. Without his constant care during all these years I wouldn't probably be where I am now. Finally, I bow down to my family who has been supporting me from many kilometers afar. This dissertation is dedicated to my grandmother Anna.

Egor Maslov

Zurich, August 2020

Contents

List of Tables

List of Figures

Chapter 1

Dissertation Overview

The title of this dissertation is *"Essays in Financial Integration, Firm Dynamics and Risk Sharing"*. It is a cumulative work, both empirical and theoretical in nature, that studies macroeconomic aspects of financial integration with a particular focus on the role of the firm in the transmission of real and financial shocks and risk sharing. To provide a better understanding of how deeply interconnected these concepts are in my research, the following paragraphs briefly focus on each of them individually.

"Financial integration". Inspired by the observation that the first decade of the euro saw a considerable drive toward deeper *de jure* and *de facto* financial integration within the eurozone, this thesis studies two ways in which the European financial integration turned out less profound than expected. It shows that while the cross-border bank lending had increased considerably prior to 2008, it mainly took the form of cross-border lending to banks, while cross-border bank lending to the non-bank sector had hardly increased. As a result, this lopsided nature of banking integration led to an unbalanced transmission of global financial shocks to individual countries and sectors, and sudden fragility of risk sharing mechanisms as the global financial and the European sovereign debt crises hit.

"Firm Dynamics". Building on these ideas, the current work emphasizes two different roles that firms play in shaping aggregate macroeconomic responses to shocks: first, through their function as an implicit insurance provider to households, and second, through the differences between how large and small firms interact with banks and the financial sector in general. Concerning the first point, it develops the idea that the general payout policy of the firm, understood broadly to include the compensation of labor, determines how much of the firm-level risk is borne by different economic agents, and concludes that risk sharing patterns on the macroeconomic level are crucially shaped by how risk is shared within the firm. With respect to the second point, it highlights the relative importance of small and medium-sized enterprises (SMEs) for shock transmission within the economy. Due to their relative opaqueness, small

firms can only imperfectly substitute other sources of credit for bank loans, and so financial shocks to the banking sector have larger effects on output and consumption in countries with a high share of SMEs.

"Risk Sharing". From the welfare perspective of individual countries and currency unions, it is crucial to know how changes in aggregate production and income (e.g., GDP) affect aggregate demand and consumption, and which institutions and policies help to reduce the macroeconomic risk. Motivated by this notion, this thesis revisits the channels and mechanisms through which risk sharing was achieved in the eurozone before and during the financial crises. It further examines the role of labor income and dividends in shaping the aggregate risk sharing patterns as well as to what extent the corporate sector and individual firms can shift risk between economic agents and thus influence the aggregate pass-through of the risk within the economy. It concludes with a short discussion of how different governments induced an external shift in corporate payout policies during the current covid-19 pandemic in order to stabilize workers' labor income and reduce the total size of the risk passing through to consumption and aggregate demand.

Methodology-wise, this dissertation uses diverse econometric techniques applied to aggregate macroeconomic data, national sectoral accounts data, and microeconomic country-firm data. It proposes several frameworks to study risk sharing on different levels of interaction between economic agents, and investigates how economic outcomes can be shaped by different types of shocks: productivity and financial, aggregate and idiosyncratic, permanent and transitory. Furthermore, it complements some of its empirical findings from a theoretical perspective by constructing and calibrating two dynamic stochastic general equilibrium (DSGE) models. These models make precise the interpretations of the risk sharing channels and the transmission of real and financial shocks within the economy in general, and through the firm sector in particular. Finally, through the use of simulated data under various shock scenarios, this approach additionally facilitates the distinction between alternative explanations of the empirical findings.

The dissertation consists of four chapters. The present *"Dissertation Overview"* is followed by Chapter 2, titled *"Small Firms and Domestic Bank Dependence in Europe's Great Recession"*, which is co-authored with Mathias Hoffmann (my PhD supervisor) and Bent E. Sørensen (University of Houston), continues with Chapter 3, titled *"Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?"*, joint with Mathias Hoffmann, Bent E. Sørensen and Iryna Stewen (University of Mainz), and finishes with the single-authored Chapter 4, titled *"Risk Sharing within the Firm and Beyond: The Role of the Firm in the Transmission of Shocks to Households"*. The main findings from these chapters are summarized below.

In Chapter 2, titled *"Small Firms and Domestic Bank Dependence in Europe's Great Recession"*, my co-authors and I show that the severity of the eurozone crisis was worse in countries where firms borrowed more from domestic banks than in countries where firms borrowed more from international banks. Eurozone banking integration in the years 2000–2008 mainly involved cross-border lending between banks while foreign banks' lending to the real sector stayed flat. Hence, SMEs remained dependent on domestic banks and were vulnerable to global banking shocks. We confirm, using a calibrated quantitative model, that domestic bank dependence makes sectors and countries with many SMEs vulnerable to global banking shocks.

In Chapter 3, titled *"Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?"*, my co-authors and I 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.

This chapter is based on the paper that has been been prepared for the *IMFER-Central Bank of Ireland* conference *"The Euro at 20"* and subsequently published in the *IMF Economic Review* as Hoffmann et al. (2019). For copyright reasons the text of this chapter is relegated to the Appendix.

Finally, in Chapter 4, titled *"Risk Sharing within the Firm and Beyond: The Role of the Firm in the Transmission of Shocks to Households"*, I study the role of the firm in international consumption risk sharing by analyzing the patterns of shock transmission from firm output and value-added to household income and consumption. I show that fluctuations in consumption are primarily driven by shocks to household labor income and shielded from shocks to household dividend income. While the former are entirely driven by the dynamics of firm-sector labor compensation, there is little evidence that household dividend income follows firm sector dividend payout. Thus, firms have a potentially pivotal role in providing consumption insurance to households by shifting risk from workers to shareholders. I show that there is indeed a high degree of such within-firm risk sharing, since firms considerably insure workers from transitory and permanent shocks to their output and value-added, while shareholders are only insured from temporal but not from persistent shocks.

References

Hoffmann, Mathias, Egor Maslov, Bent E. Sørensen, and Iryna Stewen. 2019. "Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?" *IMF Economic Review*, 67(3): 443–495.

Chapter 2

Small Firms and Domestic Bank Dependence in Europe's Great Recession

Joint with Mathias Hoffmann and Bent E. Sørensen

Abstract: Small businesses (SMEs) depend on banks for credit. We show that the severity of the Eurozone crisis was worse in countries where firms borrowed more from domestic banks ("domestic bank dependence") than in countries where firms borrowed more from international banks. Eurozone banking integration in the years 2000–2008 mainly involved cross-border lending between banks while foreign banks' lending to the real sector stayed flat. Hence, SMEs remained dependent on domestic banks and were vulnerable to global banking shocks. We confirm, using a calibrated quantitative model, that domestic bank dependence makes sectors and countries with many SMEs vulnerable to global banking shocks.

Keywords: Small and medium enterprises, SME access to finance, Banking integration, Domestic bank dependence, International transmission, Eurozone crisis.
JEL classification: F30, F36, F40, F45.

Citation: Hoffmann, Mathias, Egor Maslov, and Bent E. Sørensen (2020). Small Firms and Domestic Bank Dependence in Europe's Great Recession. A version of this paper has been submitted to *Journal of International Economics*.

Acknowledgements: This project started as part of the European Commission's 2014-15 Fellowship initiative. We gratefully acknowledge comments from workshop participants during the various conferences of the fellowship program as well as at Humboldt University, the EEA meetings 2019, the annual meeting of the Verein für Socialpolitik, the ADEMU network workshop on "Risk Sharing Mechanisms for the European Union" at the European University Institute, T2M conference in Lisbon 2017 and IFABS 2017 conference in Oxford. We are particularly grateful to Nir Jaimovich, Kari Korhonen, Karl Pichelmann, Elias Papaiannou, and Michael Thiel for discussions and comments.

Mathias Hoffmann is at the University of Zurich, Dept. of Economics, International Trade and Finance Group, Zürichbergstrasse 14, CH-8032 Zürich. He is also affiliated with University of Zurich's Research Priority Program in Financial Market Regulation (URPP FinReg), the CESifo Munich and the Centre for Applied Macroeconomic Analysis (CAMA) at the Australian National University. E-mail: mathias.hoffmann@uzh.ch

Egor Maslov is at the University of Zurich, Dept. of Banking and Finance. He is also affiliated with University of Zurich's Research Priority Program in Financial Market Regulation (URPP FinReg) and Swiss Finance Institute (SFI). E-mail: egor.maslov@bf.uzh.ch

Bent E. Sørensen is with the Dept. of Economics, University of Houston, Houston, TX, USA. He is also affiliated with the Centre for Economic Policy Research (CEPR). E-mail: besorensen@uh.edu

2.1 Introduction

Since the inception of the Euro until 2008, cross-border bank lending in the Eurozone increased considerably but mainly took the form of cross-border lending to banks, while cross-border bank lending to the non-bank sector hardly increased. Thus, the real economy in most member countries remained dependent on the provision of credit by domestic banks. This pattern—which we refer to as "domestic bank dependence"—implied that the growth in domestic credit to the real sector in the years before the crisis was financed mainly by domestic banks, which in turn funded themselves through cross-border interbank borrowing. During the Eurozone crisis cross-border interbank lending declined sharply, while cross-border bank lending to the real sector remained relatively stable. This left economies and sectors that were reliant on domestic banks for finance particularly exposed to the global retrenchment in cross-border interbank lending. In this paper we provide empirical evidence consistent with this mechanism and propose a model which explains how the global retrenchment in cross-border interbank flows disproportionately affects countries with a high share of domestic banks and sectors with many small and medium-sized firms (SMEs). We show that our model produces predictions that qualitatively and quantitatively match the documented empirical patterns and that no other alternative scenarios we consider can by themselves replicate these findings.

We expect that sectors and countries with many SMEs would be particularly dependent on domestic banks for the provision of credit because SMEs are generally too small and too opaque to borrow from banks in other countries or from the bond market. Domestic banks generally have better information about local small firms and often engage in long-term relationships with their borrowers. This allows SMEs to satisfy their demand for finance that is not easily available from big foreign banks that mainly lend at arms-length. On the other hand, domestic bank dependence makes small firms particularly vulnerable to shocks that affect the domestic banking sector. Due to their relative opaqueness, SMEs can only imperfectly substitute other sources of credit for their domestic (often local) bank loans. Consistent with this firm-borrowing channel, we find empirically that the decline in cross-border interbank lending had larger negative real effects on output in countries with high domestic bank dependence, in particular in sectors with many SMEs.

In order to provide a fully articulated interpretation of our findings, we build a dynamic stochastic general equilibrium (DSGE) model. The model allows for both global and domestic ("local") banks and includes two sectors: a sector populated by "small" firms, which are reliant on borrowing from local banks, and a sector populated by "large" firms, which can satisfy a larger portion of their borrowing needs from global banks. Global banks, in contrast to local banks, do not satisfy the funding needs of firms (especially, small firms) completely and, as a result, firms have to borrow some funds from local banks, giving rise to "domestic bank dependence" in our model. Local banks collect deposits from their home country, but can also fund themselves in the European cross-border interbank market by borrowing from global banks, which in turn refinance themselves through wholesale funding in the global interbank market (the U.S.).

The baseline simulations of our model posit that the global financial crisis corresponds to a period of a large contraction of cross-border funding available to banks while TFP or local credit supply did not decline. The central assumption of our model is that banks actively adjust their risk-weighted leverage ratio as documented by Adrian and Shin (2014). Under this assumption, cross-border lending to banks contracts more than cross-border lending to the real sector following a global deleveraging shock. This is because profit-maximizing banks shift lending to high-return activities that have high regulatory risk weights, in particular lending to firms. This benefits larger firms, but as the contraction in cross-border interbank lending reduces local banks' lending capacity, it disproportionately hurts SMEs which are particularly dependent on local banks. The model is able to replicate these patterns in the data and therefore provides a structural interpretation.

We examine if our central interpretation is robust to a number of other features of the model. We consider alternative specifications for shocks in the crisis period, where we mute the global bank shocks and instead allow for either a concomitant drop in TFP in all countries, a synchronized drop in TFP in (model countries designed to match) the southern European countries Greece, Italy, Ireland, Greece, and Spain (GIIPS), or a synchronized rise in a refinancing cost for local banks in the GIIPS countries during the crisis. Results from simulations with TFP shocks, synchronized regionally or globally, do not explain the patterns in the data, as the model delivers coefficients of interest that are either zero or of the wrong sign.[1] We interpret this as evidence that a synchronized drop in demand for loans from local banks does not provide an alternative explanation in conjunction with active leverage adjustment. Finally, results from simulations with synchronized local banking shocks also have a hard time matching the data, as the main coefficient of interest under this scenario is noisily estimated, albeit close in magnitude to the coefficient we get in the baseline case. This suggests that local credit supply shocks transmit to the real sector through a mechanism similar to that of global banking shocks, but

[1] Brunnermeier and Reis (2019) explain how liquidity dried up in the Great Recession and its aftermath. They also point out that banks have migrated their liabilities from traditional deposit taking to a mixture of deposits, repos, and wholesale funds while assets have shifted from government bonds, loans, and mortgages to include a sizable fraction of tradeable assets. Many banks held domestic tradeable assets and in crisis-hit countries these assets lost value, causing banks to lose equity. This loss of equity would reinforce the contraction in lending that we model and our model permutation that allows for synchronized shocks in GIIPS countries is designed to capture such effects in reduced form.

that the degree of synchronization of these shocks needs go well beyond the GIIPS countries, effectively needing to be pan-European in order to match the data. Thus, although we find more support for the global nature of the retrenchment in cross-border interbank lending than local crises, the exact source of the bank credit supply shocks is irrelevant for our key finding that interbank integration leaves countries more exposed to banking sector shocks than direct banking integration, with sectors with many SMEs being particularly exposed.

The remainder of the paper is structured as follows: Section 2.2 provides a first look at the data and some initial stylized facts. Section 2.3 places our analysis in the context of the literature. Section 2.4 uses a stylized theoretical framework to motivate our empirical specifications that allow us to study the transmission of the financial crisis across countries on real data. Our DSGE model is laid out and brought to the data in Section 2.5, while Section 2.6 summarizes the quantitative results obtained from model simulations. Section 2.7 offers conclusions.

2.2 A look at the data

It is commonly observed that the European Monetary Union has given a boost to banking integration in Europe. Figure 2.1, which is based on locational banking statistics from the Bank for International Settlements (BIS), displays lending by foreign banks for a range of EMU countries, separately and combined (EMU-11). Flows of bank loans surged in the first decade of the EMU, but most of this growth was due to increased foreign bank lending to domestic banks—foreign bank lending to the domestic non-bank sector (which here includes the domestic private sector and government) increased less and has remained relatively flat. We argue that foreign lending to domestic banks versus lending to the non-bank sector are not simple substitutes, and, indeed, foreign lending to the non-bank sector generally proved resilient during the financial and sovereign debt crisis while bank-to-bank lending virtually imploded. The synchronization of the collapse in cross-border bank-to-bank lending is noteworthy in this context. Even though countries' post-2008 experiences varied considerably in terms of the severity of banking and sovereign crisis and in their real effects, the initial trigger (the U.S. subprime crisis spilling over to Europe and leading to a worldwide crisis in interbanking markets) can be seen as a common factor which had differential impacts across countries, depending on their pre-existing vulnerabilities.

Figure 2.1 sets the scene for our empirical analysis. Banking sector integration in Europe was lopsided in the sense that there was too little real banking integration: the real sector was unable to diversify its sources of finance away from domestic banks. Domestic real-sector lending continued to be financed by domestic banks, which fund themselves by borrowing from foreign banks. This led to the pattern we observe in the data, with the growth in cross-border lending driven by bank-to-bank lending.[2] We illustrate these two different concepts of banking integration in Figure 2.2. There are two countries, one referred to as the core country, and the other as the periphery country. The thick red arrow indicates the large cross-border banking flows in the data, whereas the thin grey arrows indicate the small flows of foreign bank lending from each country's banks to the other country's real sector. As was the case in the EMU before the crisis, net bank-to-bank flows were largely in the direction of the periphery country. The graph illustrates that, in the absence of direct cross-border real sector lending (thin or absent grey arrows), and in spite of high levels of bank-to-bank integration (thick red arrows between the two countries' banking sectors), the periphery remains vulnerable to both international liquidity shocks and domestic real shocks.[3] This happens for two reasons: first, domestic banks have domestically concentrated asset portfolios, which make them vulnerable to any real-sector shocks in the home economy. Second, an international world-wide funding shock to banks in the periphery country may cut off bank credit supply to the domestic real sector.[4]

Figure 2.2 suggests that the impact of a domestic banking sector shock on the domestic economy will depend on the extent to which real sector credit is provided by domestic banks. As a measure of domestic bank dependence in country c—abbreviated as DBD^c—we propose the share of total real sector credit that is provided by domestic banks:

$$\text{DBD}^c = \frac{\text{Domestic bank lending to the real private sector in country } c}{\text{Total credit to the real private sector in country } c}.$$

We construct DBD^c using data from the Private Sector Credit Database (PSCD) compiled by the BIS. This database contains detailed information by country on the borrowing sector and the source of credit (domestic banks and foreign banks as well as debt securities). In the PSCD, the private sector comprises private non-financial corporations, households, and non-profit institutions serving households. The database rests on multiple data sources (national accounts, monetary surveys, and the BIS banking statistics) and has some gaps in its country coverage, which generally limits our European sample in the remainder of the paper to 11 Eurozone countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain). The data is quarterly and starts in the first quarter of 1997. We therefore limit all of our data to the time period 1997Q1–2013Q4 in order to focus on the

[2]Specifically, banks in the EMU periphery countries mainly borrowed from banks located in core economies which in turn borrowed in the U.S. money market (Hale and Obstfeld (2016)).

[3]As pointed out by Morgan, Rime and Strahan (2004), financial integration provides insurance against local liquidity shocks, because international lending quickly can replace local lending as long as the return to local investment remains high.

[4]For example, this could be the case in a global banking crisis when cross-border bank lending—which is arguably much more short-term than cross-border bank-to-real sector lending—dries up.

period of the Eurozone crisis and the preceding years. We obtain a time-invariant (pre-crisis) measure for DBD^c by taking pre-2008 averages for each country.

Because we construct DBD^c as a pre-crisis average, it is an *ex ante* measure of how exposed aggregate credit supply in a country was to domestic banking sector shocks at the beginning of the Great Recession. The real effects in terms of output, consumption, or employment of any given drop in credit supply will depend on how elastic the private sector is in its choice of financing source. Figure 2.3 provides data from the 2011 edition of the European Central Bank's and EU Commission's Survey of Access to Finance by Enterprises (SAFE) on sources of external finance of SMEs (defined as firms with fewer than 250 employees). The figure illustrates that bank loans are by far the most important source of external finance for SMEs in most countries.

We would therefore expect that SMEs during the crises were strongly affected in countries with high domestic bank dependence. Figure 2.4 provides *prima facie* evidence that this is the case. The first panel plots the share of SMEs that reported problems with obtaining external finance against country-level banking dependence (DBD^c). The second panel plots the share of firms reporting increased interest expenses minus the share of firms reporting decreased expenses against DBD^c. The two plots deliver the same message: in countries with high levels of domestic bank dependence, the impact of the crisis on the financial situation of SMEs was worse.

In the remainder of the paper, we examine in more detail the patterns outlined in this section. In particular, we estimate how cross-country variation in domestic bank dependence interacted with cross-country and cross-sectoral variation in SME shares in the international transmission of the common shock presented by the financial crisis.

2.3 Related literature

Our analysis draws on several strands of the literature. The first strand concerns the role of banking integration in the transmission of macroeconomic shocks. Here, we also connect to the literature on the global financial cycle, which examines how changes in global financial conditions lead to heterogeneous, but highly synchronized, real outcomes across countries. The second strand encompasses recent empirical work that emphasizes the particular financing constraints faced by small firms during the European financial and sovereign debt crisis.

Regarding the empirical literature on the international transmission of banking sector shocks, we build on Peek and Rosengren (1997, 2000), who show how the burst of Japan's property bubble in the 1990s was reflected in Japanese banks contracting lending in the United States. Imai and Takarabe (2011) use a similar approach to study how the same shock spread across Japan's prefectures. Our paper is also related to work by Cetorelli and Goldberg (2012*a*,*b*) in its emphasis on the role of global banks' internal capital markets in international transmission and to Kalemli-Ozcan, Papaioannou and Peydro (2013) and Kalemli-Ozcan, Papaioannou and Perri (2013), who show that the impact of banking integration on business cycle synchronization differs between crisis and tranquil periods. By illustrating how the international financing structure of an economy affects the transmission of global financial shocks, we also make contact with the literature on the global financial cycle (Rey (2015); Bruno and Shin (2015*a*))

Recent papers that have recognized the role of the particular financing constraints faced by SMEs during the Eurozone crisis include Ferrando and Mulier (2015) and Ferrando, Popov and Udell (2018). Ferrando and Mulier (2015) match SMEs' survey responses to balance sheet information to check whether reported financial constraints line up with balance sheet facts. Our analysis is also close to Ferrando, Popov and Udell (2018), who use firm-level data to document that SME-financing constraints are exacerbated in countries which were under macroeconomic and sovereign risk "stress" during the financial crisis.

Different from the studies discussed so far, our analysis of international transmission focuses on the interaction of SME prevalence and the nature of banking integration in the Eurozone, with its focus on bank-to-bank integration as a key factor in the transmission of the crisis across countries, regions, and sectors.[5] A starting point for our analysis is the observation by Hale and Obstfeld (2016) that the inception of the Euro changed the geography of international banking flows. Global European banks head-quartered in the northern core countries started to intermediate funds from the global (dollar) interbank market to the European periphery. We focus on the fact that this lending boom mainly took the form of bank-to-bank lending while direct (bank-to-nonbank) lending from northern European core countries to the periphery increased much less.

Our emphasis on the differential impact of international and domestic bank lending on sector-level growth during the Eurozone crisis closely connects our work to that of Schnabel and Seckinger (2015). While Schnabel and Seckinger (2015) focus on external finance dependence in the sense of Rajan and Zingales (1998), we draw attention to firm size and the particular dependence of small firms on the local provision of credit as a key friction. The empirical framework for our analysis heavily draws on earlier work by one of us: Hoffmann and Okubo (2017) find that mechanisms, similar to the ones we document for Europe, were at work during Japan's lost decade.

[5]We do not evaluate the benefits from integrated cross-border lending to banks relative to the more fragmented markets that existed before the introduction of the euro. See the survey of Sørensen and Villegas-Sanchez (2015) for the benefits of financial integration in the absence of market imperfections.

Our paper also relates closely to work at the International Monetary Fund (2015), which emphasizes the different impacts that cross-border and direct local lending by foreign banks have on financial stability. We add to this by focusing on how international lending has affected real outcomes during the crisis in the Eurozone and by highlighting that it is important to distinguish between international bank-to-bank and bank-to-real sector lending. In this context, we also connect to a paper by Martinez (2015), who documents the role of cross-border bank-to-bank lending in fueling boom and bust cycles.

Our empirical findings are rationalized and evaluated within a DSGE model. This model builds on Kalemli-Ozcan, Papaioannou and Perri (2013) and extends it along several dimensions. First, we introduce an interbanking market to allow for a distinction between cross-border lending to banks and the real sector. Second, we introduce a non-tradeable sector populated by SMEs that borrow from global banks and local domestic banks. The latter, in turn, fund themselves from global banks in the interbank market. We use this model to replicate the stylized facts that we document in our empirical analysis.

Our model also relates to Kollmann, Enders and Müller (2011), Kollmann (2013), Bruno and Shin (2015*b*) and Kerl and Niepmann (2015). Kollmann, Enders and Müller (2011) and Kollmann (2013) examine the role of global banks in global business cycle transmission. Our framework differs from theirs by allowing for different modalities of international bank lending—direct lending to firms by global banks vs. interbank lending—and by allowing for two sectors which differ in their financing needs. Bruno and Shin (2015*b*) formulate a model of "double-decker" banking integration by allowing global banks to interact with local banks, while Kerl and Niepmann (2015) explain the choice between direct and interbank cross-border lending as a function of barriers to entry into foreign banking markets. In our model, entry barriers take the form of frictions which give local banks an advantage in lending to SMEs and, because we embed direct and interbank cross-border bank lending into a fully dynamic model, we can study how the modality of cross-border bank lending affects the dynamics and transmission of macroeconomic shocks.

The idea that small firms rely on relationship lending and therefore require local access to credit is well-established in the banking literature. Starting with Berger and Udell (1995) a large literature shows that small firms are more likely to borrow from small, local banks which have a comparative advantage in relationship lending. Degryse and Ongena (2005) emphasize the role of distance for the intensity of banking relationships and for the intensity of banking competition. Mian (2006) provides empirical evidence on the role of foreign vs domestic banks in lending to small firms in the context of a developing economy. While long-standing banking relationships may help a firm to obtain credit more easily when facing adverse firm-specific shocks (Petersen and Rajan (1994)), relationship lending also creates a hold-up problem if a negative shock affects the lender. In this situation it may be difficult to turn to alternative sources of finance (Sharpe (1990)). Giannetti and Ongena (2007) show that the presence of foreign banks improves small firm access to credit. Our macroeconomic model captures these mechanisms in reduced form.

Starting with Khwaja and Mian (2008), the micro-banking literature has begun to explore the real effects of banking shocks in matched bank-firm-level data. In this paper, our interest is in understanding the macroeconomic relevance of the above mechanisms for the EMU as a whole. In particular, we are interested in how the structure of cross-border lending (interbank vs. direct lending to firms) affects the transmission of macroeconomic shocks. We are not aware of matched bank-firm level data sets that would allow us to study this nexus, i.e. that would be (a) representative at the level of individual countries (and in particular, would also cover small firms); (b) would allow us to distinguish between direct and indirect (via the impact of the interbank market on domestic banks) exposures of firms; and (c) at the same time would cover sufficiently many EMU countries.[6] We therefore conduct our empirical analysis at the sector-country level, discussing identification assumption and potential challenges in detail. Then, building on the approach in Kalemli-Ozcan, Papaioannou and Perri (2013), we use our DSGE model to target the empirical specifications and as a laboratory in which we simulate the impact of confounding factors on our empirical results. This allows us to strike a balance between the high levels of internal validity achieved by the micro-banking literature and the external validity of a more macroeconomic approach.

2.4 Domestic bank dependence and the transmission of the financial crisis across the Eurozone

Econometric specifications

As starting point for our empirical analysis, we posit the following reduced-form link between fluctuations in domestic real sector credit and output growth:

$$\Delta \log \text{GDP}_t^{c,s} = \gamma^{c,s} \times \Delta \log \text{CREDIT}_t^c + \eta_t^{c,s}, \tag{2.1}$$

[6]To our knowledge, Hale, Kapan and Minoiu (forthcoming) is the first paper to examine the role of cross-border interbank exposures for firm-level lending, but their evidence is based on syndicated loan data and thus on big firms.

where $\Delta \log \text{GDP}_t^{c,s}$ is the growth rate of gross valued added in country c, in sector s, $\Delta \log \text{CREDIT}_t^c$ is the growth of domestic credit to the real sector in country c, and $\eta_t^{c,s}$ is a productivity shock. This specification acknowledges that firms are heterogeneous in their ability to substitute fluctuations in the availability of bank credit for other forms of funding.[7] We can think of the coefficient $\gamma^{c,s}$ as capturing this ability, which is likely to vary by sector and/or country. For instance, if $\gamma^{c,s} = 0$, firms can fully offset variations in bank loan supply by turning to internal or non-bank finance (e.g., by issuing bonds). If $\gamma^{c,s} > 0$, fluctuations in bank finance cannot be fully offset and will have real effects. Based on our earlier discussion, we conjecture that country-sectors with higher SME shares will be more sensitive to variation in lending growth, so that

$$\gamma^{c,s} = \gamma_0 + \gamma_1 \times \text{SME}^{c,s}, \tag{2.2}$$

where $\text{SME}^{c,s}$ stands for the share of SMEs with less than 250 employees in value added in country c, sector s in 2008, and where we expect that $\gamma_1 > 0$.

We next link domestic credit supply to shocks to cross-border bank lending. We interpret the financial crisis as a global shock to banks' lending capacity that, in principle, was common to all Eurozone countries, but that affected countries differently according to their dependence on domestic banks for finance. Based on this presumption, we conjecture the relation:

$$\Delta \log \text{CREDIT}_t^c = \text{DBD}^c \times \Delta\text{GBS}_t + \xi_t^c, \tag{2.3}$$

where DBD^c is our measure of domestic bank dependence, ΔGBS_t is an indicator of the shock to the global banking sector, and $\xi_t^{c,s}$ is a country-sector specific credit demand shock.

Our hypothesis is that the global banking sector shock mainly manifested itself in a breakdown of cross-border lending between banks, whereas, as we have seen in Figure 2.1, direct cross-border bank lending to the real sector was much less affected. We therefore construct a measure ΔGBS_t,that captures bank-to-bank lending net of bank-to-nonbank lending, as

$$\Delta\text{GBS}_t = -\left[\Delta \log \text{B2B}_t - \Delta \log \text{B2N}_t\right],$$

where B2B_t and B2N_t denote the total (in sample) cross-country volume of indirect (bank-to-bank) and direct (bank-to-nonbank) cross-border lending, respectively. We construct ΔGBS_t as the relative growth rates of bank-to-bank and bank-to-nonbank lending because our focus in this paper is on how the shift in the composition of cross-border lending asymetrically affected

[7] This is in the spirit of the literature on the firm-borrowing channel (e.g. Khwaja and Mian (2008)). However, unlike in most of that literature, for the reasons discussed in the previous section our focus here is on the country-sector rather than the bank-firm level.

SMEs in economies dependent on domestic banks. Also, the drop in cross-border lending during the global financial crisis could have a large common component due to global drop in credit demand. To the extent that this drop affected foreign and domestic banks equally, relative growth rates of direct and indirect lending would eliminate this common demand component. We discuss this point more formally below.

Putting equations (2.1), (2.2) and (2.3) together, we obtain

$$\Delta \log \text{GDP}_t^{c,s} = \Delta\text{GBS}_t \times [\alpha_1 \text{DBD}^c \times \text{SME}^{c,s} + \alpha_2 \text{SME}^{c,s} + \alpha_3 \text{DBD}^c] + \text{CONTROLS} + \tau_t + \mu^{c,s} + \varepsilon_t^{c,s}, \quad (2.4)$$

which is our main empirical specification. The coefficient of interest is α_1 and we expect $\alpha_1 < 0$: the global banking sector shock should have particularly adverse effects in countries and sectors that are particularly dependent on domestic banks for credit provision, because they have a high share of SMEs.

To see how our approach achieves identification of α_1, we note first that ΔGBS_t is an aggregate ("world"-wide) variable and is therefore uncorrelated with purely local (country- and/or sector-specific) credit demand shocks. As is easy to verify, the residual term can be written as $\varepsilon_t^{c,s} = \gamma^{c,s} \times \xi_t^{c,s} + \eta_t^{c,s}$. This term absorbs country-sector specific components of credit demand that are orthogonal to ΔGBS_t, while the effects of ΔGBS_t that are common to all country-sectors (as well as any other common factor with homogeneous effects across country-sectors) will be absorbed by the time effect, τ_t.[8]

One remaining challenge to identification is that we are neglecting unobserved common factors that may be correlated with ΔGBS_t and that also differ in their impact across countries and sectors in a way that is correlated with the country-sector variation in $\text{DBD}^c \times \text{SME}^{c,s}$. To see this, let f_t be a potential un-modelled factor which loads on output in country-sector c, s with loading $\delta^{c,s}$. Then, whenever $\text{Cov}(f_t,\ \Delta\text{GBS}_t) \neq 0$, we need to assume that the *cross-sectional* covariance $\text{Cov}(\delta^{c,s},\ \text{DBD}^c \times \text{SME}^{c,s})$ equals zero.[9]

The assumption $\text{Cov}(\delta^{c,s},\ \text{DBD}^c \times \text{SME}^{c,s}) = 0$ might be violated if, during the global financial crisis, there was also an aggregate (EU-wide or global) decline in the demand for loans. This decline plausibly could have been strongest in countries with high local bank dependence and in sectors that have many SMEs that mainly serve local markets. Our measure of the global banking-sector shock addresses this concern by focusing on the difference in growth rates between cross-border bank-to-bank and bank-to-nonbank lending. To the extent that a global credit-

[8]Because $\text{SME}^{c,s}$ and DBD^c are time-invariant in our estimation, their respective first-order effects will be absorbed by the country-sector fixed effects, $\mu^{c,s}$. In addition, several versions of the main regression that we present below will also control for country-time and sector-time effects.

[9]See Hoffmann and Okubo (2017) for a detailed discussion.

demand shock affects the two forms of lending symmetrically, their difference is left to capture shocks that are specific to the global banking sector and thus mainly to the credit supply-side. Our theoretical model below will allow us to quantitatively explore whether this identifying assumption is justified.

Data

To implement the above regressions, we measure output growth using quarterly data on gross value added at the sectoral level from Eurostat.[10] For all output measures, we obtain real per capita values by deflating with the respective sectoral deflators and using population data from the same source. Because quarterly data can be noisy, we study annual growth rates of all variables (notably real per capita GVA) by taking differences between quarter t and $t-4$, so that $\Delta \log \text{GDP}_t^{c,s} = \log \text{GDP}_t^{c,s} - \log \text{GDP}_{t-4}^{c,s}$ throughout the paper.

While DBD^c is constructed in the way already described in Section 2.2, our data on SME importance is from the 2018 issue of the annual database accompanying the European Commissions' SME performance review.[11] Specifically, we construct our measure $\text{SME}^{c,s}$ as the share in value added at factor costs (million euros at current prices) at the country-sector level of firms with fewer than 250 employees. While the values for DBD^c are constructed as pre-2008, within-country averages, data on the value added of small businesses is not generally available before 2008. We therefore use the 2008 values to construct $\text{SME}^{c,s}$.

Main empirical results

The results of the baseline country-sector level specifications (2.4) are summarized in Table 2.1. Consistent with our theoretical interpretation, the main coefficient of interest, α_1, is negative and significant throughout. The first column of the table shows the results for all countries. The following columns examine the sensitivity of our results to the exact sample of countries. Specifically, we augment the baseline specification to include a dummy for the EMU core economies (Belgium, France, Germany, and the Netherlands) or a dummy for Greece in the interactions with the crisis indicator.

In all specifications, the coefficient α_1 stays negative, significant and quite stable relative to the baseline estimate in the first column. The results suggest that dependence on domestic

[10] Sectoral gross value added is obtained from Eurostat's *Gross value added and income A*10 industry breakdowns* (namq_10_a10). We drop agriculture, finance and insurance, and public administration and limit our sample to six sectors (1-digit NACE rev 2 codes in parentheses) for which we also have data on the corresponding SME shares: industry except construction (BCDE), construction (F), wholesale and retail + transport and storage + accomodation and food services (GHI), information and communication (J), real estate (L), and professional activities + administrative and support services (MN).

[11] https://ec.europa.eu/growth/smes/business-friendly-environment/performance-review_en

banks for finance was detrimental mainly for country-sectors with many SMEs. The standalone terms for $\text{SME}^{c,s}$ and DBD^{c} are insignificant across almost all specifications. This suggests that for the average country-sector an increase (decrease) in the SME share or a lower dependence on domestic banks does not unambiguously lead to higher or lower growth. Rather, it seems that the real effects of the global banking shock are robustly modulated through the interaction between these two variables.

In Table 2.2, we subject our country-sector level regressions to further robustness checks. In the first two columns, we add, in turn, sector-time and country-time effects, in addition to the country-sector and time effects that were already included in the previous specifications. Our estimate of α_1 stays negative in both specifications and remains significant. This is also true for a fully saturated specification in which we include both country-time and sector-time effects. We also run a version of our regression, in which we split the sample of country-sectors into high (above-median) and low (below-median) shares of SMEs. Again, our results hold up. This regression, reported in column (4), will be our main reference point when comparing the DSGE model that we present in the next section to the regressions results based on actual data. In the DSGE model, within each country, there are two sectors: one populated only by SMEs and one populated only by large firms. This setup directly maps into the specification reported in column (4) of Table 2.2, where sectors are coded as being SME-intensive (or not) using a dummy. The economic magnitude of the results is large. A one standard deviation shock to ΔGBS_t (0.09) in a country with a domestic bank dependence one standard deviation (0.13) above the sample average results in a 0.5 percentage points larger drop in gross value added in high SME sectors compared with low SME sectors ($0.005 \approx 0.43 \times 0.09 \times 0.13$).

The last two columns of Table 2.2 show that our findings hold up even in the cross-section: column (5) presents a cross-sectional regression of the post-2008 drop in sectoral GVA growth on 2008 SME shares and the interaction of SME with local bank dependence, while column (6) repeats the before-after regression, but now coding the SME share as high or low, as in the panel regression in column (4). The result with high-low SME dummy remains significant and economically large: the decline in average growth rate in gross value added in the crisis period for a country with a domestic bank dependence one standard deviation (0.13) above the sample average is 1.3 percentage points stronger in high SME sectors compared with low SME sectors ($0.013 \approx 0.009 \times 0.13$).[12]

[12] As pointed out by Bertrand, Duflo and Mullainathan (2004), panel diff-in-diff regressions such as our baseline specifications can be spuriously significant if there is essentially only one common treatment (in our case: the crisis). They therefore recommend a "before-after" cross-sectional regression such as the one presented here as a robustness check.

Figure 2.5 visualizes the results from the before-after regression in column (6). For each country, it plots the difference between post-2008 and pre-2008 sectoral growth rates against the pre-2008 levels of domestic bank dependence. Sectors with above-median shares of SMEs appear as red dots and those with below-median shares of SMEs appear as blue diamonds. Across the whole sample, the link between growth and SME shares seems weak; however, once we distinguish between high and low levels of SME shares, we find that there is a clear negative link between growth and domestic bank dependence in country-sectors with high SME shares. This negative link is much weaker for low-SME sectors.

We also study the dynamic response of real activity to the global banking sector shock. To this end, we split the sample in two groups: country-sectors with above-median shares of SMEs and country-sectors with low SME shares. For each group, we then estimate local linear projections of the form:

$$\log \textsc{gdp}^{c,s}_{t+h} - \log \textsc{gdp}^{c,s}_{t-1} = \alpha_h \times \textsc{dbd}^c \times \Delta\textsc{gbs}_t + \tau_t + \mu^{c,s} + \varepsilon^{c,s}_{t+h}, \tag{2.5}$$

at horizons of $h = 0, 1, ..., 4$ years. Local linear projections (LLP) were first proposed by Jordà (2005) and capture the dynamics of the dependent variable in a very general way. While conceptually similar to impulse responses, LLP do not require the underlying data generating process to be linear.

Figure 2.6 plots the coefficients α_h up to horizon of 4 years for our country-sector data set (reflecting the effects on cumulative GVA growth) separately for high (red lines) and low (blue lines) SME country-sectors. Shaded areas indicate corresponding 90% confidence bands, constructed with standard errors clustered by country and time. For the high-SME sectors, the effect of high domestic bank dependence is highly persistent and statistically significant, accumulating to an output loss of around 1.5 percent over five years to a one standard deviation shock to $\Delta\textsc{gbs}_t$ (0.09) for a country with a domestic bank dependence one standard deviation (0.13) above the sample average ($0.015 \approx 1.25 \times 0.09 \times 0.13$). For the low-SME sectors, there is virtually no effect.

2.5 A theoretical model

We propose a tractable DSGE model with local and global banks and two production sectors, which we use to interpret the empirical results. Specifically, the model formalizes the idea that bank-to-bank lending exposes local bank sectors to global banking sector shocks without reducing the exposure of the economy to idiosyncratic shocks.

Agents and markets

There are two open economies in our model, each populated by a representative household, a big firm producing tradeable goods, a small firm producing non-tradeable goods, and a local bank.[13] The (small) home country represents one of the 11 EMU countries in our sample, while the (large) foreign one represents the "rest of the EMU." Additionally, there is a global bank, which operates in the two countries (EMU) and has access to wholesale funding in the rest of the world (e.g., the U.S. money market).

Firms Firms in sector $s = \{\text{BF}, \text{SME}\}$ (BF refers to big firms and SME to SMEs) have the production function:

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

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

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

where $\Lambda_{t:t+l}$ is the household stochastic discount factor at horizon l. Dividends are defined as:

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

where P_t^s denotes price of output in sector s, P_t is the price of the final good, W_t is wages, and I_t^s is investment in sector s.[14] Furthermore, L_t^s denotes total sector s borrowing and $r_t^{l,s}$ is the net effective interest rate paid by firms in sector s. The law of motion for sectoral capital is given by $K_t^s = (1-\delta)K_{t-1}^s + I_t^s$, and both capital and investment are produced out of the final good subject to a sector-specific quadratic adjustment cost in investment; i.e., $\varphi_t^{I,s} = \frac{1}{2}\varphi^I K_{t-1}^s \left(\frac{I_t^s}{K_{t-1}^s} - \delta \right)^2$.

Firms need to borrow in order to finance their operating expenses; i.e., the wage bill and investment. This setup follows Neumeyer and Perri (2005), who rationalize the wage bill pre-financing need of firms through within-period loans by the timing structure of wage contracts

[13] The assumption that SMEs are all in the non-tradeable sector is inessential for our results and made here for convenience. However, it is consistent with the observation in the trade literature that smaller, less productive, firms are less likely to engage in international trade (Melitz (2003)). It is additionally supported by the results in the Survey of Access to Finance by Enterprises (SAFE), according to which ca. 60% of the participating SMEs did not export any goods or services in 2014, and 22% of the SMEs generate less than 25% of their turnover in foreign markets.

[14] We normalize the price of tradeable goods to unity in both countries.

and firm production. We extend their argument along two dimensions. First, firms need to pre-finance investment outlays, and second, loans need to be repaid after dividends have been distributed. This makes firm loans intertemporal, which matches the timing of deposits and interbank loans in the economy. The identity for external finance is thus

$$L_t^s = W_t N_t^s + P_t I_t^s.$$

Firms in both sectors have to bundle loans from global and local banks to satisfy their borrowing needs. Specifically, we posit the following borrowing technology:

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

where $L_t^{s,\mathrm{GB}}$ and $L_t^{s,\mathrm{LB}}$ are sector s borrowing from global and local banks, respectively, and τ^s captures the degree to which firms in sector s depend on local bank credit (lower τ^s translating into higher dependence). Firms decide how much to borrow from global and local banks by minimizing the expected repayment $L_t^s \left(1 + r_t^{l,s}\right) = L_t^{s,\mathrm{GB}} \left(1 + r_t^{l,s,\mathrm{GB}}\right) + L_t^{s,\mathrm{LB}} \left(1 + r_t^{l,s,\mathrm{LB}}\right)$, subject to the borrowing technology.[15]

This setup implies that loans from local and global banks are imperfect substitutes, with an elasticity of substitution being captured by the parameter ν. This is meant to reflect that global and local banks have different business models. Large international banks engage mainly in arm's-length lending, while local banks engage mainly in relationship-lending. During a long-term relationship local banks acquire information about the small firm. This leads to the well-known hold-up problem (Sharpe (1990) and Petersen and Rajan (1994)) and makes it difficult for the borrowing firm to move away from the local bank. Therefore, loans from global and local banks are imperfect substitutes from the point of view of the borrowing firm and compared to large firms, SMEs are more dependent on local banks ($\tau^{\mathrm{SME}} < \tau^{\mathrm{BF}}$). The borrowing technology above captures these features in a reduced form.

Banks In each country, there is a local (domestic) bank. Additionally, local households own a constant fraction of the global bank. Local banks fund themselves by borrowing from global banks and through deposits, while global banks have access to funds in a global money market (which we do not model). This setup is meant to reflect the structure of the "double-decker"

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

banking integration that was characteristic for the Eurozone in the years before the crisis, as documented by Bruno and Shin (2015*b*) and Hale and Obstfeld (2016). In particular, big French, German, and Dutch banks borrowed in the U.S. money market, while Southern European local banks borrowed short-term from the global northern European banks.

The *local bank* extends loans to small and large firms, $L_t^{\text{SME,LB}}$ and $L_t^{\text{BF,LB}}$, and raises funds in the European interbank market (M_t) and in the form of domestic deposits (D_t). Its balance sheet identity is correspondingly given by:

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

The local bank is owned by domestic households and maximizes expected discounted profits. Because the bank's problem is effectively intratemporal, this amounts to maximizing (and fully disbursing) its profits (Π_t^{LB}) each period:

$$\max_{L_t^{\text{SME,LB}},\ L_t^{\text{BF,LB}},\ M_t,\ D_t} \quad \Pi_t^{\text{LB}},$$

where $\Pi_t^{\text{LB}} = L_t^{\text{SME,LB}} r_t^{l,\text{SME,LB}} + L_t^{\text{BF,LB}} r_t^{l,\text{BF,LB}} - M_t r_t^m - D_t r_t^d - \varphi_t^{\text{LB}}$ and $r_t^{l,\text{SME,LB}}$, $r_t^{l,\text{BF,LB}}$, r_t^m and r_t^d denote interest rates on local bank loans to small and large firms, the interbank lending rate, and the deposit rate, respectively. The last term, φ_t^{LB}, is a quadratic "adjustment cost" in deposits, modeled as a function of the relative deviation of deposits from their long-run value, namely, $\varphi_t^{\text{LB}} = \frac{1}{2}\varphi^{\text{LB}} D \left(\frac{D_t - D}{D}\right)^2$. This term reflects the difficulty for banks to undergo short-term changes in their funding structure and prevents unit-root dynamics in deposits and interbank loans, known to be otherwise a feature of this type of models (Schmitt-Grohé and Uribe (2003)).

The *global bank* provides funds to small and large firms in both countries ($L_t^{\text{SME,GB}}$ and $L_t^{\text{BF,GB}}$) and additionally lends an amount M_t in the interbank market. It refinances itself through wholesale funding, B_t, in the global interbank market, such that its balance sheet is given by:

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

where an asterisk (*) indicates the foreign country. Its objective is to maximize total expected discounted profits. The global bank's problem is again intratemporal—as for the local bank—this amounts to maximizing profits (Π_t^{GB}) each period:

$$\max_{L_t^{\text{SME,GB}} L_t^{\text{SME,GB}^*}, L_t^{\text{BF,GB}},\ L_t^{\text{BF,GB}^*},\ M,\ M_t^*,\ B_t} \Pi_t^{\text{GB}},$$

where

$$\begin{aligned}\Pi_t^{\text{GB}} &= \left(L_t^{\text{SME,GB}} + L_t^{\text{SME,GB}^*}\right) r_t^{l,\text{SME,GB}} + \left(L_t^{\text{BF,GB}} + L_t^{\text{BF,GB}^*}\right) r_t^{l,\text{BF,GB}} \\ &\quad + \left(M_t + M_t^*\right) r_t^m - B_t r_t^b - \varphi_t^{\text{GB}}\end{aligned}$$

and where $r_t^{l,\text{SME,GB}}$ and $r_t^{l,\text{BF,GB}}$ denote interest rates on global bank loans to small and large firms, 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 $\mu^{\text{GB}*} = 1 - \mu^{\text{GB}}$.[16]

The global bank is exposed to lending conditions in the rest of the world through exogenous fluctuations in the supply of funds offered in the global money markets. In particular, a drop in B_t raises the global interest rate r_t^b, which transmits to lending conditions to firms and households in both countries. Adrian and Shin (2014) show that, at least in the years before the crisis, global banks adjusted leverage mainly via changes in risk-weighted assets (RWA). We introduce this concept into our model via the adjustment cost in the bank's risk-weighted assets, namely, $\varphi_t^{\text{GB}} = \varphi^{\text{GB}} RWA \left(\frac{RWA_t - RWA}{RWA}\right)^2$, where we define the risk-weighted assets as $RWA_t = \gamma^L \left(L_t^{\text{SME,GB}} + L_t^{\text{SME,GB}^*} + L_t^{\text{BF,GB}} + L_t^{\text{BF,GB}^*}\right) + \gamma^M \left(M_t + M_t^*\right)$, where γ^L and γ^M are the risk weightings associated with real-sector and bank-to-bank loans, respectively, and where RWA denotes risk-weighted assets in the steady-state. Given differences in risk weightings on different assets, and in particular $\gamma^L > \gamma^M$, the global shock does not affect the interbank and real sector lending rates symmetrically, but causes a positive spread between them as the global bank rebalances its asset side away from (notionally) low-risk interbank loans towards (notionally) high-risk real sector loans.

The risk weights, γ^L and γ^M play a key role for the transmission of the global banking shock in our model. Under Basel II regulation, real sector financing is considered to be riskier than interbank loans or investments into highly-rated "risk-less" assets (among which mortgage-backed securities or southern European sovereign bonds used to be counted before the crisis). This implies that $\gamma^L > \gamma^M$and the bank will have a higher shadow cost of real sector-loans and

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

demand a higher interest rate. Assume that a global banking shock lets B_t shrink to zero. As the bank's balance sheet shrinks, it can shift lending to higher interest-rate real loans while still maintaining the level of risk-weighted assets—cross-border lending to banks declines relative to real sector lending, very much as we observe in the data.

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 large and small firms.

The optimal supply of credit, arising from local and global bank optimization problems given the monopolistic competition and costly adjustment in risk-weighted assets is the following:

$$r_t^{l,\mathrm{SME},\mathrm{GB}} = \left(r_t^b + \gamma^L \varphi^{\mathrm{GB}} \left(\frac{RWA_t - RWA}{RWA}\right)\right) \times MU^{\mathrm{SME}},$$

$$r_t^{l,\mathrm{BF},\mathrm{GB}} = \left(r_t^b + \gamma^L \varphi^{\mathrm{GB}} \left(\frac{RWA_t - RWA}{RWA}\right)\right) \times MU^{\mathrm{BF}},$$

$$r_t^m = r_t^b + \gamma^M \varphi^{\mathrm{GB}} \left(\frac{RWA_t - RWA}{RWA}\right),$$

$$r_t^{l,\mathrm{SME},\mathrm{LB}} = (r_t^m + lbs_t) \times MU^{\mathrm{SME}},$$

$$r_t^{l,\mathrm{BF},\mathrm{LB}} = (r_t^m + lbs_t) \times MU^{\mathrm{BF}},$$

$$r_t^d = r_t^m + lbs_t - \varphi^{\mathrm{LB}} \frac{D_t - D}{D},$$

where MU^{SME} and MU^{BF} denote mark-ups applied to loans to SMEs and large firms, respectively, and lbs_t is the exogenous local banking shock. We incorporate local banking shocks directly into the optimality condition by imposing a country-specific wedge on the equilibrium interbank loan rates demanded by the global bank. These shocks are mean-zero and potentially correlated across countries and shift the respective loan supply schedules up. In particular, a positive local banking shock would result in local bank demanding higher interest rates from its borrowers, as its own cost of funds rises. Due to mark-ups, the effective spread for the firms rises and they cut on production, employment, investment and credit. The real effects of the local banking shocks are most pronounced among firms that are particularly dependent on credit from local banks, namely SMEs.

Households Households consume a bundle of tradeable and local non-tradeable goods, supply labor to firms, and receive dividends (profits) from the firms and banks they own. They maximize their lifetime utility given by:

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

where β is the discount factor, σ is the coefficient of risk aversion, ψ is the inverse 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 a CES aggregate of consumption of the tradeable and non-tradeable goods (produced by large firms and SMEs, respectively), given by:

$$C_t = \left(\omega^{\frac{1}{\epsilon}} {C_t^{\mathrm{BF}}}^{\frac{\epsilon-1}{\epsilon}} + (1-\omega)^{\frac{1}{\epsilon}} {C_t^{\mathrm{SME}}}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}},$$

where ω expresses the household's preference towards tradeable goods and therefore determines relative sizes of the two sectors, and ϵ denotes the elasticity of substitution between the two goods.

The household's flow budget constraint is given by

$$P_t C_t + D_t = W_t N_t + D_{t-1}(1 + r_{t-1}^d) + \mathrm{DIV}_t^{\mathrm{BF}} + \mathrm{DIV}_t^{\mathrm{SME}} + \Pi_{t-1}^{\mathrm{LB}} + \mu^{\mathrm{GB}} \Pi_{t-1}^{\mathrm{GB}},$$

where P_t is the aggregate consumer-price index, D_t is the holding of household deposits earning net interest r_t^d, and $W_t N_t$ is the total wage received by the household.

An optimizing household responds to shocks to discount factor by adjusting its labor supply, with associated equilibrium impacts on employment, output, and wages. In order to dampen these effects such that the reactions to interest shocks matches the data, we introduce real wage rigidities in a reduced form as proposed by Blanchard and Galí (2007), as follows:

$$\log\left(\frac{W_t}{P_t}\right) = \gamma \log\left(\frac{W_{t-1}}{P_{t-1}}\right) + (1-\gamma) \log MRS_t,$$

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 an empirically consistent negative response of labor and output to an interest rate shock for a wide range of parameters.

Market clearing Local markets for non-tradeable (SME-produced) goods clear according to:

$$Y_t^{\text{SME}} = (1-\omega)\left(\frac{P_t^{\text{SME}}}{P_t}\right)^{-\epsilon}\big(C_t + I_t + \Gamma_t\big),$$

where Γ_t is total net real costs present in the model, which therefore can be thought of as part of gross real investment.[17]

The tradeable goods market clears according to:

$$Y_t^{\text{BF}} = \omega\left(\frac{P_t^{\text{BF}}}{P_t}\right)^{-\epsilon}\big(C_t + I_t + \Gamma_t\big) + \frac{NX_t}{P_t^{\text{BF}}},$$

Total net exports to rest of the world (from both home and foreign countries) are given by $NX_t + NX_t^* = B_{t-1}(1 + r_t^b) - B_t$.

Market clearing conditions for the factor markets are given by $K_t = K_t^{\text{BF}} + K_t^{\text{SME}}$, $I_t = I_t^{\text{BF}} + I_t^{\text{SME}}$ and $N_t = N_t^{\text{BF}} + N_t^{\text{SME}}$.

Definitions Aggregate real GDP in the model is given by

$$Y_t = \frac{P_t^{\text{BF}}}{P_t} Y_t^{\text{BF}} + \frac{P_t^{\text{SME}}}{P_t} Y_t^{\text{SME}}.$$

The SME share in the economy is then

$$\textsc{sme}_t = \frac{P_t^{\text{SME}} Y_t^{\text{SME}}}{P_t Y_t},$$

with $\textsc{sme} \approx 1 - \omega$ in the steady-state.

Domestic bank dependence is defined as the ratio of locally originated loans to total loans to private sector in the economy:

$$\textsc{dbd} = \frac{L^{\text{LB}}}{L^{\text{LB}} + L^{\text{GB}}}.$$

[17]In our model, Γ_t is composed of implicit firm borrowing costs $\left(L_t^{\text{SME,GB}} + L_t^{\text{SME,LB}} - L_t^{\text{SME}}\right) + \left(L_t^{\text{BF,GB}} + L_t^{\text{BF,LB}} - L_t^{\text{BF}}\right)$, and all (second-order) adjustment costs.

Mapping the model to the data

Calibration We normalize the size of GDP for each "home" economy to 1 and calibrate the baseline model at the quarterly frequency using parameter values displayed in Table 2.3. And because the "foreign" country represents "the rest of the EMU," we normalize its GDP to 10; i.e., the number of countries in the sample minus one. We additionally calibrate steady-state SME shares and domestic bank dependence for 11 countries in our sample as shown in Table 2.4. The model is then solved by log-linearizing around the deterministic steady-state.

The model counterpart of the global banking shock in our regressions, ΔGBS_t, is constructed as follows. We first simulate the model for all 11 countries in our sample to obtain artificial data on cross-border bank-to-bank lending M_t and cross-border real sector lending L_t^{GB} (both for the "home" country). Given this data, we proceed in the same fashion as in the empirical section by calculating (the negative of) the difference between growth rates of aggregate cross-border lending to banks and cross-border lending to firms (where c indexes the country):

$$\Delta\text{GBS}_t = -\left[\Delta \log\left(\sum_{c=1}^{11} M_t^c\right) - \Delta \log\left(\sum_{c=1}^{11} L_t^{\text{GB},c}\right)\right].$$

Some of the parameters have been calibrated to standard values common in the literature. Households' discount factor β is set to 0.99, to match the steady-state quarterly net deposit rate of 1%. The household's coefficient of relative risk aversion σ is one, such that its instantaneous utility function is logarithmic with respect to the consumption bundle. The inverse of the Frisch elasticity ψ in the utility function is set to 2, while the scale parameter Ψ is determined by the steady-state restrictions. We assume a Cobb-Douglas specification for the consumption aggregate by setting the elasticity of substitution between tradeable and non-tradeable goods in consumption (ϵ) to 1. The household preference parameter ω is then implicitly pinned down by the share of SMEs in a given economy.

The production functions of large and small firms are Cobb-Douglas with the capital intensity parameter α^s equal to 0.35 for each firm, which corresponds to a long-term share of capital in production in advanced economies. We set the capital depreciation parameter δ to 0.025, and the investment adjustment cost parameter φ^I to 2. The index of real wage rigidities, γ, is set to 0.85 in order to match the business cycle moments for hours worked and is consistent with Blanchard and Galí (2007). We choose mark-ups of 3.5 and 2.5 for the loans extended to small and large firms, respectively. These values are in line with the calibration in Gerali et al. (2010), who use the value of 3.12, while we choose a larger mark-up for loans to small firms than for loans to large firms.

As to the risk-weights of the global bank, we assume that the regulator chooses higher risk weights for credit extended to the real sector than for interbank loans. Because claims on corporations are associated with risk weights ranging from 20% for firms with AAA to AA-ratings to 100% for unrated firms or those with low rating (BBB+ to BB-), to 150% for firms with ratings below BB-, and depend on a range of additional criteria, including the quality of collateral, we assume that an average loan to a big firm receives the same weight attached to it as a loan to a small firm, equal to 75%. This value is applied to loans to small businesses within regulatory retail portfolios in Basel II rules, and at the same time lies in the middle field within range of applied weights to rated and unrated corporations as described above. For bank-to-bank credit, we choose the weight 35%, which is a simple average of weights applied to loans to banks with AAA to AA- ratings (20%) and those with A+ to A- ratings (50%), and at the same time is used to weight claims secured by residential property, which was a common way of obtaining interbank liquidity through repo agreements prior to the crisis.

The next step in our calibration is choosing values for adjustment cost parameters for local and global banks. The first (φ^{LB}) is set to 0.01, which allows us to match the consumption moments to the data. It also prevents perfect substitutability of interbank loans for deposits, especially in times of global downturns. As the cost is proportional to the percentage deviation of deposits from the steady-state, we choose the same steady-state value for deposits (relative to GDP) for all countries, at the value of 0.2. We set the second adjustment cost parameter (φ^{GB}) to the value of 2, such that the degree of substitutability between global bank real sector and interbank loans is high enough to manifest itself in a significantly higher contemporaneous drop of interbank loans in the crisis as a consequence of a negative banking shock.

We set the value for the elasticity of substitution between loans from local and global banks of firms (ν) to 0.5, implying that firms treat these loans as complements, but still allow for imperfect correlation between them. This choice is consistent with our interpretation of firms borrowing technology as arising from hold-up problems due to relationship lending.

The corresponding CES preference parameters τ^{SME} and τ^{BF} are chosen to exactly match the model-implied DBD parameter to that obtained from the data, given the country-specific SME shares. In particular, the following approximation holds in the steady state: $\text{DBD} \approx \text{SME} \times \left(1-\tau^{\mathrm{SME}}\right) + (1-\text{SME}) \times \left(1-\tau^{\mathrm{BF}}\right)$.[18] Because we lack sectoral data allowing us to calibrate sectoral parameters τ directly, we assume that the domestic bank dependence of high-SME sectors in every country is a constant multiplier on the domestic bank dependence of the low-

[18] $\text{DBD} = \frac{L^{\mathrm{LB}}}{L^{\mathrm{LB}}+L^{\mathrm{GB}}} = \frac{L^{\mathrm{SME}}}{L^{\mathrm{LB}}+L^{\mathrm{GB}}} \times \frac{L^{\mathrm{LB,SME}}}{L^{\mathrm{SME}}} + \frac{L^{\mathrm{BF}}}{L^{\mathrm{LB}}+L^{\mathrm{GB}}} \times \frac{L^{\mathrm{LB,BF}}}{L^{\mathrm{BF}}} \approx \text{SME} \times \left(1-\tau^{\mathrm{SME}}\right) + (1-\text{SME}) \times \left(1-\tau^{\mathrm{BF}}\right)$.

SME sectors. In particular, assuming $\left(1-\tau^{\mathrm{SME}}\right) = 1.5 \times \left(1-\tau^{\mathrm{BF}}\right)$, allows us to calibrate sectoral local bank dependencies for every country in the range of $(0,\ 1)$.[19]

Forcing variables There are three major sources of shocks in our setup: shocks to total factor productivity (both high and low SME sectors), shocks to local banks, and shocks to the global bank. The TFP processes for any country c (one for each sector s) are given by the following equations. For a home country (representing the simulation country c):

$$\log \theta_t^s = \rho^\theta \log \theta_{t-1}^s - \sigma^s \left(\frac{\rho^\dagger}{\alpha^\dagger} \eta_t^{s,\dagger} + \sqrt{1 - \left(\frac{\rho^\dagger}{\alpha^\dagger} \right)^2} \eta_t^s \right),$$

and for a foreign country (representing "rest-of-EMU"):

$$\log \theta_t^{s*} = \rho^\theta \log \theta_{t-1}^{s*} - \alpha^\dagger \sigma^s \eta_t^{s,\dagger}.$$

Similarly, the local banking shocks for both countries are as follows. For a home country (representing the simulation country c):

$$lbs_t = \rho^{lbs} lbs_{t-1} + \sigma^{lbs} \left(\frac{\rho^\dagger}{\alpha^\dagger} \eta_t^{lbs,\dagger} + \sqrt{1 - \left(\frac{\rho^\dagger}{\alpha^\dagger} \right)^2} \eta_t^{lbs} \right),$$

and for a foreign country (representing "rest-of-EMU"):

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

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

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

In the setup above, $\eta_t^s,\ \eta_t^{s,\dagger},\ \eta_t^{lbs},\ \eta_t^{lbs,\dagger},\ \eta_t^{gbs} \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$, and correspond, respectively, to idiosyncratic home-country sectoral TFP shocks, rest-of-the-EMU sectoral TFP shocks, idiosyncratic home-country local banking shocks, rest-of-the-EMU local banking shocks, and global

[19] A potential alternative calibration assuming a constant value of domestic bank dependence for one of the sectors across all countries would need infeasible values outside the range of $(0,\ 1)$ for at least one country in order to match the data.

(EMU-wide) banking shocks. All exogenous processes follow autoregressive dynamics with persistence parameters ρ^{θ} and ρ^{gbs} equal to 0.95, and ρ^{lbs} equal to 0.80. The cross-country correlation between shocks is $\rho^{\dagger} = 0.25$. Given this correlation structure, the variance of the rest-of-the-EMU shocks are scaled by a parameter $\alpha^{\dagger}$, which also enters the stochastic processes of the home country. This parameter is defined for each simulation country c as follows: $\alpha_c^{\dagger} = (\omega_c' \Omega \omega_c)^{\frac{1}{2}}$, where $\omega_c = vec\left(\frac{GDP_j}{\sum_{j \neq c} GDP_j}\right)$ and $\Omega = \begin{bmatrix} 1 & \cdots & \rho^{\dagger} \\ \vdots & \ddots & \vdots \\ \rho^{\dagger} & \cdots & 1 \end{bmatrix}$.

The standard deviation of the global banking shock (σ^{gbs}) is then set to 0.02 to match the volatility of the simulated ΔGBS_t measure for a series of the standard normal shocks that allows to reconstruct the empirically observed series in the model, given the rest of the calibrated parameters. The volatility of the local banking shocks (σ^{lbs}) is set to 0.0025. It provides a comparable magnitude of the real effects of the local banking shocks, but at the same time does not bias the business cycle moments from the model-simulated data, that we briefly discuss below. Given these values and in order to match the standard deviation of the real GDP that we find in the data, the standard deviation of the TFP shocks σ^{θ} is set to 0.0125.

Business cycle properties The business cycle properties of the calibrated model are given in Table 2.5. The first two columns present statistics for model simulations calibrated for Austria, which is typical for the countries in our sample in terms of SME and DBD, while the last two columns contain the respective data-counterparts, calculated for EMU-11 countries using data from Eurostat. For each variable in the table, we present the standard deviations relative to the 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 model statistics are obtained from 1000 simulations with all shocks switched on and over 250 quarters, with the first 50 quarters dropped. All real data statistics are obtained from applying the HP-filter to variables in logarithms for the sample 1996Q1–2017Q4. To avoid that the HP-filter induces extreme values at either end of the sample and in order to focus on the pre-crisis period, we use the sample 1999Q1–2007Q4 to calculate the empirical moments.

The model matches almost all the data-statistics well in terms of standard deviations and correlations with GDP. The exceptions are investment and net exports-GDP ratio volatility, which are somewhat too high in the model for the Austria calibration.

2.6 Quantitative results

2.6.1 Matching the empirical regressions

We evaluate the ability of the model to fit the data by asking whether it can replicate the empirical findings in Tables 2.1 and 2.2, which motivated this study. To this end, we generate artificial data from the model and run the same regressions that we performed before, now on the simulated data. Because our actual data set comprises 11 countries, we calibrate the model for 11 countries, matching the pre-2008 average domestic bank dependence and 2008 SME share (see Table 2.4). We simulate the data for 60 quarters by calibrating global bank shocks (η_t^{gbs}) to closely match the observed dynamics of our empirical ΔGBS measure prior to and during the crisis. As with the real data, we calculate annual growth rates of real per capita sectoral GVA by taking differences between quarter t and $t-4$, so that $\Delta \log \text{GDP}_t^{c,s} = \log \text{GDP}_t^{c,s} - \log \text{GDP}_{t-4}^{c,s}$.

Table 2.6 presents two sets of regression results corresponding to our main empirical specification (2.4) (summarized in Table 2.2), and obtained from 10000 realizations of the scenarios described above. The output of the panel transmission regression on country-sector level, in which the dependent variable corresponds to sectoral value added growth, are presented in column (1). Further, column (2) replicates the before-after (cross-sectional) analysis, in which the dependent variable is the change of average sectoral output growth between the pre-2008 and the post-2008 periods. We demean all variables cross-sectionally (except for the sector indicator variable $\text{SME}^{c,s}$) and include country-sector and time-sector fixed effects in the regression in column (1), and sector fixed effects in the regression in column (2). For each simulation we run the regressions, save the estimated coefficients, and use their distribution to construct the reported regression coefficients and t-statistics. In each simulation run, we draw new local banking shocks and global, country and sector-specific TFP shocks.

In Table 2.6, the interaction term $\Delta\text{GBS}_t \times \text{SME}^{c,s} \times \text{DBD}^c$, which captures any interaction between SME-share and domestic banking dependence, is negative and highly significant in the country-sector transmission regression in column (1). Moreover, we find a clear negative link between growth and domestic bank dependence in SME sectors across countries as supported by the results in column (2). The evidence from the before-after country-sector regression in column (2) is visualized in Figure 2.8 (cf. Figure 2.5): the slope is negative for SME firms and is much weaker for the sectors populated by large firms.

Quantitatively, our model-implied results from sectoral regressions of crisis transmission come close to the empirical findings in Table 2.2 (see column (4), which utilizes a dummy for high/low SME dependence). The interaction term (α_1) are highly significant and compare as

−0.47 (model) against −0.43 (data). The same is true with regard to the before-after cross-sectional regression results. Although the coefficient on the interaction term in the empirical specifications in Table 2.2 (column (6) with high/low SME coding) (–0.10) is larger in absolute value than the coefficient implied by the model-simulated data (−0.03), they compare well and consistently point in the same direction.

We complement our findings with results from local linear projection regressions (2.5) using model-simulated data and standardized ΔGBS_t measure, separately for SME and non-SME sectors. These results are summarized in Figure 2.9. They closely mimic the local linear projections estimated from the data that we reported in Figure 2.6.

2.6.2 Using the model to assess challenges to identification

Our model simulations allow us to match the empirical regressions in Tables 2.1 and 2.2. Our setup so far assumed that the decline in cross-border bank-to-bank lending is driven by a shock to the balance sheet of global banks, which fits a narrative of the banking crises emanating from the United States. This raises the question to what extent other shock constellations could generate patterns similar to what we observe in the data.

For example, our interpretation of the banking shock as capturing credit supply to SMEs could be questioned, if there was a common (across countries) reduction in demand for loans that particularly affected countries with high domestic bank dependence and sectors with many SMEs. If that were the case, $\text{Cov}(\delta^{c,s},\ \text{DBD}^c \times \text{SME}^{c,s})$ might be non-zero. Because such a negative credit demand shock would also be correlated with ΔGBS_t, our identification assumption would be violated. In the same vein, one might conjecture that shocks to local banks that occurred simultaneously in the crisis countries could be driving our results.

To address this possibility, we simulate data from the model under three scenarios: first, a scenario with a global (i.e., common across countries) TFP shock in the SME sector. Second, a scenario with local correlated TFP shocks to the SME sectors in crisis countries and, third, a scenario with local correlated banking sector shocks in the crisis countries. In all three scenarios, the global banking sector shock is switched off and all other shocks for the non-crisis countries are assumed to be uncorrelated. Using the simulated data, we re-run our main regression (2.4) to assess how our coefficient of interest, α_1, would be affected.[20] Table 2.6 presents the results.

None of the counterfactuals delivers a negative significant coefficient to the interaction term $\Delta \text{GBS}_t \times \text{SME}^{c,s} \times \text{DBD}^c$. If all countries experience simultaneous declines in the productivity of

[20]In order for the local shocks in the second and third scenario to cause the estimate of α_1 to be significant, the shocks need to be correlated across crisis countries. Uncorrelated local shocks in all countries by construction are uncorrelated with ΔGBS_t and will not affect our results.

the high-SME sectors (counterfactual in column 1), the coefficient of interest is in fact positive. This result is due to the fact that while SME sectors are slightly more affected in high DBD countries (see row 1, column (3) in Figure 2.7, which plots the theoretical impulse responses to the shocks we discuss; see below), the B2B-over-B2N loans ratio increases. This effect seems to weaken (and even reverse) if instead, see column (2), only the set of crisis countries—Greece, Ireland, Italy, Portugal, and Spain—are hit by TFP shocks. The coefficient of the interaction term is negative, but close to zero and imprecisely estimated. Synchronized shocks to the local banking sector in the crisis countries, as shown in column (3) of Figure 2.7, induce a negative coefficient of a magnitude comparable to our baseline findings. This is consistent with the fact that the transmission of the global banking shock is similar to the transmission of the local banking shock in the model (confer columns (1) and (2) in Figure 2.7). However, because only a set of all countries is hit by the shocks and because the measure of the shock that we construct—ΔGBS_t— is based on the growth rate of the average of bank flows of all countries in the sample, the global crisis proxy gets very noisy and leads to a high dispersion of the distribution of the simulated coefficients. In an empirical sample, this would lead us to reject the hypothesis that the global shock affects high SME sectors disproportionately in high DBD countries.

We conclude that, although all scenarios that we describe above could lead to a bias in the effect that we study, none of them delivers an alternative that fits the data. Only when we include a shock to the global banking sector do we find a large significant differential effect of the variable ΔGBS_t on growth of sectoral value added.

Impulse responses: shock transmission To shed more light on the economic mechanisms that drive the results in Tables 2.6 and 2.7, Figure 2.7 displays impulse responses for small firm production, large firm production, bank-to-bank lending, and bank-to-bank over bank-to-non-bank lending. The impulse responses are plotted for the model calibrated to the domestic bank dependence and small-firm share of Austria and Greece, respectively, as well as a counterfactual calibration for "Greece," where domestic banking dependence has been adjusted to the low level of Belgium.

The effect of a one standard deviation (2 percent) global banking shock—shock to interbank funds—is quite severe for a country with domestic banking dependence and small-firm share at the level of Greece, for which it causes more than a 1.5 percent drop in the production of small firms on impact. The effect is smaller for a country like Austria and not very large for Greece if the domestic bank dependence had been similar to that of Belgium. Large firms, in the second row of figures, increase production but with little difference between the parametrizations. The third row shows the decline in bank-to-bank lending and the fourth row the decline in bank-to-bank lending over bank-to-real-sector lending. Both plummet on impact and remain low for many quarters ahead, with the magnitude of the decline between 5 and 8 percent.

The mechanics of the model is that a reduction in the size of the balance sheet of the global bank leads the bank to adjust its portfolio by investing relatively more in the real sector by providing more funds to firms and relatively less funds to local banks. This is because the latter carry a lower regulatory risk weight. Consequently, cross-border bank-to-bank credit falls more than bank-to-real sector credit, and local banks experience a shock to their liabilities making them reduce real sector lending. As a result, firms experience a more-than-proportional decrease in loan supply from local banks compared to global banks. Because SMEs are more dependent on local credit than big firms are, they adjust their production plans by reducing labor input and investment more than big firms. Large firms produce tradeable goods and the global banking shock induces a rise in domestic net exports and they benefit from the global bank shocks.

A local banking shock hurts small firms and this effect is larger if the country is dependent on domestic banks as seen for the Greece calibration in the middle column of figures. Large firms initially benefit, but after four quarter their production declines. Bank-to-bank lending declines and only slowly recovers. The impulse responses for a global TFP shock in SME sectors are plotted in column (3) of Figure 2.7, while the last column shows the transmission of the local TFP shocks in SME sectors. TFP shocks affect both large and small firms and "Austrian" and "Greek" large firms are similarly affected. However, small firms are hit slightly harder when the country is dependent on local banks even if bank-to-bank (over bank-to-non-bank) lending actually increases.

Overall, the impulse response functions clearly point to the mechanism that we want to draw attention to: the combination of domestic banking dependence and a large SME-sector leaves a country vulnerable to banking shocks, whether local or in the form of global liquidity shocks.

2.7 Conclusion

Small and medium-sized businesses have little access to outside capital, making their production vulnerable to banking shocks. The results in this paper show that sectors (and economies) with many small firms were less exposed to the recent crisis in the Eurozone in countries where they had access to credit from foreign banks rather than from purely domestic banks. We argue that banking integration in the Eurozone in the years before 2008 was of the "wrong" kind in the sense that it was driven by lending from international banks to domestic banks, rather than by lending from international banks to the real economy. As we have shown empirically (using reduced-form regressions) and theoretically (in a DSGE model), this left local SMEs highly dependent on the domestic banking sector which in turn (due to short-term bank-to-bank lending) was vulnerable to the global banking sector shock.

Our findings have some interesting policy implications. Banking integration in Europe may require a "reset" that involves cross-border mergers between banks and consolidation of branch networks by retail banks across country-borders in the Eurozone, as happened in the United States after the state liberalization of state-level banking in the 1980s. In this way, international banks could operate genuine internal capital markets across national borders, allocating funds to bank-dependent SMEs in a recession.

References

Adrian, Tobias, and Hyun Song Shin. 2014. "Procyclical Leverage and Value-at-Risk." *The Review of Financial Studies*, 27(2): 373–403.

Berger, Allen N., and Gregory F. Udell. 1995. "Relationship Lending and Lines of Credit in Small Firm Finance." *The Journal of Business*, 68(3): 351–381.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. "How much should we trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics*, 119 (1): 249–275.

Blanchard, Olivier, and Jordi Galí. 2007. "Real Wage Rigidities and the New Keynesian Model." *Journal of Money, Credit and Banking*, 39: 35–65.

Brunnermeier, Markus K., and Ricardo Reis. 2019. "Are Industrial-Country Consumption Risks Globally Diversified?" , (26229).

Bruno, Valentina, and Hyun Song Shin. 2015*a*. "Capital flows and the risk-taking channel of monetary policy." *Journal of Monetary Economics*, 71: 119–132.

Bruno, Valentina, and Hyun Song Shin. 2015*b*. "Cross-Border Banking and Global Liquidity." *Review of Economic Studies*, 82(2): 535–564.

Cetorelli, Nicola, and Linda S. Goldberg. 2012*a*. "Banking Globalization and Monetary Transmission." *Journal of Finance*, 67(5): 1811–1843.

Cetorelli, Nicola, and Linda S. Goldberg. 2012*b*. "Liquidity management of U.S. global banks: Internal capital markets in the great recession." *Journal of International Economics*, 88(2): 299–311.

Degryse, Hans, and Steven Ongena. 2005. "Distance, Lending Relationships, and Competition." *The Journal of Finance*, 60(1): 231–266.

Ferrando, Annalisa, Alexander Popov, and Gregory F. Udell. 2018. "Do SMEs Benefit from Unconventional Monetary Policy and How? Microevidence from the Eurozone." *Journal of Money, Credit and Banking*.

Ferrando, Annalisa, and Klaas Mulier. 2015. "Firms' Financing Constraints: Do Perceptions Match the Actual Situation?" *The Economic and Social Review*, 46(1): 87–117.

Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti. 2010. "Credit and Banking in a DSGE Model of the Euro Area." *Journal of Money, Credit and Banking*, 42: 107–141.

Giannetti, Mariassunta, and Steven Ongena. 2007. "Financial Integration and Firm Performance: Evidence from Foreign Bank Entry in Emerging Markets*." *Review of Finance*, 13(2): 181–223.

Hale, Galina, and Maurice Obstfeld. 2016. "The Euro and the Geography of International Debt Flows." *Journal of the European Economic Association*, 14(1): 115–144.

Hale, Galina, Tumer Kapan, and Camelia Minoiu. forthcoming. "Shock Transmission Through Cross-Border Bank Lending: Credit and Real Effects." *Review of Financial Studies*.

Hoffmann, Mathias, and Toshihiro Okubo. 2017. "'By a Silken Thread': regional banking integration and credit reallocation during Japan's lost decade ." Manuscript, University of Zurich (https://mhoffmann.ocloud.de/index.php/s/0gRzCFnFLFlOa0I).

Imai, M., and S. Takarabe. 2011. "Bank Integration and Transmission of Financial Shocks: Evidence from Japan." *American Economic Journal: Macroeconomics*, 3(1): 155–183.

International Monetary Fund. 2015. "Chapter 2: International Banking after the Crisis: Increasingly Local and Safer?"

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review*, 95(1): 161–182.

Kalemli-Ozcan, Sebnem, Elias Papaioannou, and Fabrizio Perri. 2013. "Global banks and crisis transmission." *Journal of International Economics*, 89(2): 495 – 510.

Kalemli-Ozcan, Sebnem, Elias Papaioannou, and José-Luis Peydro. 2013. "Financial Regulation, Financial Globalization, and the Synchronization of Economic Activity." *The Journal of Finance*, 68(3): 1179–1228.

Kerl, Cornelia, and Friederike Niepmann. 2015. "What Determines the Composition of International Bank Flows?" *IMF Economic Review*, 63(4): 792–829.

Khwaja, Asim Ijaz, and Atif Mian. 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market." *American Economic Review*, 98(4): 1413–42.

Kollmann, Robert. 2013. "Global Banks, Financial Shocks, and International Business Cycles: Evidence from an Estimated Model." *Journal of Money, Credit and Banking*, 45(s2): 159–195.

Kollmann, Robert, Zeno Enders, and Gernot J. Müller. 2011. "Global Banking and International Business Cycles." *European Economic Review*, 55(3): 407 – 426. Special Issue: Advances in International Macroeconomics: Lessons from the Crisis.

Martinez, Regina. 2015. "International Banking Flows and Credit Booms: Do Booms Go with the Flow?" Working Paper.

Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695–1725.

Mian, Atif. 2006. "Distance Constraints: The Limits of Foreign Lending in Poor Economies." *The Journal of Finance*, 61(3): 1465–1505.

Morgan, Donald P., Bertrand Rime, and Philip E. Strahan. 2004. "Bank Integration and State Business Cycles." *Quarterly Journal of Economics*, 119 (4): 1555–85.

Neumeyer, Pablo A., and Fabrizio Perri. 2005. "Business Cycles in Emerging Economies: The Role of Interest Rates." *Journal of Monetary Economics*, 52(2): 345–380.

Peek, Joe, and Eric S. Rosengren. 1997. "The International Transmission of Financial Shocks: The Case of Japan." *The American Economic Review*, 87(4): pp. 495–505.

Peek, Joe, and Eric S. Rosengren. 2000. "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States." *The American Economic Review*, 90(1): 30–45.

Petersen, Mitchell A., and Raghuram G. Rajan. 1994. "The Benefits of Lending Relationships: Evidence from Small Business Data." *The Journal of Finance*, 49(1): 3–37.

Rajan, Raghuram G., and Luigi Zingales. 1998. "Financial Dependence and Growth." *The American Economic Review*, 88(3): 559–586.

Rey, Hélène. 2015. "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence." National Bureau of Economic Research Working Paper 21162.

Schmitt-Grohé, Stephanie, and Martín Uribe. 2003. "Closing Small Open Economy Models." *Journal of International Economics*, 61(1): 163–185.

Schnabel, Isabel, and Christian Seckinger. 2015. "Financial Fragmentation and Economic Growth in Europe." GSME Discussion Paper Series.

Sharpe, Steven A. 1990. "Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships." *The Journal of Finance*, 45(4): pp. 1069–1087.

Sørensen, Bent E., and Carolina Villegas-Sanchez. 2015. "Factor Movements: FDI." In *Handbook of the Economics of European Integration.* , ed. Harald Badinger and Volker Nitsch. Routledge.

Tables and Figures

Table 2.1. Domestic Bank Dependence, SME shares and crisis transmission

	Sector-country level			
	(1)	(2)	(3)	(4)
	Growth in sectoral value added			
$\Delta\textsc{gbs}_t \times \textsc{sme}^s \times \textsc{dbd}$	-1.32^{***}	-1.24^{***}	-1.04^{**}	-0.97^{**}
	(-3.23)	(-3.04)	(-2.13)	(-2.08)
$\Delta\textsc{gbs}_t \times \textsc{sme}^s$	0.12	0.13	0.12	0.13
	(1.24)	(1.37)	(1.26)	(1.39)
$\Delta\textsc{gbs}_t \times \textsc{dbd}$	-0.25	-0.11	0.02	0.15^{**}
	(-1.04)	(-0.53)	(0.16)	(2.51)
$\Delta\textsc{gbs}_t \times \textsc{core}$		0.10^{***}		0.09^{***}
		(3.02)		(3.51)
$\Delta\textsc{gbs}_t \times \textsc{greece}$			-0.24^{***}	-0.23^{***}
			(-4.88)	(-4.92)
Observations	4,224	4,224	4,224	4,224
Adjusted R^2	0.27	0.28	0.28	0.28

NOTES: The table presents estimates of our baseline specification:

$$\Delta \log \textsc{gdp}_t^{c,s} = \Delta\textsc{gbs}_t \times [\alpha_1\textsc{dbd}^c \times \textsc{sme}^{c,s} + \alpha_2\textsc{sme}^{c,s} + \alpha_3\textsc{dbd}^c] + \textsc{controls} + \tau_t + \mu^{c,s} + \varepsilon_t^{c,s}.$$

Regressions include time and country-sector effects. Standard errors are clustered by country and time, t-statistics are in parentheses. Columns 2-4 include an interaction of the $\Delta\textsc{gbs}_t$ indicator with a dummy for the core economies and/or for Greece. The sample includes 66 country-sectors, six in each of the 11 EMU countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain. The core economies are Belgium, France, Germany, and the Netherlands. The sample period is 1997Q1-2013Q4.

Table 2.2. Domestic Bank Dependence, SMEs and crisis transmission: Robustness of country-sector results

	Sector-time	Country-time	Fully saturated	Fully saturated High-low SME	Before-after	Before-after High-low SME
	(1)	(2)	(3)	(4)	(5)	(6)
	Growth in sectoral value added				Pre-/post 2008 change in avg. growth rate	
$\Delta\text{GBS}_t \times \text{SME}^s \times \text{DBD}$	-1.17^{**}	-0.99^{**}	-0.97^{*}	-0.43^{**}		
	(−2.12)	(−2.03)	(−1.82)	(−2.01)		
$\Delta\text{GBS}_t \times \text{SME}^s$	−0.07	0.13	0.13	0.01		
	(−0.28)	(1.27)	(0.48)	(0.47)		
$\Delta\text{GBS}_t \times \text{DBD}$	−0.21					
	(−0.89)					
$\text{SME}^s \times \text{DBD}$					−0.13	-0.10^{**}
					(−0.84)	(−2.35)
SME^s					−0.02	−0.01
					(−0.25)	(−0.46)
DBD					−0.08	−0.03
					(−1.00)	(−0.38)
Observations	4,224	4,224	4,224	4,224	66	66
Adjusted R^2	0.32	0.33	0.40	0.40	0.17	0.19

NOTES: The table presents estimates of the sector-level regressions. Columns 1-4 are based on interaction regressions:

$$\Delta \log \text{GDP}^c_t = \Delta\text{GBS}_t \times [\alpha_1 \text{DBD}^c \times \text{SME}^{c,s} + \alpha_2 \text{SME}^{c,s} + \alpha_3 \text{DBD}^c] + \text{CONTROLS} + \varepsilon^c_t.$$

Regressions in columns 1-4 include time and country-sector effects. Columns 1 and 2 report the panel country-sector transmisson regression, including sector-time or country-time effects, respectively. Columns 3 and 4 report saturated regressions that additionally contain both country-year and sector-year dummies. The t-statistics (in parentheses) are based on standard errors clustered by country and year.
Columns 5-6 are based on "before-after" cross-sectional regressions:

$$\Delta \log \text{GDP}^{c,s}_{crisis} - \Delta \log \text{GDP}^{c,s}_{pre-crisis} = \alpha_1 \text{DBD}^c \times \text{SME}^{c,s} + \alpha_2 \text{SME}^{c,s} + \alpha_3 \text{DBD}^c + \varepsilon^{c,s}.$$

Regressions in columns 5-6 include sector fixed effects. The t-statistics (in parentheses) are based on standard errors clustered by country.
The sample includes 66 country-sectors, six in each of the 11 EMU countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain. The sample period is 1997Q1-2013Q4.

Table 2.3. Model calibration

Parameter	Description	Value
β	Households' discount factor	0.99
ψ	Inverse of Frisch elasticity	2
σ	Households' risk aversion	1
ϵ	Elasticity of substitution between tradeable and non-tradeable goods	1
γ	Index of real wage rigidities	0.80
α^{BF}	Capital intensity in BFs' production function	0.35
α^{SME}	Capital intensity in SMEs' production function	0.35
φ^{I}	Investment adjustment cost parameter	2
δ	Capital depreciation	0.025
ν	Firms' elasticity of substitution between GB and LB loans	0.5
MU^{BF}	Mark-up on BF's credit rates	2.5
MU^{SME}	Mark-up on SME's credit rates	3.5
φ^{LB}	Local bank adjustment cost in deposits	0.01
φ^{GB}	Global bank adjustment cost in risk-weighted assets	2
D/GDP	Steady state ratio of deposits to GDP	0.2
γ^{L}	Risk weight on credit to real sector	0.75
γ^{M}	Risk weight on interbank credit	0.35
ρ^{θ}	TFP shocks autocorrelation coefficient	0.95
ρ^{gbs}	Global banking shock autocorrelation coefficient	0.95
ρ^{lbs}	Local banking shock autocorrelation coefficient	0.80
σ^{θ}	Standard deviation of TFP shocks	0.0125
σ^{gbs}	Standard deviation of global banking shock	0.02
σ^{lbs}	Standard deviation of local banking shock	0.0025
$\rho^{\dagger}$	International correlation of TFP shocks	0.25

NOTES: Additionally, we calibrate home and foreign nominal SME share and DBD parameters (see Table 2.4). These parameters implicitly determine the values of other model parameters ω, τ, and Ψ.

Table 2.4. Calibration of SME and DBD for EMU-11 countries

	SME	DBD
Austria	0.60	0.68
Belgium	0.59	0.46
Finland	0.54	0.44
France	0.60	0.54
Germany	0.52	0.78
Greece	0.64	0.85
Ireland	0.54	0.62
Italy	0.71	0.73
Netherlands	0.64	0.51
Portugal	0.68	0.68
Spain	0.67	0.75
EMU	0.61	0.67

NOTES: The values for DBD are constructed as pre-2008 within-country averages, while the 2008 data are used to construct the values for SME.

Table 2.5. Business cycle properties of the model

	Austria		Data	
	St.Dev.	Corr.	St.Dev.	Corr.
GDP	1.60*		1.59*	
Consumption	0.65	0.69	0.64	0.74
Investment	4.96	0.65	2.85	0.82
Employment	0.58	0.79	0.62	0.75
Net exports	2.35	–0.09	1.09	–0.26

NOTES: The table reports theoretical and empirical standard deviations ("St.Dev.") and correlations ("Corr.") of the variables. The theoretical moments are shown for Austria, which is the "representative" country in our sample. The empirical moments are averages across 11 countries in our sample: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain. All statistics are obtained from applying the HP-filter to variables in logarithms for the sample 1996Q1–2017Q4. To avoid HP-filter induced beginning-of-sample extreme values and to focus on the pre-crisis period, we use the sample 1999Q1–2007Q4 to calculate the empirical moments. 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). All model statistics are obtained from 1000 simulations with all shocks switched on, over 250 quarters, with the first 50 quarters dropped.

Table 2.6. Domestic bank dependence, SME-sectors, and crisis transmission: Baseline model simulation results

	(1) Growth in sectoral value added	(2) Pre-/post crisis change in avg. growth rate
SME^s × DBD × ΔGBS	–0.467***	
	(–2.713)	
DBD × ΔGBS	0.082	
	(0.769)	
SME^s × DBD		–0.033
		(–0.919)
DBD		–0.003
		(–0.106)
N	1408	22

NOTES: The table presents estimates of our baseline specification in column (1) and the cross-sectional before-after analysis in column (2).
In column (1), we estimate the following specification:

$$\Delta \log \text{GDP}_t^{c,s} = \Delta \text{GBS}_t \times [\alpha_1 \text{DBD}^c \times \text{SME}^{c,s} + \alpha_2 \text{DBD}^c] + \mu^{t,s} + \mu^{c,s} + \varepsilon_t^{c,s}.$$

This regression includes time-sector and country-sector fixed effects. The term $\Delta \text{GBS}_t \times \text{SME}^{c,s}$ is absorbed by time-sector fixed effects, since in the model $\text{SME}^{c,s}$ only varies across sectors, but not across countries.
In column (2), we estimate the following specification:

$$\Delta \log \text{GDP}_{crisis}^{c,s} - \Delta \log \text{GDP}_{pre-crisis}^{c,s} = \alpha_1 \text{DBD}^c \times \text{SME}^{c,s} + \alpha_2 \text{DBD}^c + \mu^s + \varepsilon^{c,s}.$$

This regression includes sector fixed effects. The term $\text{SME}^{c,s}$ is absorbed by sector fixed effects, since in the model $\text{SME}^{c,s}$ only varies across sectors, but not across countries.
Estimated coefficients and t-stats (in parentheses) are derived from sample means and standard deviations of the simulated regression coefficients. In particular, for every of 10000 simulations, we run the regressions, save the estimated coefficients, and use their distribution to construct the reported values. The model has been calibrated for 11 EMU countries. We obtained time series over 60 quarters for each of the simulated variables. All variables have been cross-sectionally demeaned. Statistical significance at 1/5/10 percent level is denoted by ***, **, and *, respectively.

Table 2.7. Domestic bank dependence, SME-sectors, and crisis transmission: Model simulation results under the counterfactuals

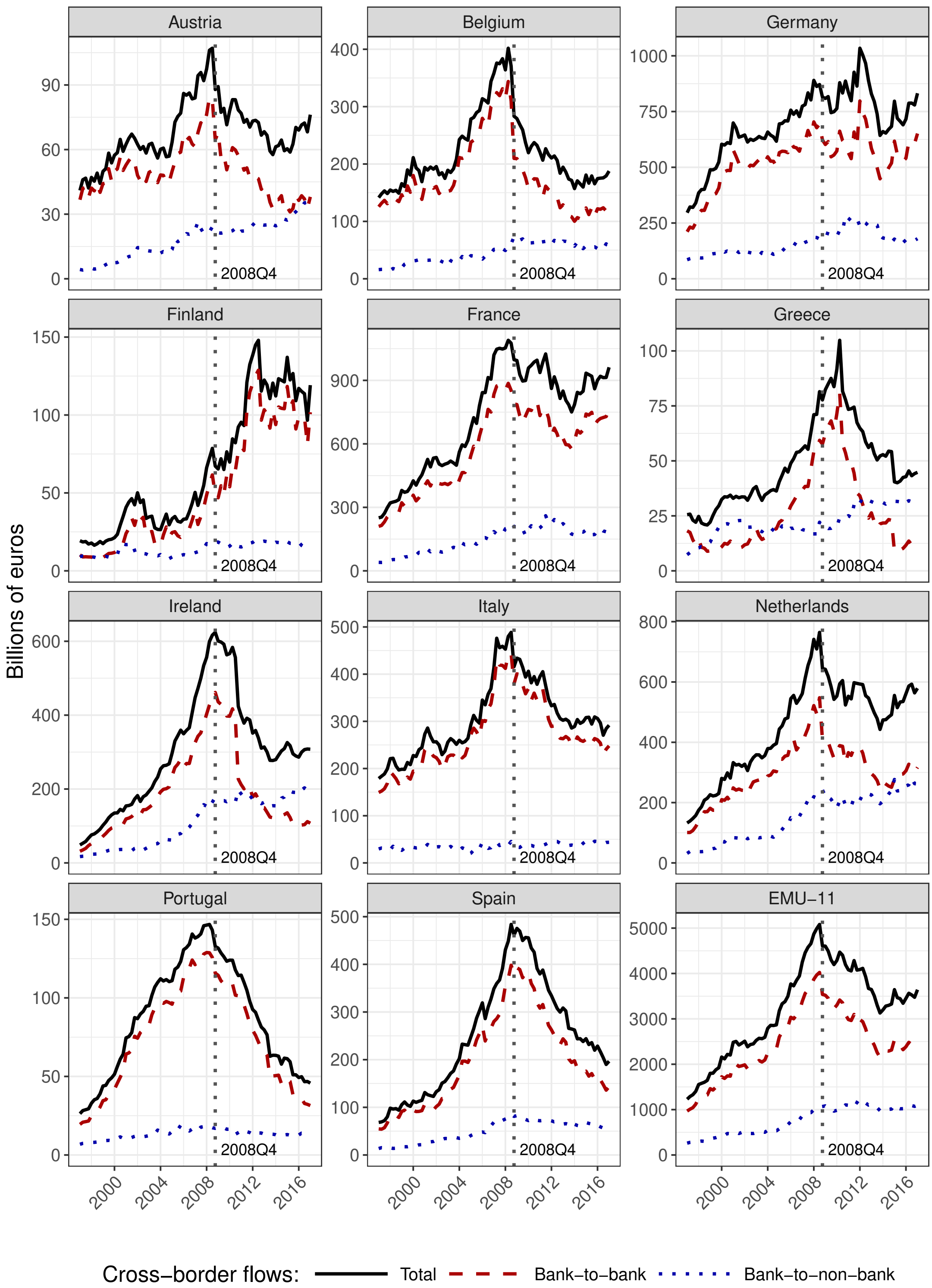
	(1) Sync global SME TFP shocks	(2) Sync local SME TFP shocks	(3) Sync local banking shocks
$\text{SME}^{s} \times \text{DBD} \times \Delta\text{GBS}$	0.831*	–0.013	–0.334
	(1.682)	(–0.067)	(–0.771)
$\text{DBD} \times \Delta\text{GBS}$	–0.613	–0.045	0.110
	(–1.393)	(–0.304)	(0.389)
N	1408	1408	1408

NOTES: The table presents estimates of our baseline specification under three counterfactual scenarios. The counterfactual in column (1) assumes that all countries experience a syncronized negative global TFP shock in SME sectors. The counterfactual in column (2) assumes that only crisis countries—Greece, Ireland, Italy, Portugal, and Spain—experience a syncronized negative TFP shock in SME sector. The counterfactual in column (3) assumes that the crisis countries—Greece, Ireland, Italy, Portugal, and Spain—experience a syncronized negative local banking shock. In all three scenarios, the global banking sector shock is switched off and all other shocks for the non-crisis countries are assumed to be uncorrelated.
The empirical specification for all counterfactuals is our baseline regression model:

$$\Delta \log \text{GDP}_t^{c,s} = \Delta\text{GBS}_t \times [\alpha_1 \text{DBD}^c \times \text{SME}^{c,s} + \alpha_2 \text{DBD}^c] + \mu^{t,s} + \mu^{c,s} + \varepsilon_t^{c,s}.$$

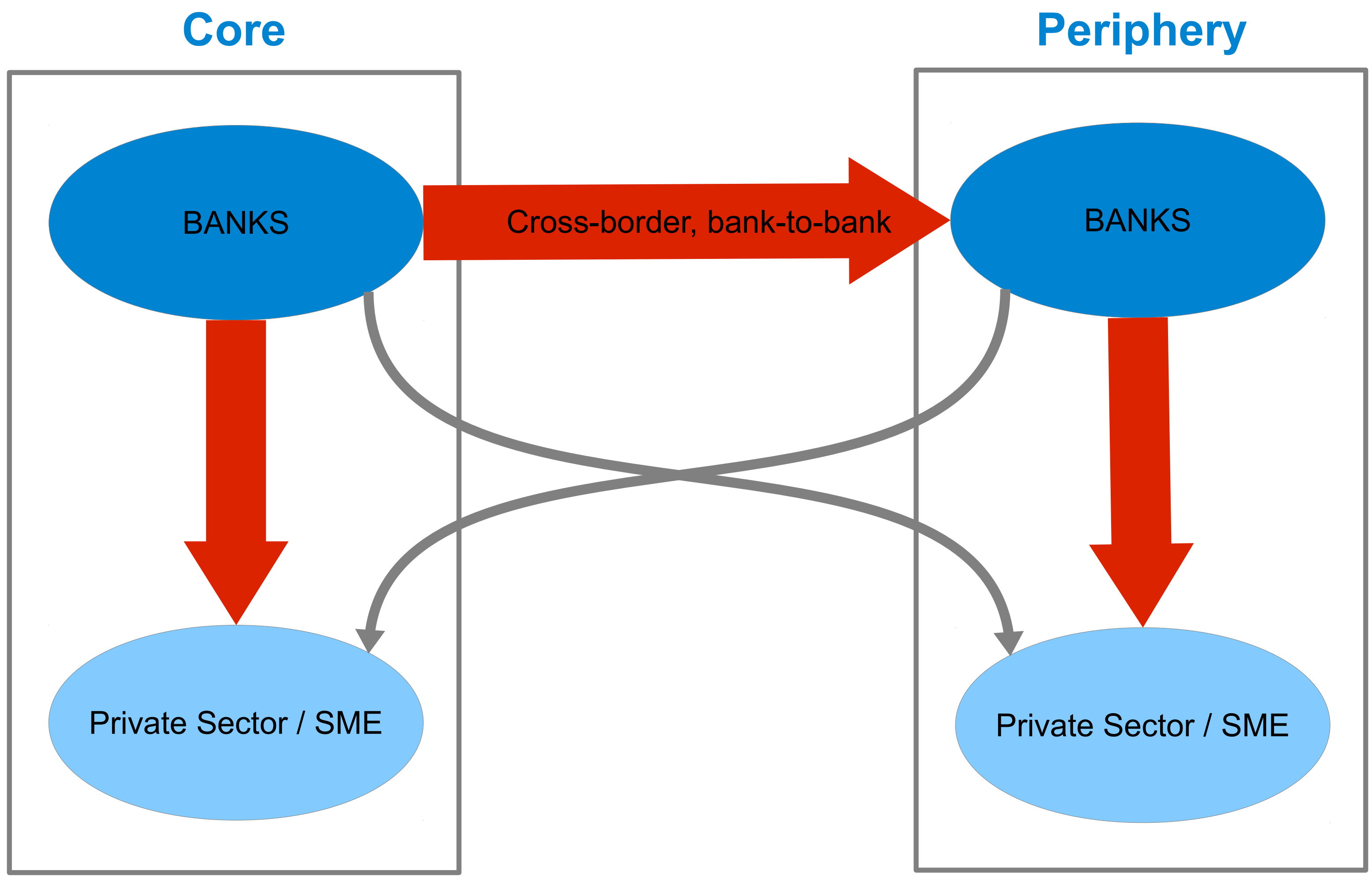
This regression includes time-sector and country-sector fixed effects. The term $\Delta\text{GBS}_t \times \text{SME}^{c,s}$ is absorbed by time-sector fixed effects, since in the model $\text{SME}^{c,s}$ only varies across sectors, but not across countries.
Estimated coefficients and t-stats (in parentheses) are derived from sample means and standard deviations of the simulated regression coefficients. In particular, for every of 10000 simulations, we run the regressions, save the estimated coefficients, and use their distribution to construct the reported values. The model has been calibrated for 11 EMU countries. We obtained time series over 60 quarters for each of the simulated variables. All variables have been cross-sectionally demeaned. Statistical significance at 1/5/10 percent level is denoted by ***, **, and *, respectively.

Figure 2.1. Cross-border bank lending in selected Eurozone countries



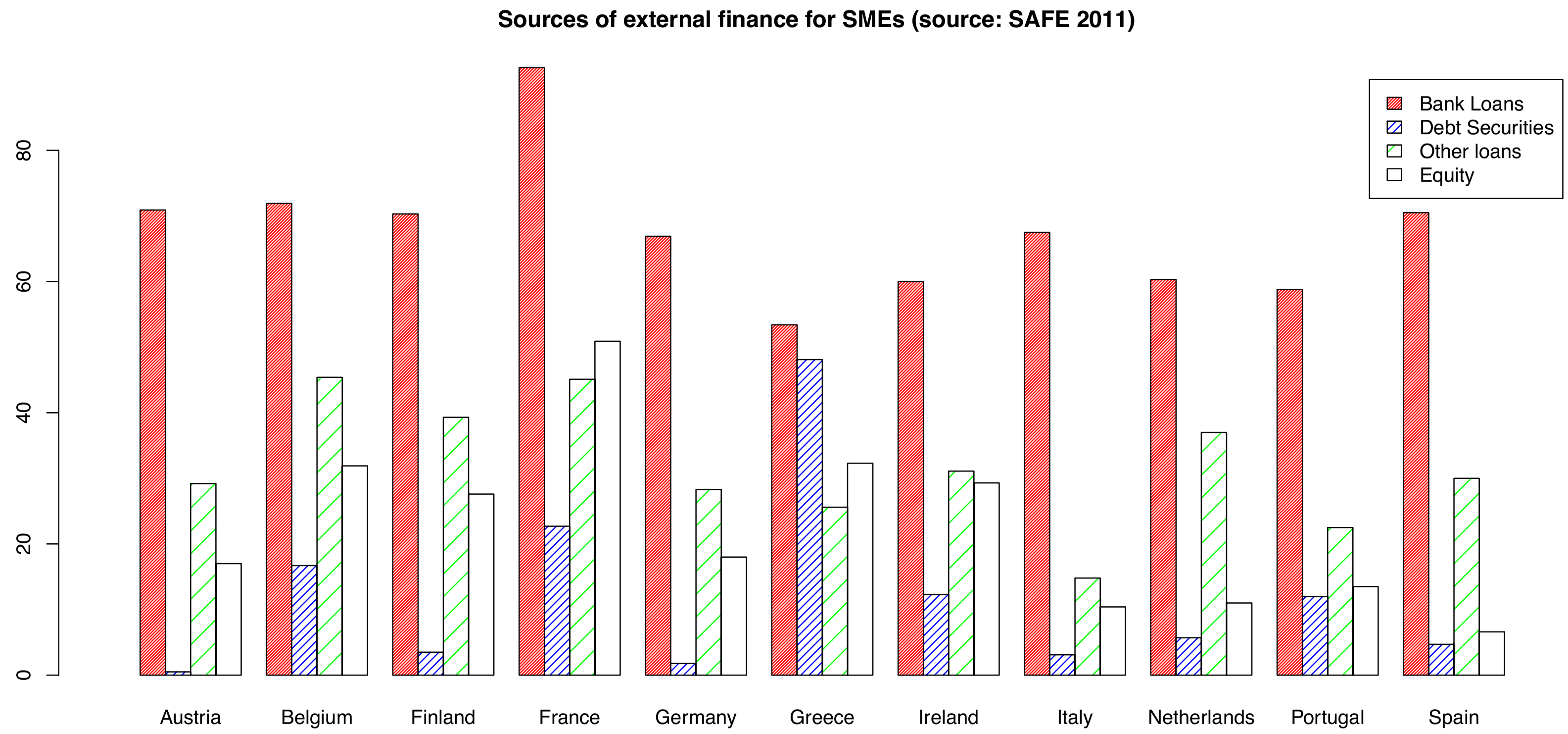
NOTES: The figure plots cross-border lending by foreign banks to each country. The last panel plots aggregate EMU-11 cross-border flows. The black solid line shows total lending, the red dashed line shows lending by foreign banks to domestic banks, and the blue dotted line shows lending by foreign banks to the domestic non-bank sector (including governments). The source is BIS locational banking statistics database.

Figure 2.2. Bank-to-bank integration vs. bank-to-real sector integration



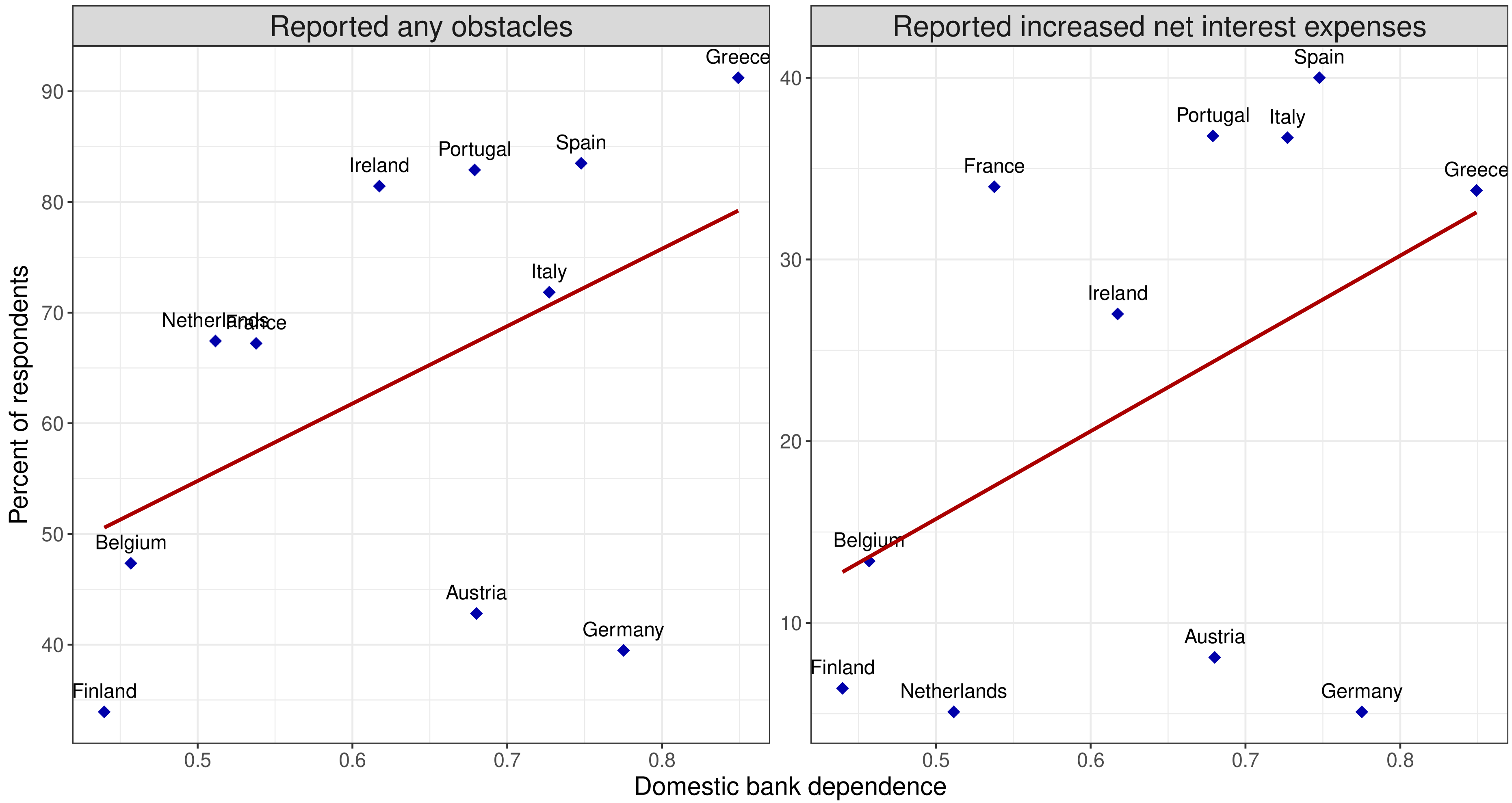
NOTES: The figure conceptualizes the structure of banking integration in the Eurozone in the years before the financial crisis. Cross-border integration mainly took place between banks (bank-to-bank integration) with net flows largely in the direction of the periphery country (big red arrow in the middle). Cross-border flows from banks to the real sector remained very limited (thin grey arrows). This left periphery economies vulnerable to sudden stops in banking flows (due to the global crisis), while keeping the domestic banking sector exposed to country-specific shocks due to its domestically concentrated loan portfolio.

Figure 2.3. Bank dependence of SMEs in the Eurozone



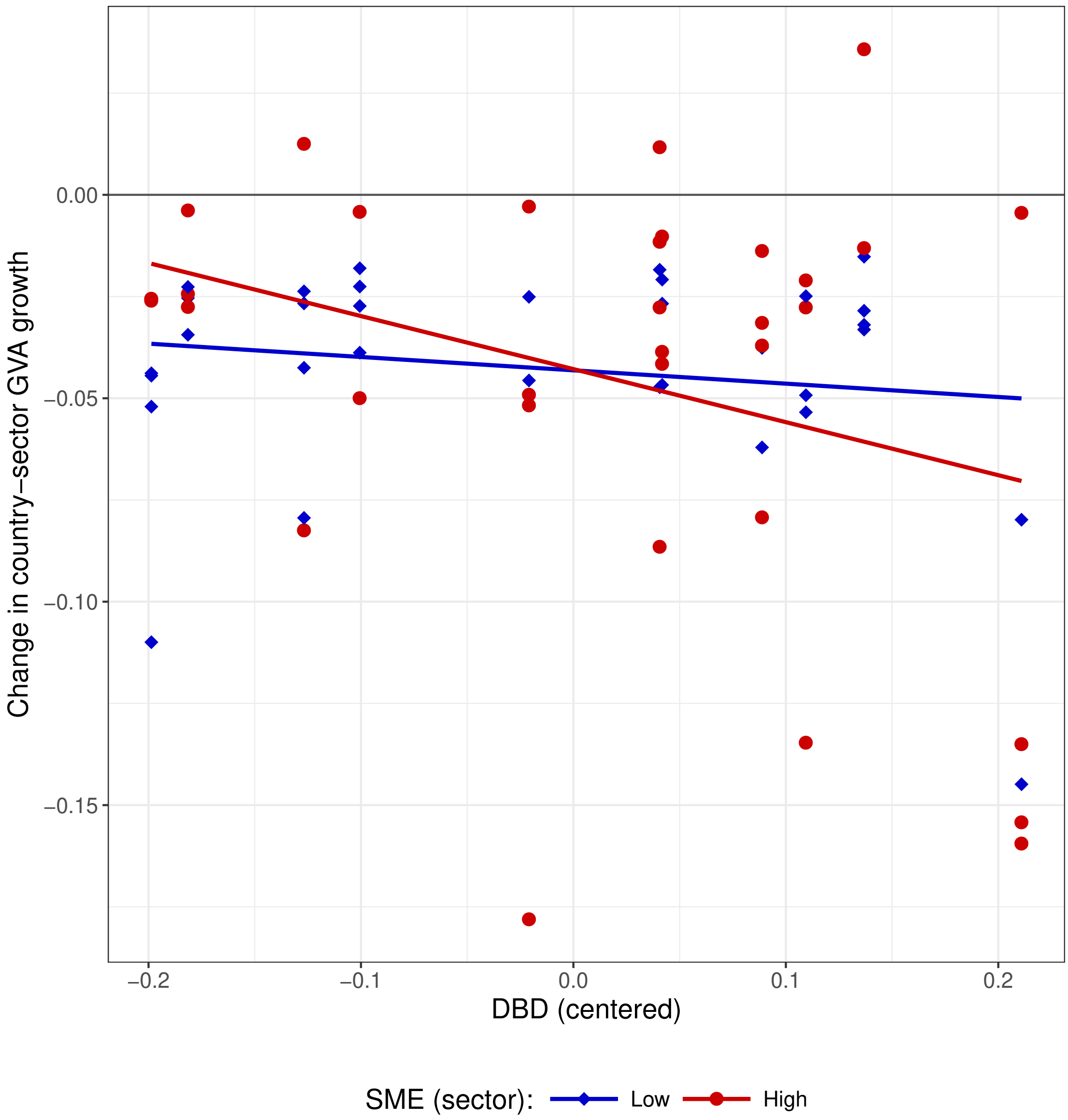
NOTES: The figure reports the fraction of SMEs (firms with fewer than 250 employees) reporting to have used or to be currently using the respective source of external finance. The data source is the European Central Bank's and EU Commission's Survey of Access to Finance by Enterprises (SAFE) 2011 for 11 Eurozone countries.

Figure 2.4. Domestic bank dependence and post-crisis SME financial conditions



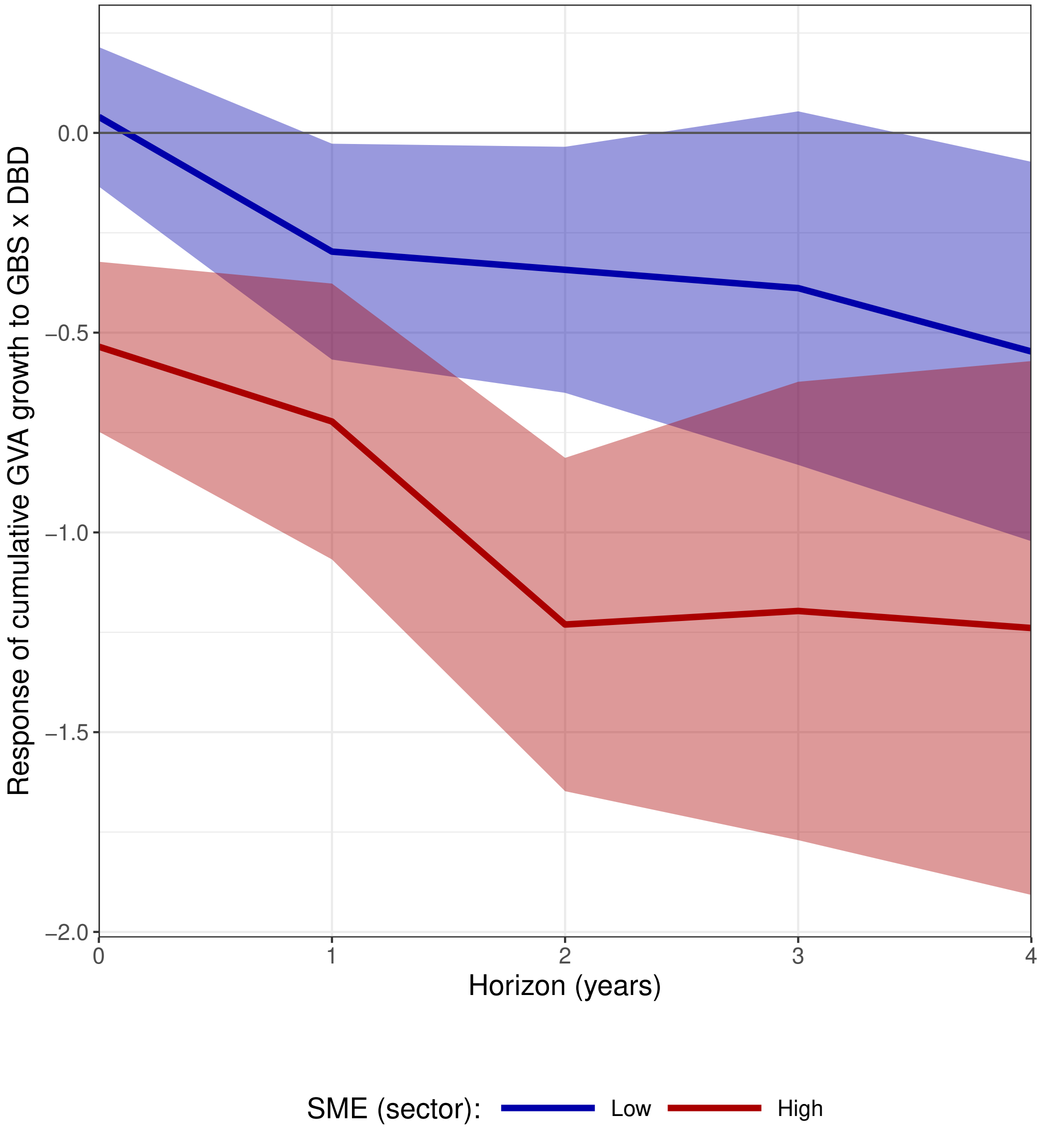
NOTES: The left panel plots the fraction of firms that reported any obstacles in obtaining finance in the ECB-EU Commission's Survey of Access to Finance of Enterprises (SAFE) 2011 against our measure of domestic bank dependence, DBD. The right panel plots the difference of the percentage of firms reporting increased interest expenses minus the percentage of firms reporting decreased interest rate expenses as reported in SAFE 2011 against DBD. For the two regression lines, the slope (robust t-stat) [R^2] in the left panel is 69.93 (1.72) [0.22], and in the right panel is 48.32 (1.79) [0.20].

Figure 2.5. Post-2008 sector-level growth and domestic bank dependence: Sectors with low vs. high SME shares



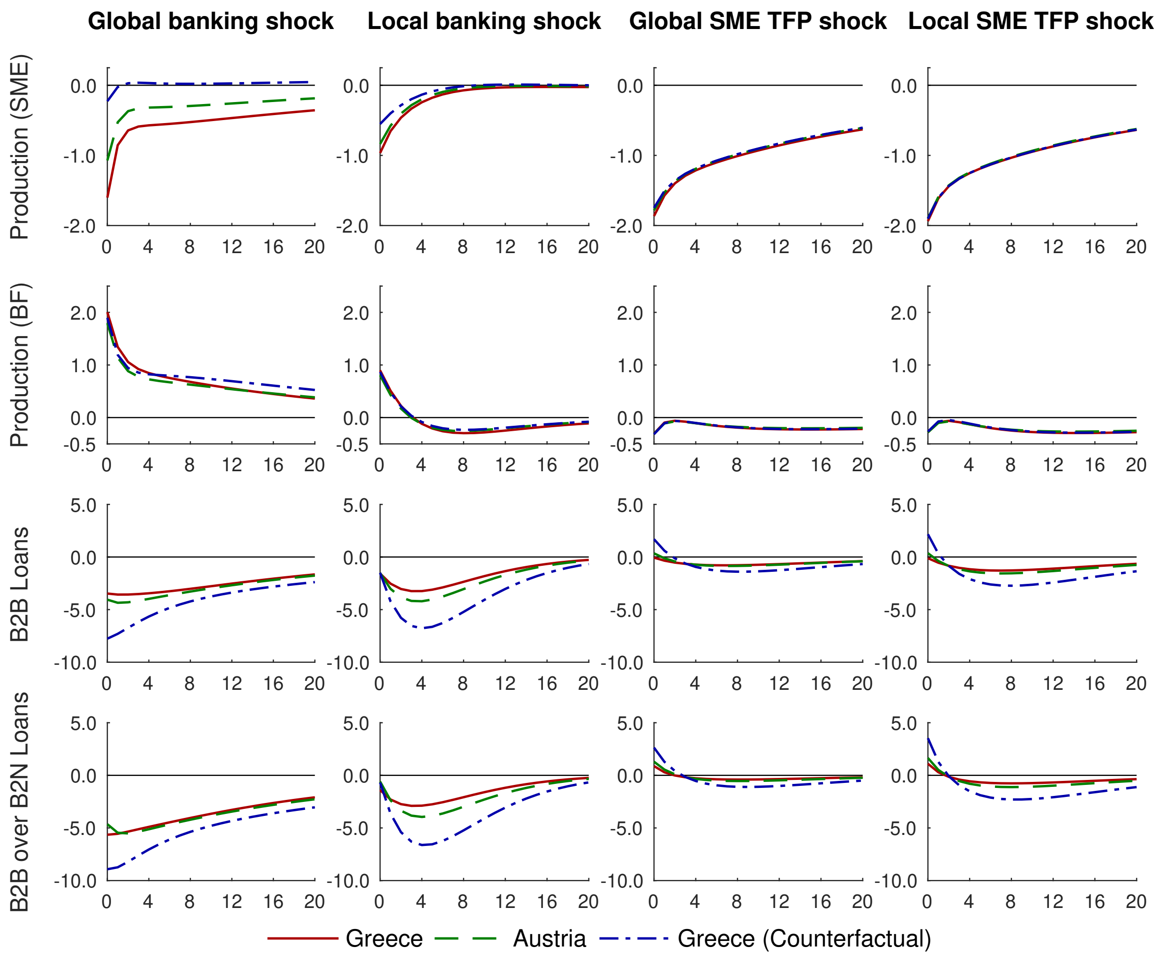
NOTES: The graph plots the change in output from pre-2008 to post-2008 average growth rates at the country-sector level against the average pre-2008 level of domestic bank dependence in each country. Blue (red) diamonds (circles) indicate country-sectors with below (above) median SME shares. The blue, dashed (red, solid) lines indicate the regression relationship between growth and domestic bank dependence for the sample of blue (red) diamonds (circles). The observation period is 1997Q1-2013Q4 for the 11 EMU countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.

Figure 2.6. Global banking shock and domestic bank dependence in sectors with low vs. high SME shares: Local linear projections



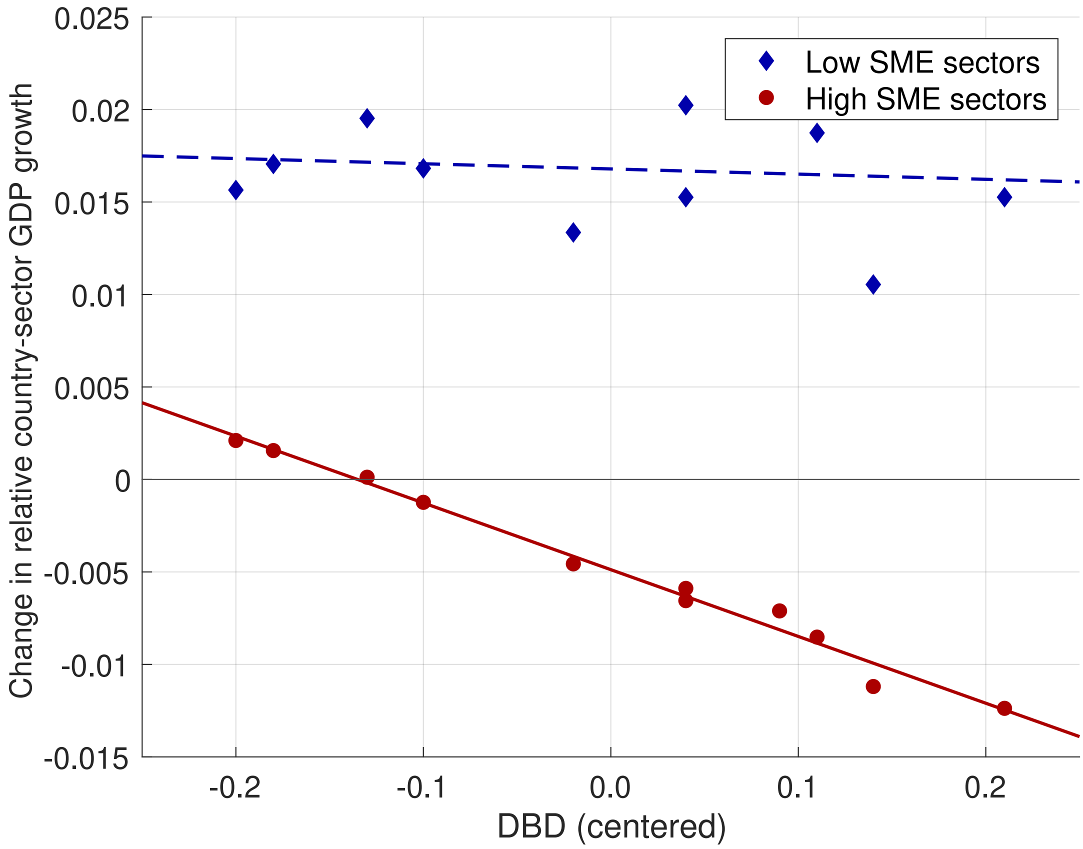
NOTES: The graph plots the cumulative effect of the interaction terms $\text{CRISIS}_t \times \text{DBD}^c$ from local linear projection regressions, separately for high-SME sectors (red) and low-SME sectors (blue). Different horizons (zero to four years) are on the x-axis, and the coefficients α_h is on the y-axis.. Colored shaded areas correspond to the respective 90% confidence bands. The observation period is 1997Q1-2013Q4 for the 11 EMU countries Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.

Figure 2.7. Model impulse responses to a global banking shock, a local banking shock, a global SME TFP shock and a local SME TFP shock



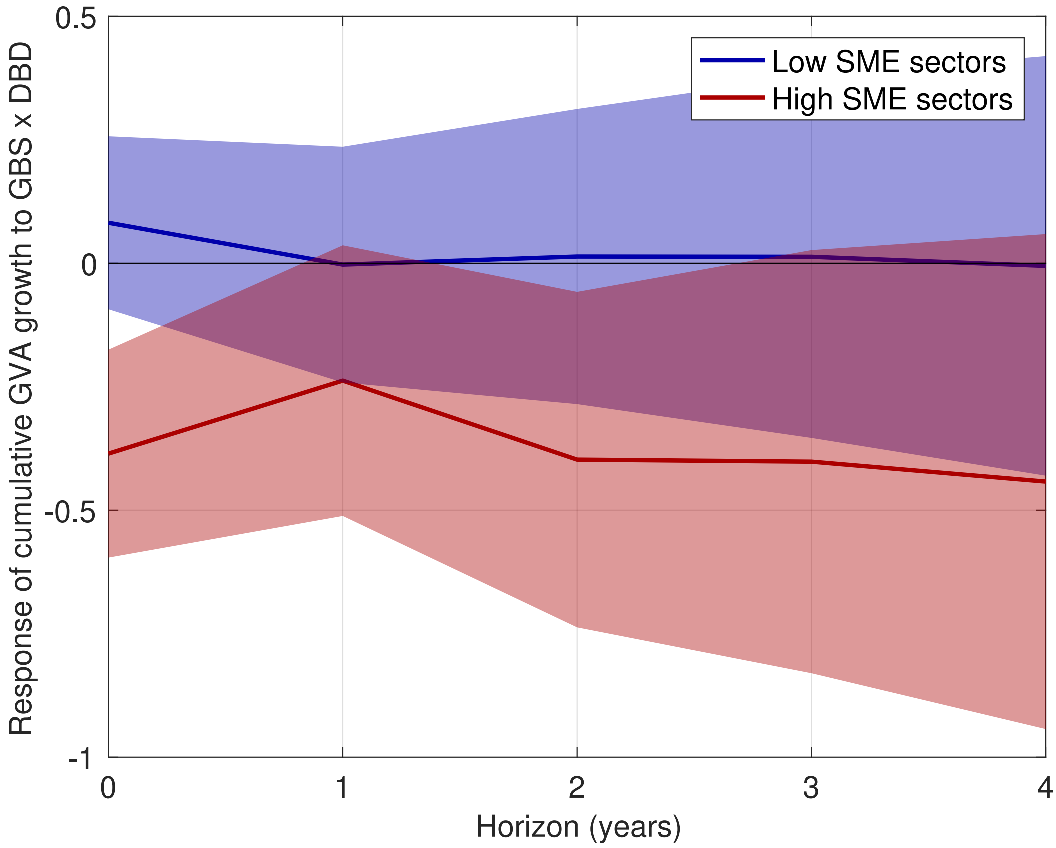
NOTES: The graph plots the model impulse response functions of SME production, big firms production, bank-to-bank loans and B2B-to-B2N ratio (rows) for "Greece" (red solid lines), "Austria" (blue dashed lines) and "Greece (Counterfactual)" (green dot-dashed lines) to a one standard deviation global banking shock, local banking shock, global SME TFP shock and local SME TFP shock (columns). "Greece" and "Austria" impulse responses are generated from models simulated using parameter values from Table 2.4. "Greece (Counterfactual)" illustrates the counterfactual scenario for Greece, in which we calibrate the model for Greece (e.g., the SME share), but set the DBD parameter to its value for Belgium. All impulse responses are percentage deviations from steady state. Number of quarters following the shock is on the x-axis.

Figure 2.8. Post-2008 sector-level growth and domestic bank dependence in sectors with low vs. high SME shares: Model simulation results



NOTES: The graph plots the change in output from "pre-crisis" to "crisis" average growth rates at the country-sector level against the steady-state level of domestic bank dependence in each country. Blue (red) diamonds (circles) indicate BF (SME) sectors. The blue, dashed (red, solid) lines indicate the regression relationship between growth and domestic bank dependence for the sample of blue (red) diamonds (circles). Data and line slopes are obtained from 1000 model simulations, calibrated for 11 EMU countries and run over 60 quarters, including 20 quarters of the "crisis" period.

Figure 2.9. Global banking shock and domestic bank dependence in sectors with low vs. high SME shares: Model simulation results using local linear projections



NOTES: The graph plots the cumulative effect of the interaction terms $\Delta \text{GBS}_t \times \text{DBD}^c$ from local linear projection regressions on model-simulated data, separately for SME sectors (red) and non-SME sectors (blue). Different horizons (zero to four years) are on the x-axis, and the coefficients α_h is on the y-axis. Colored shaded areas correspond to the respective 90% confidence bands, calculated from the distribution of the estimated coefficients across model simulations. The impulse responses are obtained from 1000 model simulations, calibrated for 11 EMU countries and run over 60 quarters, including 20 quarters of the "crisis" period.

Appendix

2A Model equations

Households

Households objective:

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

(s.t.) Intertemporal budget constraint

$$P_t C_t + D_t = W_t N_t + D_{t-1}(1 + r_{t-1}^d) + \text{DIV}_t^{\text{BF}} + \text{DIV}_t^{\text{SME}} + \Pi_{t-1}^{\text{LB}} + \mu^{\text{GB}} \Pi_{t-1}^{\text{GB}} \tag{2A.1}$$

SDF (FOC w.r.t. C_t):

$$\Lambda_{t:t+1} = \mathbb{E}_t \left[\beta \frac{P_t}{P_{t+1}} \left(\frac{C_{t+1}}{C_t} \right)^{-\sigma} \right] \tag{2A.2}$$

FOC w.r.t. N_t including real wage rigidity (Blanchard & Gali (JMBC 2007)):

$$\log \left(\frac{W_t}{P_t} \right) = \gamma \log \left(\frac{W_{t-1}}{P_{t-1}} \right) + (1-\gamma) \log \left(\Psi {N_t}^{\psi} {C_t}^{\sigma} \right) \tag{2A.3}$$

FOC w.r.t. D_t:

$$\mathbb{E}_t \left[\Lambda_{t:t+1} (1 + r_t^d) \right] = 1 \tag{2A.4}$$

Minimization problem:

$$\min_{\{C_t^{\text{BF}},\ C_t^{\text{SME}}\}} P_t C_t = P_t^{\text{SME}} C_t^{\text{SME}} + P_t^{\text{BF}} C_t^{\text{BF}}$$

(s.t.) Consumption bundle:

$$C_t = \left(\omega^{\frac{1}{\epsilon}} {C_t^{\text{BF}}}^{\frac{\epsilon-1}{\epsilon}} + (1-\omega)^{\frac{1}{\epsilon}} {C_t^{\text{SME}}}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{\epsilon-1}} \tag{2A.5}$$

Cost minimization w.r.t. C_t^{BF}:

$$C_t^{\text{BF}} = \omega \left(\frac{P_t^{\text{BF}}}{P_t} \right)^{-\epsilon} C_t \tag{2A.6}$$

Cost minimization w.r.t. C_t^{SME}:

$$C_t^{SME} = (1-\omega)\left(\frac{P_t^{\text{SME}}}{P_t}\right)^{-\epsilon} C_t \tag{2A.7}$$

Implied price index (for reference):

$$P_t = \left(\omega P_t^{\text{BF}\,1-\epsilon} + (1-\omega) P_t^{\text{SME}\,1-\epsilon}\right)^{\frac{1}{1-\epsilon}}$$

Firms

Firms objective:

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

Dividends:

$$\text{DIV}_t^s = P_t^s Y_t^s - W_t N_t^s - P_t\left(I_t^s + \frac{1}{2}\varphi^I K_{t-1}^s\left(\frac{I_t^s}{K_{t-1}^s} - \delta\right)^2\right) + L_t^s - L_{t-1}^s\left(1 + r_{t-1}^{l,s}\right) \tag{2A.8}$$

Production function:

$$Y_t^s = \theta_t^s (K_{t-1}^s)^{\alpha^s} (N_t^s)^{1-\alpha^s} \tag{2A.9}$$

Capital law of motion:

$$K_t^s = (1-\delta)K_{t-1}^s + I_t^s \tag{2A.10}$$

Financing demand (with Ξ_t^s as Lagrange multiplier):

$$L_t^s = W_t N_t^s + P_t I_t^s \tag{2A.11}$$

FOC w.r.t. N_t:

$$W_t(1+\Xi_t^s) = P_t^s(1-\alpha^s)\frac{Y_t^s}{N_t^s} \tag{2A.12}$$

FOC w.r.t. K_t:

$$Q_t^s = \mathbb{E}_t\left[\Lambda_{t:t+1}\left(P_{t+1}^s \alpha^s \frac{Y_{t+1}^s}{K_t^s} + (1-\delta)Q_{t+1}^s\right)\right] \tag{2A.13}$$

FOC w.r.t. I_t (Tobin's Q):

$$\frac{Q_t^s}{P_t} = 1 + \varphi^I\left(\frac{I_t^s}{K_{t-1}^s} - \delta\right) \tag{2A.14}$$

FOC w.r.t. L_t^s:

$$1 + \Xi_t^s = \mathbb{E}_t \left[\Lambda_{t:t+1}(1 + r_t^{l,s}) \right] \tag{2A.15}$$

Minimization problem:

$$\min_{\{L_t^{s,\text{GB}},\ L_t^{s,\text{LB}}\}} \ L_t^s(1 + r_t^{l,s}) = L_t^{s,\text{GB}}(1 + r_t^{l,s,\text{GB}}) + L_t^{s,\text{LB}}(1 + r_t^{l,s,\text{LB}})$$

(s.t.) Borrowing technology:

$$L_t^s = \left(\tau^s{}^{\frac{1}{\nu}} L_t^{s,\text{GB}}{}^{\frac{\nu-1}{\nu}} + (1 - \tau^s)^{\frac{1}{\nu}} L_t^{s,\text{LB}}{}^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}} \tag{2A.16}$$

Cost minimization w.r.t. $L_t^{s,\text{GB}}$:

$$L_t^{s,\text{GB}} = \tau^s \left(\frac{1 + r_t^{l,s,\text{GB}}}{1 + r_t^{l,s}} \right)^{-\nu} L_t^s \tag{2A.17}$$

Cost minimization w.r.t. $L_t^{s,\text{LB}}$:

$$L_t^{s,\text{LB}} = (1 - \tau^s) \left(\frac{1 + r_t^{l,s,\text{LB}}}{1 + r_t^{l,s}} \right)^{-\nu} L_t^s \tag{2A.18}$$

Effective interest rate:

$$1 + r_t^{l,s} = \left(\tau^s \left(1 + r_t^{l,s,\text{GB}}\right)^{1-\nu} + (1 - \tau^s) \left(1 + r_t^{l,s,\text{LB}}\right)^{1-\nu} \right)^{\frac{1}{1-\nu}}$$

Local Bank

Local bank objective:

$$\max_{L_t^{\text{LB,SME}},\ L_t^{\text{LB,BF}},\ D_t,\ M_t} \ \Pi_t^{\text{LB}}$$

Balance sheet:

$$L_t^{\text{LB}} = M_t + D_t \tag{2A.19}$$

Profits (accruing in the beginning of next period):

$$\Pi_t^{\text{LB}} = L_t^{\text{SME,LB}} r_t^{l,\text{SME,LB}} + L_t^{\text{BF,LB}} r_t^{l,\text{BF,LB}} - M_t r_t^m - D_t r_t^d - \frac{1}{2} \varphi^{\text{LB}} D \left(\frac{D_t - D}{D} \right)^2 \tag{2A.20}$$

FOC w.r.t. D_t (comb. with FOC w.r.t. M_t):

$$r_t^d = r_t^m + lbs_t - \varphi^{\mathrm{LB}} \frac{D_t - D}{D} \tag{2A.21}$$

FOC w.r.t. $L_t^{\mathrm{SME,LB}}$ (comb. with FOC w.r.t. M_t):

$$r_t^{l,\mathrm{SME,LB}} = (r_t^m + lbs_t)\, MU^{\mathrm{SME}} \tag{2A.22}$$

FOC w.r.t. $L_t^{\mathrm{BF,LB}}$ (comb. with FOC w.r.t. M_t):

$$r_t^{l,\mathrm{BF,LB}} = (r_t^m + lbs_t)\, MU^{\mathrm{BF}} \tag{2A.23}$$

Composition of loans to firms:

$$L_t^{\mathrm{LB}} = L^{\mathrm{SME,LB}} + L^{\mathrm{BF,LB}} \tag{2A.24}$$

Global Bank

Global bank objective:

$$\max_{L_t^{\mathrm{GB,SME}},\ L_t^{\mathrm{GB,SME}*},\ L_t^{\mathrm{GB,BF}},\ L_t^{\mathrm{GB,BF}*},\ M_t,\ M_t^*,\ B_t} \Pi_t^{\mathrm{GB}}$$

Balance sheet:

$$L_t^{\mathrm{GB}} + L_t^{\mathrm{GB}*} + M_t + M_t^* = B_t \tag{2A.25}$$

Profits (accruing in the beginning of next period):

$$\begin{aligned}\Pi_t^{\mathrm{GB}} = &\left(L_t^{\mathrm{BF,GB}} + L_t^{\mathrm{BF,GB}*}\right) r_t^{l,\mathrm{BF,GB}} + \left(L_t^{\mathrm{SME,GB}} + L_t^{\mathrm{SME,GB}*}\right) r_t^{l,\mathrm{SME,GB}} + (M_t + M_t^*)\, r_t^m \\ &- B_t r^b - \frac{1}{2}\varphi^{\mathrm{GB}} RWA \left(\frac{RWA_t - RWA}{RWA}\right)^2\end{aligned} \tag{2A.26}$$

Risk-weighted assets definition:

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

FOC w.r.t. $L_t^{\mathrm{SME,GB}(*)}$ (comb. with FOC w.r.t. B_t):

$$r_t^{l,\mathrm{SME,GB}} = \left(r_t^b + \gamma^L \varphi^{\mathrm{GB}} \left(\frac{RWA_t - RWA}{RWA}\right)\right) MU^{\mathrm{SME}} \tag{2A.27}$$

FOC w.r.t. $L_t^{\text{BF,GB}(*)}$ (comb. with FOC w.r.t. B_t):

$$r_t^{l,\text{BF,LB}} = \left(r_t^b + \gamma^L \varphi^{\text{GB}} \left(\frac{RWA_t - RWA}{RWA} \right) \right) MU^{\text{BF}} \tag{2A.28}$$

FOC w.r.t. $M_t^{(*)}$ (comb. with FOC w.r.t. B_t):

$$r_t^m = r_t^b + \gamma^M \varphi^{\text{GB}} \left(\frac{RWA_t - RWA}{RWA} \right) \tag{2A.29}$$

Composition of loans to firms:

$$L_t^{\text{GB}(*)} = L_t^{\text{SME,GB}(*)} + L_t^{\text{BF,GB}(*)} \tag{2A.30}$$

Macroeconomy

GDP:

$$Y_t = \frac{P_t^{\text{BF}}}{P_t} Y_t^{\text{BF}} + \frac{P_t^{\text{SME}}}{P_t} Y_t^{\text{SME}} \tag{2A.31}$$

Total bank loans:

$$L_t = L_t^{\text{GB}} + L_t^{\text{LB}} \tag{2A.32}$$

SME share:

$$\text{SME}_t = \frac{P_t^{\text{SME}} Y_t^{\text{SME}}}{P_t Y_t}$$

Domestic bank dependence:

$$\text{DBD}_t = \frac{L_t^{\text{LB}}}{L_t^{\text{LB}} + L_t^{\text{GB}}}$$

Total net costs:

$$\Gamma_t = (L_t^{\text{SME,GB}} + L_t^{\text{SME,LB}} - L_t^{\text{SME}}) + (L_t^{\text{BF,GB}} + L_t^{\text{BF,LB}} - L_t^{\text{BF}}) + O(2) \tag{2A.33}$$

Price normalization:

$$P_t^{\text{BF}} = 1 \tag{2A.34}$$

Current account:

$$CA_t = -\Delta M_t - \Delta L_t^{\text{GB}} \tag{2A.35}$$

Net exports:

$$NX_t = CA_t - \left(-L_{t-1}^{\mathrm{BF,GB}} r_{t-1}^{\mathrm{BF,GB}} - L_{t-1}^{\mathrm{SME,GB}} r_{t-1}^{\mathrm{SME,GB}} - M_{t-1} r_{t-1}^{m} + \mu^{\mathrm{GB}} \Pi_{t-1}^{\mathrm{GB}}\right) \tag{2A.36}$$

Market Clearing

Current account to ROW:

$$CA_t = -\Delta B_t \tag{2A.37}$$

Net exports to ROW:

$$NX_t = CA_t + B_{t-1} r_{t-1}^{b} \tag{2A.38}$$

Labor:

$$N_t = N_t^{\mathrm{BF}} + N_t^{\mathrm{SME}} \tag{2A.39}$$

Investment:

$$I_t = I_t^{\mathrm{BF}} + I_t^{\mathrm{SME}} \tag{2A.40}$$

Capital:

$$K_t = K_t^{\mathrm{BF}} + K_t^{\mathrm{SME}} \tag{2A.41}$$

Non-tradable good:

$$Y_t^{\mathrm{SME}} = (1-\omega)\left(\frac{P_t^{\mathrm{SME}}}{P_t}\right)^{-\epsilon}\left(C_t + I_t + \frac{\Gamma_t}{P_t}\right) \tag{2A.42}$$

Tradable good (Follows from Walras Law):

$$Y_t^{\mathrm{BF}} = \omega\left(\frac{P_t^{\mathrm{BF}}}{P_t}\right)^{-\epsilon}\left(C_t + I_t + \frac{\Gamma_t}{P_t}\right) + \frac{NX_t}{P_t^{\mathrm{BF}}}$$

Exogenous Processes

Sectoral TFP shocks (home):

$$\log \theta_t^{s} = \rho^{\theta} \log \theta_{t-1}^{s} - \sigma^{s}\left(\frac{\rho^{\dagger}}{\alpha^{\dagger}}\eta_t^{s,\dagger} + \sqrt{1 - \left(\frac{\rho^{\dagger}}{\alpha^{\dagger}}\right)^{2}}\,\eta_t^{s}\right), \tag{2A.43}$$

Sectoral TFP (foreign, i.e. "rest-of-EMU"):

$$\log \theta_t^{s*} = \rho^{\theta} \log \theta_{t-1}^{s*} - \alpha^{\dagger}\sigma^{s}\eta_t^{s,\dagger}, \tag{2A.44}$$

where $\eta_t^{s,\dagger},\ \eta_t^{s} \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$.

Local banking shocks (home):

$$lbs_t = \rho^{lbs} lbs_{t-1} + \sigma^{lbs}\left(\frac{\rho^{\dagger}}{\alpha^{\dagger}}\eta_t^{lbs,\dagger} + \sqrt{1-\left(\frac{\rho^{\dagger}}{\alpha^{\dagger}}\right)^2}\eta_t^{lbs}\right), \tag{2A.45}$$

Local banking shocks(foreign, i.e. "rest-of-EMU"):

$$lbs_t^{*} = \rho^{lbs} lbs_{t-1}^{*} + \alpha^{\dagger}\sigma^{lbs}\eta_t^{lbs,\dagger}, \tag{2A.46}$$

where $\eta_t^{lbs,\dagger},\ \eta_t^{lbs} \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$ and for each country c (the simulation country) $\alpha_c^{\dagger} = (\omega_c' \Omega \omega_c)^{\frac{1}{2}}$, $\omega_c = vec\left(\frac{GDP_j}{\sum_{j\neq c} GDP_j}\right)$, and $\Omega = \begin{bmatrix} 1 & \cdots & \rho^{\dagger} \\ \vdots & \ddots & \vdots \\ \rho^{\dagger} & \cdots & 1 \end{bmatrix}$.

Global banking shock:

$$\log B_t = \left(1-\rho^{gbs}\right)\log B + \rho^{gbs}\log B_{t-1} - \sigma^{gbs}\eta_t^{gbs}, \tag{2A.47}$$

where $\eta_t^{gbs} \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$.

Chapter 3

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

Joint with Mathias Hoffmann, Bent E. Sørensen and Iryna Stewen

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.

Keywords: Banking integration, Capital market integration, DSGE, Eurozone crisis, Risk sharing.
JEL classification: E21, E32, E44, F30, F36, F40, F45.

Citation: Hoffmann, M., Maslov, E., Sørensen, B.E. et al. Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?. *IMF Econ Rev* 67, 443–495 (2019).

Acknowledgements: This paper has been been prepared for the IMFER-Central Bank of Ireland conference "The Euro at 20" and the IMF Economic Review. We could like to thank the editors Sebnem Kalemli-Ozcan, Philippe Martin, and Linda Tesar and discussants Marcel Fratzscher and Rosen Valchev as well as two anonymous referees for many useful suggestions and comments. We are also grateful to conference and seminar participants in Dublin, at the Bank of Finland, the University of Zurich, and the ASSA meetings 2019 for comments.

Mathias Hoffmann is at the University of Zurich, Dept. of Economics, International Trade and Finance Group, Zürichbergstrasse 14, CH-8032 Zürich. He is also affiliated with University of Zurich's Research Priority Program in Financial Market Regulation (URPP FinReg), the CESifo Munich and the Centre for Applied Macroeconomic Analysis (CAMA) at the Australian National University. E-mail: mathias.hoffmann@uzh.ch

Egor Maslov is at the University of Zurich, Dept. of Banking and Finance. He is also affiliated with University of Zurich's Research Priority Program in Financial Market Regulation (URPP FinReg) and Swiss Finance Institute (SFI). E-mail: egor.maslov@bf.uzh.ch

Bent E. Sørensen is with the Dept. of Economics, University of Houston, Houston, TX, USA. He is also affiliated with the Centre for Economic Policy Research (CEPR). E-mail: besorensen@uh.edu

Iryna Stewen is at Gutenberg School of Management and Economics, Johannes Gutenberg University Mainz, Jakob-Welder-Weg 4, D-55128 Mainz, Germany. She is also affiliated with URPP FinReg. E-mail: iryna.stewen@uni-mainz.de

This paper has been published in the IMF Economic Review as:

Hoffmann, M., Maslov, E., Sørensen, B.E. et al. Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?. *IMF Econ Rev* 67, 443–495 (2019). https://doi.org/10.1057/s41308-019-00083-3.

For copyright reasons the text of this chapter is relegated to the Appendix.

Chapter 4

Risk Sharing within the Firm and Beyond: The Role of the Firm in the Transmission of Shocks to Households

Abstract: This paper studies the role of the firm in international consumption risk sharing by analyzing the patterns of shock transmission from firm output and value-added to household income and consumption. I show that fluctuations in consumption are primarily driven by shocks to household labor income and shielded from shocks to household dividend income. While the former are entirely driven by the dynamics of firm-sector labor compensation, there is little evidence that household dividend income follows firm sector dividend payout. Thus, firms have a potentially pivotal role in providing consumption insurance to households by shifting risk from workers to shareholders. I show that there is indeed a high degree of such within-firm risk sharing, since firms considerably insure workers from transitory and permanent shocks to their output and value-added, while shareholders are only insured from temporal but not from persistent shocks.

Keywords: Consumption, Dividends, Firm shocks, Labor compensation, Payout policy, Risk Sharing, Sectoral accounts.
JEL classification: D2, E2, F3, G3, G35, J3.

Citation: Egor Maslov (2020). Risk Sharing within the Firm and Beyond: The Role of the Firm in the Transmission of Shocks to Households.

Acknowledgements: I would like to thank my supervisor Mathias Hoffmann for his continuing support during my PhD studies and during the work on this paper, in particular. I am particularly grateful to him as well as Per Östberg, Bent Sørensen and Steven Ongena for valuable discussions and comments. Additionally, this work benefited greatly from discussions during my presentations at the University of Zurich (Department of Economics and Department of Finance), where I first presented the ideas that led to this project.

Egor Maslov is at the University of Zurich, Dept. of Banking and Finance. He is also affiliated with University of Zurich's Research Priority Program in Financial Market Regulation (URPP FinReg) and Swiss Finance Institute (SFI). E-mail: egor.maslov@bf.uzh.ch

4.1 Introduction

What is the role played by the firm in the transmission of output and value-added shocks to household income and consumption? By combining two approaches prevalent in the literature—the first one focusing on individual firm-worker-shareholder nexus and insurance within the firm and the second one studying aggregate patterns of shock transmission on the level of individual countries and regions—I show that firms play a pivotal role in providing consumption insurance to households by shifting risk from workers to shareholders, and examine the channels through which this outcome is achieved.

The main argument in this paper is built upon the idea that the general payout policy of the firm (understood broadly to include the compensation of labor) determines the type and the amount of income risk borne by different economic agents (workers and shareholders), and consequently the diversification and the consumption smoothing potential for the total risk.

The first part of this logic is inspired by the literature starting with Knight (1921), who traced the very existence of the firm to the provision of insurance by risky entrepreneurs to risk-averse workers.[1] Overall, this literature is primarily concerned with the role of the firm in reducing the workers' wage and employment risk, but it does not emphasize the implications of general firm payout policy for the rest of the macroeconomy.

However, from the welfare perspective of individual countries and regions, it is crucial to know how changes in aggregate production and income affect aggregate demand and consumption. While the existing literature has provided many useful insights—it identified channels through which these typed of shocks get smoothed, discussed the role played by various institutions, such as the general government, public and private insurance, or capital, credit and labor markets, and examined the scope for risk sharing across national and regional borders—it has traditionally focused on patterns relating to aggregate macroeconomic quantities and prices without much attention to within- and between-sector interactions.[2]

In this paper, I embrace both perspectives and develop the thesis that the way firms share income between workers and shareholders is of first-order importance for the overall patterns of risk sharing in the economy as a whole. This claim is further motivated by the patterns in Figure 4.1, namely that labor income and dividends are the two most important components of the aggregate household primary income originating outside their own balance sheets.[3]

[1] See, for example, Guiso, Pistaferri and Schivardi (2005), Fagereng, Guiso and Pistaferri (2017), Ellul, Pagano and Schivardi (2017), and Pagano (2020).

[2] See, among others, Asdrubali, Sørensen and Yosha (1996), Sørensen and Yosha (1998) and Hoffmann et al. (2019).

[3] Note that "entrepreneurial" income—the sum of operating and mixed income of unincorporated entities—makes a substantial part of the total households' income in some countries, e.g., Greece and Italy. However, by

To illustrate this point, consider two extreme cases, where a negative shock to firms' sales is either entirely reflected in (i) a reduction of total payoff to equity holders, or (ii) in one-to-one cut in labor payout. From the aggregate national accounting perspective, there is no difference in the measured reduction in total domestic income. However, the implications are different for who gets affected and how: in the first case the shock affects domestic and potentially foreign shareholders; in the second one, it is almost entirely transmitted to domestic workers, since labor risk is local in nature and is hard to insure against. In the aggregate, one is likely to see a smaller response of the aggregate consumption in the first case. Firstly, because at least a portion of the shareholder risk can be insured *ex ante* through capital markets and thus diversified away; and secondly, because households exposed to this type of risk are likely to be overall wealthier and have better access to other means of consumption smoothing: savings, financial assets and bank credit. For economies and regions, which differ only along the stated dimension but have otherwise identical institutions, aggregate consumption is therefore expected to respond very differently. In other words, this example shows that countries with similar institutions, capital and credit markets, government policies, and so on, but different firm payout policies can have very different consumption elasticities. From a policy-maker's perspective, such differential responses are crucial to understand.

I am not aware of any other study that explores the role played by the general corporate payout policy of individual firms for shock transmission between economic sectors and different levels of risk sharing within the economy. The current paper does so in three steps, with the main procedures and findings summarized as follows.

First, using the firm-level data from *Compustat North America* and *Compustat Global* for a panel of advanced economies from 1999 to 2019, I study the general firm payout policy patterns by pinning down the degree of pass-through of idiosyncratic shocks to firm productivity, as proxied by sales and value-added, to various firm-level outcomes, e.g., employees' compensation, wages, employment, operating income, dividends, total equity payout, and capital expenditures. Importantly, given the fact that the permanent and transitory shocks can lead to potentially very different reactions, I adapt the econometric procedure in Guiso, Pistaferri and Schivardi (2005), which allows me to describe the firm payout policy not only as a mixed reaction to long- and short-lived productivity shocks, but also distinguish between the two.

Starting with the reaction of labor compensation, I largely confirm the conclusions from the previous literature (see, e.g., Guiso, Pistaferri and Schivardi (2005), Fagereng, Guiso and Pistaferri (2017), and Ellul, Pagano and Schivardi (2017)) that workers are well insured against

definition the risk from this type of income originates on the balance sheets of the households themselves and thus constitutes background risk not stemming from the rest of the economy.

transitory idiosyncratic shocks to firm-level productivity and less so against persistent shocks. In particular, the estimates of the current study imply the combined pass-through rate to labor expenses of between $25-40\%$ (depending on a particular specification and shock definition), with the effect being smaller for transitory shocks, at between $0-25\%$, and larger for persistent shocks, at between $40-50\%$. By decomposing labor expenses into wages and number of employees—I conclude that firms largely adjust the former in response to transitory shocks and the latter in response to permanent shocks.

Consistent with the findings above, operating income reacts strongly to both types of shocks, with the pass-through coefficient of around 2. However, this strong reaction is not resembled one-to-one in the dynamics of dividends and total equity payout.[4] While dividends and total equity payout are strongly pro-cyclical in general, as evidenced from the combined pass-through coefficient of $60-75\%$, this positive effect is entirely driven by the reaction to permanent shocks ($80-120\%$), with the elasticity to transitory shocks being either small and insignificant, or negative.

While the previous result is consistent with the view that firms usually adopt conservative dividend payout policies and thus adapt dividends mostly in response to persistent changes in firm operations only (see, e.g., Lintner (1956) and Leary and Michaely (2011)), the findings in this paper uncover an additional pattern. Across most specifications, firms tend to adjust dividends in the opposite direction of the shock impact. While this might be surprising at first glance, this observation is consistent with standard business cycle models, which predict counter-cyclical firm dividends due to the fact that firms pursue the interest of their shareholders who want to maintain a steady consumption profile across booms and recessions. I am not aware of any empirical study that finds support for this theory with firm-level data. It should be noted, though, that such reaction is not observable for total equity payout, which is consistent with the "substitution" hypothesis between dividends and share repurchases (Jagannathan, Stephens and Weisbach (2000)) and evidence that firms prefer share repurchases as a means of passing large transitory shocks to their shareholders (Brav et al. (2005)).[5]

Finally, I find that firms adjust investment in a pro-cyclical manner, but that this result is entirely driven by the response to permanent productivity shocks. Overall, the results above suggest that firms play an important role in insuring workers against transitory and permanent shocks to firm performance, and firm owners against transitory shocks.

[4] The distinction between dividends and total equity payout is due to the impact of share repurchases and is particularly important for come individual countries like the United States but almost irrelevant for most European countries.

[5] In some of their specifications Covas and Den Haan (2011) reach similar conclusions.

In the second step, I use the *sectoral* accounts data from *Eurostat* to explore and extend the above patterns at the level of individual countries and sectors within countries. In particular, I repeat the preceding analysis to study the aggregate firm reaction to country-wide productivity shocks and see if there are substantial differences in this reaction compared to the patterns shaped by the dynamics of idiosyncratic firm shocks. I also ask to what extent households in the aggregate are exposed to firm-sector shocks to value added, labor expenses and dividends, and how the transmission mechanism works.

This analysis is similar in nature to the international risk sharing literature, but differs from it in two important ways. First, the units of analysis are not countries as a whole, but country-sectors (non-financial firms and households). And second, I consider how firm productivity shocks affect household consumption through two different income channels: labor payout and dividends.

Starting with estimates of an analogue to the classical consumption risk-sharing coefficient, I show that aggregate household consumption is shielded from ca. 40% of the shocks to aggregate firm value-added, which, despite differences in methodology, is in line with the existing literature (see, e.g., Hoffmann et al. (2019)). What drives this aggregate sensitivity of consumption is a composite influence of three forces: how aggregate productivity shocks affect various firm-sector income components, how, conditional on these patterns, the respective household income components react to changes in their firm-level counterparts (extensive margin), and how household consumption reacts to shocks to different components of their income (intensive margin).

Within the firm sector I find that a much higher share of *aggregate* firm productivity shocks is transmitted to wages, at ca. 75%, compared to idiosyncratic firm productivity shocks, where this share is in the range $25-40\%$. This finding is not surprising, since the analysis with the firm-level data is conceived to measure the impact of *idiosyncratic* firm shocks, while the aggregate dynamics is driven by *common* shocks. Clearly, aggregate shocks are harder to insure against both from an individual firm's perspective, and the economy as a whole. Furthermore, consistent with firm-level results above, I find that the response of aggregate dividends is large (above one) but still entirely driven by the influence of permanent shocks.

Concerning the role of the labor income in the process of shock transmission of the residual risk from firms to households, empirical evidence suggests that 70% of this risk is transmitted to household consumption. Lack of insurance on the between-sector dimension amounts to ca. 90% of the transmission (extensive margin), while the on-balance sheet lack of insurance within the household sector amounts to ca. 80% of the transmission (intensive margin). For dividends, the overall picture is different: the combined effect of firm-sector dividend risk for household consumption is almost negligible at 2%, with about 50% of the risk being diversified away (extensive margin).

These findings show that labor income risk is harder than the dividend risk to diversify away *ex ante* (e.g., through capital markets) and smoothen *ex post* (e.g., through credit markets or via saving). Consequently, the patterns of risk sharing within the firm, i.e., whether the risk is primarily passed on through labor or equity payout, determine the ultimate response of household consumption to firm-level output and value-added shocks.[6]

In the last step, I combine firm-level microeconomic data with the sectoral accounts macroeconomic data and use the former to construct an instrument for aggregated firm value-added, output, labor expenses and dividends. One issue with the procedure in step two, common to much of the macroeconomic literature in general, is that it measures the reduced form combined effect of *all* shocks causing firm productivity, labor income, dividends, and consumption to co-move. Such results are instructive but must be interpreted with caution, especially in countries and times dominated by alternative (non-productivity) shocks (see also discussion and simulation results in (Hoffmann et al., 2019)). A properly defined instrument allows to potentially circumvent this problem, and provide a robust way of gauging the impact of aggregate firm-sector outcomes on the household sector balance sheets and consumption.

For this purpose, I apply a simple version of the approach developed by Gabaix and Koijen (2019). These authors develop a framework which allows one to identify the causal effects of one macroeconomic variable on another by exploiting the granular nature of the underlying microeconomic data in a particular instrumental-variables (IV) setting.

While the implementation of the granular residual approach with the data used in the current study does not lead to universally useful results (weak first stage and insufficient instrument power in some cases), the results with instrumenting firm-sector labor expenses with a granular residual from *Compustat* data are relatively strong and interpretable.

Particularly, I find that fluctuations in the uninsured portion of firm labor payments have a very strong impact on household wages (extensive margin), with a pass-through coefficient of 97%, total primary income (86%), and nominal and real consumption ($98 - 99\%$). All these coefficients are strongly statistically different from zero and not different from one, with their magnitudes roughly doubling if the responses to persistent shocks are considered. Overall, these findings confirm the previous result that the uninsured component of firm labor compensation is entirely passed on to households' income and consumption.

[6]The patterns of the aggregate household income are also substantially shaped by the dynamics of entrepreneurial income. However, this income type by definition cannot be smoothed within the firm or the corporate sector. The results using macro-level data show that a significant fraction (54%) of the shocks to entrepreneurial income find their way to the household consumption.

Taken together, the findings in this paper provide a comprehensive picture of how shocks are transmitted from firm output and value-added to household income and consumption. It shows that fluctuations in consumption are primarily driven by shocks to household labor income and shielded from shocks to household dividend income. While the former are entirely driven by the dynamics of firm-sector labor compensation, there is little evidence that household dividend income follows firm sector dividend payout. Thus, firms play a pivotal role in providing consumption insurance to households by shifting risk from workers to shareholders, as they insure workers from transitory and permanent shocks to their output and value-added, while shareholders are only insured from temporal but not from persistent shocks.

I conclude that risk sharing patterns on the macroeconomic level are crucially shaped by the risk sharing within the firm. The main policy implication of this thesis therefore implies the need to target firm-related outcomes and general firm payout policy directly, if households are to be *effectively* insulated from the fluctuations in idiosyncratic and economy-wide shocks to firm output, e.g., during the current covid-19 pandemic.

This paper is structured as follows. Section 4.2 provides a survey of related literature and highlights the main contributions of the current approach. The sources of firm- and country-level data used in the subsequent analysis and data preparation steps are described in Section 4.3. The next three sections describe the empirical methodology and perform data analysis: a study of risk sharing within the firm is conducted in Section 4.4, an investigation of shock transmission from non-financial firm sector to households within countries in Section 4.5, and an alternative identification from firm-level data in Section 4.6. Concluding remarks are given in Section 4.7.

4.2 Literature Review

The academic literature has concerned itself with the trade-off at the firm level regarding the distribution of income between workers and shareholders at least since the work by Knight (1921), who traced the very existence of the firm to the provision of insurance by risky entrepreneurs to risk-averse workers. The first rigorous formalization of this intuition was done in Azariadis (1975) and Baily (1974). Pagano (2020) offers an excellent recent account of the theory of risk sharing within the firm, followed by an observation that risk sharing within firms has declined steadily in the last three decades.

Empirically, the idea that firms provide implicit insurance to workers was first studied by Guiso, Pistaferri and Schivardi (2005) (see also an overview in Guiso and Pistaferri (2020)). Using matched firm-worker data for Italy, they show that firms fully insure workers from transitory shocks to their value added and partially so from permanent shocks. Fagereng, Guiso and Pistaferri (2017) build on this idea and explore the effects of uninsurable wage shocks on household portfolio choice. Guiso, Pistaferri and Schivardi (2013) show that workers provide implicit credit to firms via the shape of their wage profile. Similar to the approach adopted in this paper, Ellul, Pagano and Schivardi (2017) adapted the empirical methodology from Guiso, Pistaferri and Schivardi (2005) for a cross-country firm data from Worldscope and Osiris (and for U.S. firms from Compustat) to show that unemployment insurance offered by the government and by firms are substitutes.

Additionally, and close related, Hartman-Glaser, Lustig and Xiaolan (2019) develop a model of firm wage insurance and show empirically that the aggregate capital share dynamics is driven by individual dynamics of very large firms; Favilukis and Lin (2016) show that the riskiness of equity increases if wages are (exogenously) sticky; and Budd, Konings and Slaughter (2005) develop an idea that international rent sharing in multinational firms can provide an implicit risk-sharing mechanism through its effect on wages.

Compared to this literature, the contribution of this paper is threefold. First, I explicitly study not only labor-related firm outcomes, but, among others, also dividends and total equity payout. Second, I study risk transmission beyond firm boundaries, all the way to aggregate household sector income and consumption. And third, I combine firm-level and country-sector data for a robust identification of the effects of the labour income shocks.

The next strand of related work embraces studies on optimal firm payout policy. While the seminal work by Miller and Modigliani (1961) shows that under certain conditions the payout policy is irrelevant, the vast existing empirical evidence points at the opposite. For example, firms are known to be aiming to provide shareholders with a stable stream of predictable dividends (see Lintner (1956) and more recent studies by Leary and Michaely (2011) and Javakhadze, Ferris and Sen (2014)). Besides, the relation between earnings, dividends, and stock repurchases has been evolving over time, with the latter having gained an increasingly prominent role (Fama and French (2001), Grullon and Michaely (2002), Skinner (2008)). This role is often framed in context of the so-called *flexibility hypothesis* (Jagannathan, Stephens and Weisbach (2000)), according to which dividends are paid by firms with higher permanent operating cash flows, while repurchases are used by firms with higher temporary cash flows (see also empirical evidence in Andres et al. (2015)). Furthermore, Brav et al. (2005) provide evidence that dividends are shielded from (temporary) firm-level shocks, while the “residual cash flow” risk is commonly passed on to shareholders though share repurchases. For these reasons, where possible, I study the role of dividends separately from the dynamics of total equity payout.

The value added of the current paper is in studying the systematic response to firm-level shocks not only of dividends and total equity payout, but also other firm outcomes, notably labor compensation. Furthermore, I emphasize the role played by the firm in the transmission of productivity risk between the economic agents within countries. Additionally, I particularly highlight the role of dividends in insuring shareholders from transitory shocks to firm output.

Related to the last point, it should be noted that the main conclusion of the corporate finance literature regarding the cyclical nature of dividends and total equity payout is at odds with typical macroeconomic models, which predict that equity payout must be highly *counter-cyclical* and volatile. Following a discussion in Huang-Meier and Freeman (2015), if negative (positive) shocks are not too short-lived, than it is optimal for the firm to cut (increase) investment in expectation of low (high) future return, while at the same time shareholders should demand higher (lower) compensation in order to maintain a stable path of consumption.

Such models consequently predict home bias in international portfolios, since they produce a negative correlation between the (uninsurable) labor income and dividends (see, for example, Heathcote and Perri (2004, 2013) and Coeurdacier and Rey (2013)). But although the home bias is indeed a long-lived feature of international capital markets (Coeurdacier and Rey (2013)), empirically the equity payout has been shown to be highly pro-cyclical at the aggregate level (see, for example, Jermann and Quadrini (2012), Huang-Meier, Freeman and Mazouz (2015)).

The results in this paper offer a rare evidence supporting the predictions of such models (some specifications in Covas and Den Haan (2011) point to the same conclusion). These patterns are clear-cut using firm-level data and also show up in the macroeconomic data, if one estimates the elasticities separately for transitory and persistent shocks.

At this point, it should be noted that I do not study the transmission of output risk to households' consumption via capital gains. While one might object that from shareholders' perspective there is not necessarily a huge difference between dividends and capital gains and that both contribute to total return on their portfolios, the focus in the current paper lies in income risk transmission via *transactions*, as defined in the European system of accounts. Studying the role of capital gains and valuation effects is beyond the scope of this paper but is an interesting avenue for future research.

Conversely, the focus of the current paper is on tracing the effect of the innovations to firm output on household consumption via *income flows*, and in this regard it closely connects to a large body of research on international (interregional) consumption risk sharing. In early contributions, Asdrubali, Sørensen and Yosha (1996) and Sørensen and Yosha (1998) identified channels, through which shocks to productivity (GDP) get smoothed before finally affecting consumption: the income channel (through capital markets), the fiscal channel (through governmental taxes and subsidies) and the consumption smoothing channel (through self-insurance and credit markets). A recent application for the euro are can be found in Hoffmann et al. (2019).[7]

The current study extends the methodology from the papers above to study channels of risk sharing within countries, between sectors and within the firm. It also considers separate roles played by labor income and dividend income and the distinction between the reactions to permanent and transitory shocks (via instrumental-variables approach).

Given the last point, I also closely relate to Becker and Hoffmann (2006) and Artis and Hoffmann (2008), who also show that it is essential to distinguish between permanent and transitory shocks to output (income), since consumption reacts mainly to the permanent component. This distinction is related to Artis and Hoffmann (2011) who show that portfolio diversification is particularly important for smoothing permanent shocks.

The analysis in this paper confirms the importance of distinguishing between the two types of shocks primarily because labor income and dividends react very differently to both components. This study is therefore highly complementary to the above-mentioned papers.

To my knowledge the current study is the first one to use firm-level data to study the relationship between output, value-added, labor earnings, dividends and consumption within a risk sharing framework, by using insights from Gabaix and Koijen (2019). These authors developed the methodology for extracting idiosyncratic shocks from the disaggregated data in order to identify macroeconomic relationships of interest. This connects the current paper to the "granularity hypothesis" literature. This hypothesis was developed in Gabaix (2011) who trace the origins of the aggregate fluctuations to the dynamics of large ("granular") individual units (here, firms). Among others, di Giovanni, Levchenko and Mejean (2014) extend this idea to quantify the contribution of firm-level sales shocks to the aggregate variation of sales and the importance of various channels. More applications can be found in Carvalho and Gabaix (2013), di Giovanni, Levchenko and Mejean (2018), and Carvalho and Grassi (2019). Leary and Roberts (2014) explore a similar idea in context of firm peer effects. Relevant elements of this approach can also be found in Covas and Den Haan (2011) and Hartman-Glaser, Lustig and Xiaolan (2019), who show that the aggregate dynamics of equity payout and capital share is driven by large firms and that it differs significantly from that of the median firm. Finally, Kalemli-Ozcan, Sørensen and Volosovych (2014) emphasize the role of the granularity of the

[7] See also Obstfeld (1993), Canova and Ravn (1996), Lewis (1996), Sørensen et al. (2007), Demyanyk, Ostergaard and Sørensen (2007), Demyanyk, Ostergaard and Sørensen (2008), Kose, Prasad and Terrones (2009), Hoffmann and Shcherbakova-Stewen (2011), Kalemli-Ozcan, Luttini and Sørensen (2014).

firm size distribution for their findings on the relation between foreign direct ownership of firms and their output volatility, and between aggregate volatility and foreign investment.

4.3 Data

There are two main sources of data that are used in this study: *Compustat* for the firm-level data and *Eurostat* for the country-sector-level data. Below I describe the two sources and document the steps made in the process of data preparation.

4.3.1 Data Compustat

First, I merge annual Compustat North America and Compustat Global databases (tables `company`, `funda`, `g_company`, and `g_funda` from library `comp`).[8]

From the former I extract data for firms located in the United States and Canada (using the firm location identifier `loc`) and from the latter data for the following 26 European countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, and Switzerland.

The time sample starts in 1999 and ends in 2019 with annual frequency. I use firms' fiscal years (`fyear`) as a time identifier.[9]

To have a data panel with entries uniquely identified by the firm id (`gvkey`) and fiscal year (`fyear`), I apply the following screens: `consol` = `C` (consolidated accounts only), `indfmt` = `INDL` (industry format only), `datafmt` = `STD`|`HIST_STD` (data format: standard for Compustat NA and historical standard for Compustat Global), and `popsrc` = `D`|`I` (population source: domestic for Compustat NA and international for Compustat Global).[10]

Besides data identifiers, the following variables are used in the subsequent analysis: `sic` (`SIC` – SIC code and industry identifier), `at` (`Asset` – total assets), `dlc` (`ShortDebt` – debt in current liabilities), `dltt` (`LongDebt` – long-term debt), `ppent` (`TangAsset` – property plant and equipment), `sale` (`Sale` – sales or output), `xopr` (`OpExp` – total operating expenses), `xsga` (`SGAExp` – selling, general and administrative expense), `oibdp` (`OpInc` – operating income before depreciation), `xlr` (`LabPay` – labor expense), `capx` (`Invest` – fixed capital expenditure), `dvc` (`DivPay` – common dividends), `prstkc` (`ShareRep` – purchase of common and preferred stock),

[8] From here on I will refer to database identifiers and variable names in `teletype font`.

[9] I choose annual and not quarterly frequency since most firms announce dividends in a particular quarter every year, meaning that there is no meaningful variation in the size of dividends across firm-quarters. This observation is also confirmed in national accounts data. Also, quarterly data is of lower quality as companies report some quantities only on an annual frequency.

[10] As I describe below, to this end I also deal with fiscal year changes which result in non-unique firm-year observations for a small sub-sample of data.

and emp (Emp – number of employees). I additionally define value-added as ValAdd = LabPay + OpInc, wages as Wage = LabPay/Emp, leverage as Leverage = (ShortDebt + LongDebt) /Asset, and tangibility as Tangibility = TangAsset/Asset. I also set negative values of DivPay and ShareRep to zero, and set missing observations of ShareRep to zero for firm-years, in which there is information on DivPay. Total equity payout is then defnined as TotEqPay = DivPay + ShareRep.

Initial data after restricting the sample and applying the screens above consists of 330'087 firm-country-sector-year observations. In a first step of the data cleaning process, I filter out companies with non-missing entries for status alert identifier (stalt), thus dropping companies in bankruptcy or liquidation and those that have undergone a leveraged buyout – 0.26% of the sample[11]; non-missing values for comparability status identifier (compst) (excluding DB – fiscal year change status), thus dropping companies with data affected by mergers and acquisitions, accounting changes, discontinued operations, short-lived operations and IPOs – 14.05%; missing values for fiscal year (fyear) – 0.03%, fiscal year end (fyr) – 0.03%, and period duration (pddur) – 0.01%, as well as values of period duration (pddur) below 9 and above 15 – 0.59%. I do the latter in particular, because of the need to re-scale observations for which the period duration (pddur) is not equal to 12 months (by a factor 12/pddur). This filtering step results in 281'792 remaining observations, or 85.37% of the initial sample.

Next, I drop observations with missing entries for Asset – 14.39%, Sale – 14.40%, and SIC – 0.09%; drop data with non-positive values for Sale – 7.44%, Emp – 1.46%, Asset – 0.39%, LabPay – 0.62%, SGAExp – 6.39%, and ValAdd – 5.69%; drop data with negative values for ShortDebt – 0.00% (13 firms), LongDebt – 0.00% (5 firms), and TangAsset – 0% (0 firms); and drop financial firms (SIC between 6000 and 6799) – 23.43%. The resulting sample contains 163'213 (57.92%) observations. Of these, I drop 1.50% of firms with less than 2 observations, yielding 160'759 observations.

In the following step I trim data based on the values of the log-differences of Sale, Asset, Emp, at 2% and observations based on log-differences of LabPay and ValAdd, at 5%. In a process, 10.07% of the observations are dropped, with the sample reducing to 144'565 observations.[12] I use a higher threshold for staff expense and value-added (its derivative), because these data are of particularly bad quality. By inspecting the dataset, it is easy to find observations with wrong placement of the decimal separator producing errors of magnitude of up to 1000. Using the indicated threshold results in a subsample with minimal growth rates of LabPay of ca. −60%.

[11] From here on the percentage of filtered data refers to individual filter impact, not conditional on other filters within the filtering step, and can therefore potentially sum to over 100%.

[12] Technically, I trim less observations than indicated because remaining missing values count to the indicated threshold.

Finally, because identifying the effects of permanent shocks requires computing leads and lags of the log-differences, I only keep firms with at least 4 observations, or 91.73% of the sample – down to 132'616.

Since some companies in the data change the end of their fiscal years (`fyr`), the `gvkey-fyear` keys do not uniquely identify observations in the resulting sample. Therefore, for such companies I first apply all needed variable transformations (such as yearly growth rates), using information from both old and new fiscal year accounts and then drop the new one for the fiscal years with both observations. The resulting panel is then uniquely identified by the `gvkey-fyear` pair. 0.04% of observations (55 firms) are affected, yielding the final sample of 132'561 firm-year observations, or 40.16% of the very first sample.

Finally, I convert all data from reporting currency (`curcd`) to euros using the *Compustat* monthly exchange rate table `exrt_mth`. The flow data are converted using the exchange rates for the last n months, where n corresponds to period duration (`pddur`); stock data are converted using the end of month exchange rates.

The summary statistics of the resulting data can be found in Table 4.1. Given a relatively large number of countries in the sample, I pool all observations. To get a sense of how observations are distributed among individual countries, Figure 4.2 plots the evolution of the number of firms by country, sorted by the number of firms in 2019. One can see, that many firms were added to the data in 2005, with there being no observations for some countries before. Because of this, I also repeated the firm-level empirical analysis using 2005 as a starting year. All results remain both qualitatively and quantitatively similar.

4.3.2 Data Eurostat

For the country-level analysis I extract data from annual *Eurostat* non-financial transactions sectoral accounts (`nasa_10_nf_tr`) and, for some background checks, financial transactions sectoral accounts (`nasa_10_f_tr`). Monthly price data comes from table `prc_hicp_midx` and population data from table `nama_10_pe`.

The data for non-financial transactions are only available for the European countries listed above less Switzerland, which I use as a primary country sample in the subsequent empirical analysis (henceforth, Europe-25).

Since the majority of data starts in 1999, I use this date as a starting point for the main sample.[13]

[13] While for some countries data is available from 1996 and before, I prefer 1999 also because it marks the introduction of the euro in core eurozone countries.

The sectoral accounts data are defined for the following aggregate country-sectors: total economy (`S1`), non-financial corporations, or simply "firms" (`S11`), financial corporations (`S12`), general government (`S13`), households and non-profit institutions serving households (NPISHs), or simply "households" (`S14_S15`), and rest-of-the-world (`S2`).

In the empirical analysis, the following variables are used: `p1` (`Output` – output), `p4` (`Cons` – actual final consumption), `p51g` (`Invest` – gross fixed capital formation), `d1` (`LabPay` – compensation of employees), `d41` (`Int` – interest), `d42` (`DivPay` – distributed income of corporations), `d43` (`Reinvest` – reinvested earnings on foreign direct investment), `b1g` (`ValAdd` – gross value added or GDP), `b2a3g` (`OpInc` – gross operating surplus and gross mixed income), `b5g` (`Inc` – gross balance of primary incomes or GNI), `b7g` (`DispInc` – adjusted gross disposable income), `b8` (`Saving` – gross saving). These definitions imply that $\texttt{Cons} \approx \texttt{DispInc} - \texttt{Saving}$, with the approximation coming from a small influence of adjustment for the change in pension entitlements (`d8` – `PensionAdj`). In some non-reported variations of the baseline, I also use `f5` (`Equity` – transactions in equity and investment fund shares) from financial transactions accounts.

All data are in million euros (`unit` = `CP_MEUR|MIO_EUR` for non-financial and financial transactions, respectively), and is consolidated (`co_nco` = `CO`) where appropriate (e.g., for financial transactions data). Since in the European system of accounts (ESA2010) the distributed income of corporations (`d42`) is defined to include reinvested earnings on foreign direct investment (`d43`), I define adjusted (actually declared) "dividends" as $\texttt{DivPay}^{\texttt{paid}}_{adj} = \texttt{DivPay}^{\texttt{paid}} - \texttt{Reinvest}^{\texttt{recv}}$. Note also, that all variables are reported on both sides of the balance sheets, as either "paid" (`paid`) or "received" (`recv`). Thus, for example, when referring to compensation of employees, I implicitly mean $\texttt{LabPay}^{\texttt{paid}}$ as paid by firms and $\texttt{LabPay}^{\texttt{recv}}$ as received by households.

In some regressions I also study the response of *real* consumption to various shocks. For this purpose, I take monthly price indices, `cp00` (`HICP`, all-items HICP) with base year 2015, average them up to the annual frequency and normalize to one in 2015. The real consumption is then defined as a ratio of nominal consumption to this price index.

There are 500 non-missing observations in total, with no particular filters are applied to these data. The summary statistics of the Eurostat data can be found in Table 4.2.

Finally, for the analysis in section 4.6, I link the firm-level *Compustat* data to the country-level *Eurostat* by `fyear-year` and `loc-geo` keys.

4.4 Risk Sharing within the Firm

The main research question of the current study asks about the role of the firm in the transmission of productivity shocks to household consumption with a particular emphasis on labor and equity payout risk. In this section I explore how labor expenses and equity payout react to firm-level idiosyncratic output and value-added shocks and thus explore how risk is shared between workers and shareholders within the firm.

As described in the Data section above (see Section 4.3.1), the main baseline sample used in the firm-level analysis below consists of over 130'000 firm-year observations across 28 advanced economies in Europe and North America between 1999 and 2019.

4.4.1 Econometric Model

The empirical methodology below is largely adapted from Guiso, Pistaferri and Schivardi (2005), who study the relationship between the residual component of individual wage growth and idiosyncratic shocks to firm performance (see also Fagereng, Guiso and Pistaferri (2017)). In particular these two papers show how one can identify permanent and transitory effects of firm-level productivity shocks on labor compensation without using data-expensive techniques of permanent-transitory decomposition common in time series analysis. Although the original papers work with matched employer-employee data, the general procedure can be extended to a typical firm panel, as shown below (see also Ellul, Pagano and Schivardi (2017)).[14]

I start by assuming the following process for the log of productivity for firm i in sector s, country c and year t, which I denote by $\ln Z_{it}$ and which can be proxied by sales or value-added:

$$\ln Z_{it} = \mathbb{X}_{it}'\varphi + \mu_i + \mu_{c(s)t} + f_{it}, \tag{4.1}$$

where $\mathbb{X}_{it}$ is a vector of controls affecting firm performance, μ_i is a firm fixed effect and $\mu_{c(s)t}$ is a country-time or a country-sector-time fixed effect[15]. The residual from this equation, f_{it}, is further assumed to be a sum of a transitory shock component, f_{it}^T, and a random walk component, Q_{it}, the latter driven by a permanent shock f_{it}^P, namely:[16]

$$f_{it} = Q_{it} + f_{it}^T. \tag{4.2}$$

$$Q_{it} = Q_{it-1} + f_{it}^P. \tag{4.3}$$

[14] The main drawback of working with non-matched data is that idiosyncratic shocks are less robustly identified, since one cannot project out firm-time fixed effects. However, the benefits of the matched data do not extend to additional firm outcomes, such as dividends, equity payout, investment, etc.

[15] In regressions below I will use firm and country-time fixed effects as a baseline and firm and country-sector-time fixed effects in robustness checks. The problem with the latter is that in many countries there is only one sector-time observation such that up to 50% of the effective data sample gets lost.

[16] Following Ellul, Pagano and Schivardi (2017) and Fagereng, Guiso and Pistaferri (2017), the setup above is a simplification of the original methodology, since it does not consider AR(1) and MA(1) components in the process specifications above (but is simpler to interpret).

A firm outcome, y_{it}, (e.g., staff expense, dividends, or investment) is assumed to respond to persistent and transitory shocks with different sensitivities, β^P and β^P, respectively:

$$y_{it} = \beta^P f_{it}^P + \beta^T f_{it}^T + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{c(s)t} + \psi_{it}, \tag{4.4}$$

where, as before, $\mathbb{X}_{it}$ is a vector of controls (potentially different from but, practically, equal to the controls in equation 4.1), μ_i is a firm fixed effect and $\mu_{c(s)t}$ is a country-time or country-sector-time fixed effect; and ψ_{it} is an idiosyncratic shock to firm outcomes uncorrelated with f_{it}^P and f_{it}^T.

The ultimate goal of the whole procedure is to estimate the pass-through coefficients β^P and β^T. This can be done in two steps.[17]

First, one estimates the following regression, based on taking first-difference of equation 4.1:

$$\Delta \ln Z_{it} = \Delta\mathbb{X}_{it}'\varphi + (\mu_i) + \Delta\mu_{c(s)t} + g_{it}, \tag{4.5}$$

where the residual g_{it} denotes the unexplained growth in firm performance and is to be saved for re-use in the next step. The firm fixed effects are surrounded by parentheses, because the existing approach in the literature seemingly prefers to estimate the equation 4.5 without them, and thus takes the differencing step literally. I find that dropping firm fixed effects in equation 4.5 leads to a non-robust specification in a sense that the calculated residuals contain the influence of firm-specific characteristics affecting the growth rates of firm outcomes (as opposed to *levels*). In non-reported results, I repeated the whole analysis without using firm fixed effects at this stage and found that the results get noisier and less consistent across different samples, primarily because the first stage of the IV regressions described below becomes weaker.

Second, one estimates the following regression using the residual g_{it} from the first step by applying two different IV specifications:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + (\mu_i) + \mu_{c(s)t} + \varepsilon_{it}, \tag{4.6}$$

where y_{it} is (the log of) an outcome variable; $\mathbb{X}_{it}$, μ_i and $\mu_{c(s)t}$ are defined as before; and β is (one of) the pass-through coefficient.

If equation 4.6 is estimated with simple OLS, the resulting elasticity measures the combined effect of permanent and transitory components, defined in equations 4.2, 4.3 and 4.4. The

[17] The original framework consists of three steps. But, because we deal with firm-level (as opposed to matched firm-employee) data in the current setup, the second and the third steps can be merged: one does not have to separately calculate the unexplained growth of firm outcomes (e.g., wages) since this can be done by including relevant controls and fixed effects into the IV regressions.

insight of Guiso, Pistaferri and Schivardi (2005) is to prove that the elasticity with respect to the permanent shock can be obtained by instrumenting g_{it} in equation 4.6 with $(g_{it-1} + g_{it} + g_{it+1})$, and the elasticity with respect to the transitory shock by instrumenting g_{it} with g_{it+1} (and the respective powers).

4.4.2 Results

The results of the baseline application of this procedure on a full country sample defined above between 1999 and 2019 can be found in Table 4.3. This specification uses firm value-added as a proxy for firm performance and traces the effect of combined, permanent and transitory shocks on (1) labor compensation, (2) wages, (3) number of employees, (4) operating income, (5) dividends, (6) equity payout and (7) fixed capital expenditure. The regressions use firm and country-time fixed effects, with standard errors (in parentheses) clustered by country.[18]

Consistent with the findings in the existing literature, I find that employee labor income is well but not perfectly insured against transitory idiosyncratic shocks to firm value-added (with a pass-through rate of 22%), and worse but still substantially insured against the permanent shocks (with a pass-through rate of 42%); the total effect amounts to 27%. By further decomposing labor expenses into the intensive and extensive margin—wages and employment—I conclude that firms mostly adjust wages in response to transitory shocks (37%/7%), and the number of employees in response to permanent shocks (36%/ − 9%).

Operating income reacts strongly to both transitory and permanent shocks, with a pass-through coefficient of 2.22. However, this strong reaction is not resembled one-to-one in the dynamics of dividends and total equity payout. While dividends and total payout are strongly pro-cyclical in general (combined pass-through coefficient of 72% and 75% respectively), this positive effect is entirely driven by the reaction to permanent shocks (113% and 116%, respectively), with the elasticity to transitory shocks being small, negative and insignificant. As mentioned before, this finding is in line with main conclusions from the literature on corporate payout policy.

For reference, I also report the response of firm investment in fixed assets in the last column, where one can see that the overall positive elasticity of 42% is driven entirely by firms adjusting their capital expenditures in response to permanent shocks only (97%).

[18] I also experimented with other clustering specifications, for example, two-way clustering by country and year. Most results remain significant, but in some samples this technique results in non-positive variance-covariance residual matrix. While restricting negative eigenvalues to zero solves the problem (but leads to very high standard errors), I take this issue as a sign that this way of error clustering should be done with caution using the current dataset. On the other hand, clustering by industry is problematic for the same reason I am not using sector-time fixed effects in this type of analysis: many sectors consist of only one or a few firms in most countries in the sample.

Note that since the responses of dividends, total equity payout and investment to transitory shocks are all negligible, while that of the total operating income are large and significant, there must be some other margin of adjustment on firm balance sheets that they utilize to deal with the transitory shocks (probably debt or retained earnings). While it is interesting to pursue this line of investigation further, the focus of the current paper lies in uncovering the impact of firm-level shocks on the components of income directly relevant to households, and is thus delegated to future research.

All results presented in this section are extremely robust concerning the relevance of the instrument for both instrumented variables. The relevant F-statistics from the first stage regressions relating to the identification of permanent effects are all in the range of $500 - 1300$, while those relating to identification of transitory effects are in the range of $70 - 240$.

Finally, regressions using sales as a proxy for firm productivity deliver qualitatively and quantitatively similar results, see Table 4.4. All results from the prior estimations go through and even get more pronounced, not least because there are less observations lost due to bad data coverage of staff expenses as a component of value-added. In particular, compensation of employees only reacts to the permanent changes in sales (with a pass-through coefficient of 53%) and insignificantly so to the transitory component, suggesting perfect insurance of labor income to idiosyncratic firm sales shocks. Wages still react strongly but only to the transitory component, while employment reacts strongly positively to the permanent component and negatively to the transitory one.[19] Operating income does no longer significantly react to transitory shocks, while dividends and investment react significantly *negatively* to them, and total payout positively but insignificantly.

While the latter finding might be surprising at first glance, it is consistent with standard business cycle models, which predict counter-cyclical firm dividends due to the fact that firms pursue the interest of their shareholders who want to maintain a steady consumption profile across booms and recessions. The no-reaction of total payout, on the other hand, signals positive reaction of share repurchases, which is consistent with the "substitution" hypothesis (Jagannathan, Stephens and Weisbach (2000)) and evidence that firms prefer share repurchases as a means of passing large transitory shocks to their shareholders (Brav et al. (2005)).

Overall, the findings above suggest that firms play an important role in insuring workers against both transitory and permanent shocks to firm value-added and sales and that firm owners are substantially insured against transitory shocks via dividends payments.

[19] This result is not immediately intuitive to me and will be explored further in the future.

Robustness

Results for four alternative samples—Europe-25, Europe-10, Europe-14, and Europe-14-plus—are documented in the Appendix, Tables 4A.1–4A.8. Specifications utilizing country-sector-time instead of country-time fixed effects can be found in Tables 4A.9–4A.10. Given the fact that year 2005 marks a huge increase in the number of firms in the sample for many European countries (see Figure 4.2), results for an alternative time sample 2005–2019 are provided in Tables 4A.11–4A.12. Qualitatively similar conclusions are reached throughout all alternative specifications. Other combinations of the alternative specifications above as well as some other unreported findings are available on request.

4.5 Risk Sharing within the Country and between Sectors

In this section I move the focus of the analysis from individual firms to individual countries and study how shocks to the *aggregate* firm sector transmit to households' balance sheets. As outlined above (see Section 4.3.2), I do so by examining the patterns in the *sectoral* accounts data from *Eurostat*. This analysis is similar in nature to the international risk sharing literature, but differs from it in two important ways. First, the units of the analysis are not countries in general but country-sectors: non-financial firms and households; and second, I consider how firm productivity shocks affect household consumption through two different income channels: employees' compensation and dividends.

4.5.1 Econometric Model

To this aim, I reapply the methodology used in the firm-level analysis for country-sectors. In particular, I trace combined, permanent and transitory effects of shocks to aggregate firm sector performance and income components on various firm-sector and household-sector outcomes. The baseline regression model then looks as follows:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct}, \tag{4.7}$$

where c indexes countries and t denotes years; μ_c is a country fixed effect and μ_t is a year fixed effect; y_{ct} is (the log of) the outcome variables defined below; and the residual g_{ct} measures the unexplained growth in one of the aggregate firm-sector performance and income indicators. The regression parameter β is interpreted as a shock pass-through coefficient. Then, following the reasoning from the previous section, the combined effect of all shocks can be estimated with simple OLS, permanent effects by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$, and transitory effects by instrumenting g_{ct} with g_{ct+1}.

While I stick to the methodology from the previous exercise, it should be noted, that permanent-transitory distinction is harder to make with a relatively small country-year panel data that is used in the current analysis.[20] One should therefore consider simple OLS results referring to the estimates of the combined pass-through coefficients as a baseline, while the results for the elasticities due too permanent and transitory shocks as useful points of reference.

4.5.2 Results

Table 4.5 reports the first set of results obtained from applying model 4.7 to shocks to the log of the firm sector value-added, in a sample of Europe-25 countries between 1999 and 2019. Standard errors are clustered by countries and reported in parentheses.

Starting with the estimates of the analogue to the classical consumption risk-sharing coefficient in Table 4.5, column (7), one can see that the aggregate household consumption is shielded from 41% of the shocks to the aggregate firm value-added, which is in line with findings in the existing literature (see, for example, Hoffmann et al. (2019)). Column (8) shows that the distinction between nominal and real consumption is not of large importance, as the reaction in consumer prices contributes to smoothing only ca. 2% of the original shock.

What drives this aggregate sensitivity of consumption is a composite influence of three forces: how aggregate productivity shocks affect various firm-sector income components, how, conditional on these patterns, the respective household income components react to changes in their firm-level counterparts (extensive margin), and how household consumption reacts to shocks to different components of their income (intensive margin).

To get a sense of magnitude for the size of the firm risk remaining uninsured through various income types within the firm sector itself, consider the results in Table 4.5, columns (1)–(3). With the pass-through coefficient of 73%, there is evidence of only minor labor income insurance taking place at this level. On the other hand, one can see that operating income and dividends react very strongly to firm-sector value-added shocks, as both estimates exceed one. This finding is not surprising, since the analysis with the firm-level data is conceived to measure the impact of *idiosyncratic* firm shocks, while the aggregate dynamics is driven by *common* shocks. Clearly, aggregate shocks are harder to insure against both from an individual firm's perspective, and economy as a whole. Note also, that the reaction of aggregate dividends is *still* entirely driven

[20]One can also see that the estimates of the combined effect no longer lay between the estimates of the responses to permanent and transitory shocks, emphasizing large effects of sample reduction on parameter estimates.

by the influence of permanent shocks. This is probably the most robust and important finding from permanent-transitory distinction in this exercise.

Results in Table 4.5, columns (4)–(6), provide tentative evidence that firm performance shocks affect the response of households labor income with the same or even larger magnitudes as the respective firm-sector outcomes, while there is a substantially lower effect on household dividend income. The total primary household income reacts to 65% of the original firm-value added shock, while between 6% and 16% of the firm-sector value-added risk is smoothed through state taxation and subsidies, household saving and bank credit (cf. columns (6) and (7)).

To further shed light onto the separate role played by the labor income risk, Tables 4.6 and 4.7 study how household labor income reacts to shocks to firm labor expenses (extensive margin) and how household saving and consumption react to changes in household labor income (intensive margin), respectively.

The results in Table 4.6 confirm the findings from the previous sub-section: a 1% shock to firm-sector labor expense leads to an adjustment of the household labor income by 0.90%, primary income by 0.78%, disposable income by 0.71%, and consumption by 0.69%. Thus, approximately 7% of this risk is insured through taxes and governmental transfer schemes and 2% through household saving. The large elasticity of saving (1.57) can be attributed to the fact that saving make only a small share in total disposable household income (see Figure 4.1).

The findings in Table 4.7 make the picture complete, as they show how household saving and consumption react to that portion of labor income risk originating within the firm sector, that reaches their balance sheets—the internal margin of adjustment. In particular, as witnessed from column (4), consumption reacts by 0.78% to every 1% change in household labor income, only 0.1% less than the reaction of the total primary household income, see column (1). As before, due to the low saving rate, the coefficient in column (3) is large at 2.

Taken together, the results above highlight the importance of the wage insurance taking place within the firm, as 70% of the risk left uninsured on the level of individual firms and the firm sector is transmitted to household consumption. Lack of insurance on the between-sector dimension amounts to ca. 90% of the transmission (extensive margin), while the on-balance sheet lack of insurance within the household sector amounts to ca. 80% of the transmission (intensive margin).

For dividends, the overall picture is different. As seen in Tables 4.8 and 4.9, the combined effect of firm-sector dividend risk for household consumption is almost negligible at 2%, see Table 4.8, column (5). This number can be decomposed into the approximate contribution of the extensive margin, at ca. 50%, see Table 4.8, column (1), and the intensive margin, at ca. 2%, see Table 4.9, column (4).

Thus, not only is the shock to firm dividends largely diversified away on the way to household balance sheets, it is easier than shocks to labor income to smoothen through saving and credit.

While two crucial components of household income—compensation of employees and dividends—originate on the balance sheets of the firm sector, its other component—"entrepreneurial" income—also contributes significantly to total fluctuations of primary household income, especially in some countries, e.g. Greece and Italy (see Figure 4.1). While there is no way to study the role of the entrepreneurial income in the complete framework of the current paper, since by definition this type of risk originates in the *non-corporate* sector, using the data from aggregate household accounts allows me to at least quantify the importance of this background risk for aggregate household consumption.

Table 4.10 reports the results of this exercise. As expected, a significant fraction of the shocks to entrepreneurial income (54%) is passed on to household consumption, see column (4).

Robustness

Table 4A.13 in the Appendix reports the results for the case, where a firm performance shock is measured by total firm output rather than value-added. The findings are qualitatively and quantitatively similar to the baseline findings. Coefficients in Table 4A.13 and generally larger than for in the baseline, consistent with the explanation that, other things equal, a larger value of the shock variable leads to higher measure pass-through coefficient. A number of additional results for alternative country samples (e.g., Europe-10 and Europe-14) and time samples (e.g., 2005–2019), are available upon request. All baseline results go through, but one can observe a reduction in the precision of the estimates due to sample reduction, particularly for the Europe-10 sample.

4.6 Risk Sharing within the Country and between Sectors: Firm-Level Identification

The results so far shed light onto micro and macro-patterns of the shock transmission from firms to labor income and dividends, all the way to household consumption. One issue with the procedure in step two, common to much of the macroeconomic literature in general, is that it measures the reduced form combined effect of *all* shocks causing firm productivity, labor income, dividends, and consumption to co-move. Such results must be interpreted with caution, especially in countries and times dominated by alternative (non-productivity) shocks.[21]

The procedure adopted in the current section allows to partially deal with this issue. In particular, it requires a combination of firm-level microeconomic data and sectoral accounts macroeconomic data in order to construct an instrument for the shock variables used in the prior analysis. For this purpose, I apply a simple version of the approach developed by Gabaix and Koijen (2019), summarized below.

4.6.1 Econometric Model

Gabaix and Koijen (2019) develop a framework which allows one to identify the causal effects of one macroeconomic variable on another by exploiting the granular nature of the underlying microeconomic data in a particular instrumental-variables (IV) setting. A simple variant of their approach can be re-formulated as follows.

Assume a data generating process for an aggregate macroeconomic outcome (e.g., household income or consumption), as in equation 4.7 (repeated below for convenience):

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct}.$$

If g_{ct} and ε_{ct} are still correlated with each other after factoring out country- and time-invariant disturbances, than the coefficient β, estimated with OLS or with Guiso, Pistaferri and Schivardi (2005) methodology (permanent and transitory effect identification) would be biased.

Suppose that this is in fact true and that there is η_{ct} such that $\mathbb{E}\left[\eta_{ct} g_{ct}\right] \neq 0$ and $\mathbb{E}\left[\eta_{ct} \varepsilon_{ct}\right] \neq 0$. Since g_{ct} is a country-wide measure of output, value-added, or another *aggregate* variable, we can write it as $g_{ct} \coloneqq g_{Sct} \equiv \sum_i S_{ict-1} g_{ict}$, where S_{ict-1} are properly defined weights, e.g., if $g_{ict} = \Delta \log \texttt{ValAdd}_{ict}$, than $S_{ict-1} = \texttt{ValAdd}_{ict-1}$ (all summations should be understood as on the by-country-time basis). Then, a simple process for g_{ict} can be written follows (ignoring fixed effects for the moment):

$$g_{ict} = \eta_{ct} + u_{ict}, \tag{4.8}$$

where u_{ict} denote idiosyncratic firm-level shocks. When aggregating this equation up on a by-country basis, we have:

$$g_{Sct} = \eta_{ct} + u_{Sct}, \tag{4.9}$$

[21] See also discussion and simulation results in (Hoffmann et al., 2019).

where the residual is a weighted sum of firm-level residuals: $u_{Sct} := \sum_i S_{ict-1} u_{ict}$. Define further an equally weighted residual u_{Ect} and an equally weighted firm outcome g_{Ect} as $u_{Ect} := \sum_i^N \frac{1}{N} u_{ict}$ and $g_{Ect} := \sum_i^N \frac{1}{N} g_{ict}$, respectively. The two can be easily shown to be related as follows:

$$g_{Ect} = \eta_{ct} + u_{Ect}, \tag{4.10}$$

Then, as proved by Gabaix and Koijen (2019), $z_{ct} := g_{Sct} - g_{Ect} = u_{Sct} - u_{Ect}$ is a valid instrument for g_{ct} in equation 4.7, as it satisfies $\mathbb{E}\left[z_{ct}\varepsilon_{ct}\right] = 0$ (exogeneity) and $\mathbb{E}\left[z_{ct} g_{ct}\right] \neq 0$ (relevance).

Practically, the procedure can be performed in three steps.

First, estimate the idiosyncratic firm disturbances g_{ict} using a model in equation 4.5, i.e. project out controls (e.g., changes in lagged firm size, leverage, and tangibility) and fixed effects (firm and country-sector-time) from the log-differences of the shock variable (sales, value-added, labor expense and dividends).

Second, construct *granular residuals* $z_{ct} := g_{Sct} - g_{Ect}$, using weights defined above. Note, that at this stage the microeconomic dataset gets collapsed onto the country-year level.

Finally, estimate the coefficient β in equation 4.7 using z_{ct} as an instrument for g_{ct}. Note, that technically, one can also estimate the effects of transitory and permanent shocks on y_{ct}, since if z_{ct} as a valid instrument for g_{ct}, than z_{ct+1} as a valid instrument for g_{ct+1} and $z_{ct-1} + z_{ct} + z_{ct+1}$ as a valid instrument for $g_{ct-1} + g_{ct} + g_{ct+1}$. Consequently, the pass-through coefficients with respect to the two types of shocks of different persistence nature can be estimated in a two-step IV procedure as before. The results below contain estimates for all types of shocks described above, with the procedure measuring the combined effect of all shocks as a baseline.

4.6.2 Results

The procedure above is used to provide alternative estimates for regressions in Tables 4.5, 4.6, 4.8, and 4A.13. To this end, I use firm-level data on value-added to construct an instrument for firm sector data on value-added, firm-level data on sales for firm sector data on output, firm-level data on staff expense for firm sector data on labor expenditures, and firm-level data on dividends for firm sector data on (adjusted) dividends.

The analysis is performed on the baseline sample of countries used with the macroeconomic data (Europe-25) for the time period 1999–2019.

Having run some preliminary models, I have found out that using firm and country-*sector*-time fixed effects yields the best first stage (despite reducing the sample due to relatively many single-firm-sectors in the data). As controls, I use log of firm size, as proxied by the book value of assets, leverage (sum of debt in current liabilities and long-term debt over assets) and tangibility (ration of property plant and equipment to assets).

Admittedly, the results for the first stage regressions turn out to be rather weak, as witnessed by the estimates of the standard errors in column (1) in respective tables. Out of four shock-instrument pairs, only labor payout regressions yield a mildly strong first stage (although still with an F-statistic at only around 4). Given this fact, I only focus on the results from this model in the main text, see Table 4.11. The other three sets of result (value-added, output, and dividends) can be found in the Appendix, see Tables 4A.14–4A.16.

As seen in Table 4.11, fluctuations in the uninsured portion of firm labor payments have a very strong impact on aggregate household wages (extensive margin), with a pass-through coefficient of 97%, see column (2), total primary income (86%), see column (3), and consumption (98%), see columns (6) and (7). All these coefficients are strongly statistically different from zero but not different from one. Overall, these findings confirm the previous result throughout the paper that the uninsured component of firm labor compensation is entirely transmitted to households income and consumption. Moreover, one can observe the doubling of elasticities in reaction to permanent shocks only, which, as opposed to transitory shocks, are well identified (first stage F-statistics of above 30).

Regarding the non-significance of other results, a plausible explanation relates to the following two factors. First, the firm-level dataset is based on fiscal years, while the national accounts data uses calendar years. While one could use quarterly data from both sources to alleviate the timing mismatch, higher frequency data have lower quality and, as mentioned before, introduces timing problems for dividends. This observation can potentially explain an overall weak first stage, i.e., also for wage regressions. A potentially more important concern is the mismatch between the boundaries of the firm and the national economies. Firms in the *Compustat* dataset are all large and usually report their financial results on a consolidated basis. Thus, a globally active firm located in one country reports sales, operating income, dividends and other financial statistics based on its operations in all countries. In such case, while the procedure above can still lead to correct results, the power of the instrument can decrease dramatically. Interestingly, this explanation is consistent with the fact that the first stage of the labor expense-related regressions is the strongest. While internationally active firms can generate sales and income abroad easily, employees usually work and earn wages within the national boundaries. An interesting avenue for future research would be to address these two explanations using supplementary data and strengthen the validity of the instruments to pin down the transmission of shocks to firm value-added, sales and dividends.

4.7 Conclusion

In this paper I developed a thesis that the way firms share income between workers and shareholders is of first-order importance for the overall patterns of risk sharing in the economy. I did so by using a combination of firm-level data from *Compustat* and sectoral accounts data from *Eurostat* on a panel of advanced economies from 1999 to 2019.

I found that fluctuations in consumption are primarily driven by shocks to household labor income and shielded from shocks to household dividend income. While the former are entirely driven by the dynamics of firm-sector labor compensation, there is little evidence that household dividend income follows firm sector dividend payout. Thus, firms play a pivotal role in providing consumption insurance to households by shifting risk from workers to shareholders, as they insure workers from transitory and permanent shocks to their output and value-added, while shareholders are only insured from temporal but not from persistent shocks.

I conclude that risk sharing patterns on the macroeconomic level are crucially shaped by the risk sharing within the firm. The main policy implication of this thesis therefore implies the need to target firm-related outcomes and general firm payout policy directly, if households are to be *effectively* insulated from the fluctuations in idiosyncratic and economy-wide shocks to firm output. An example of such policies implemented recently has been the introduction of furlough and other related schemes in many countries around the globe, including the United States and Europe, as a response to the covid-19 pandemic. While time and future research will show how effective these policies have been, the preliminary evidence does point to significant positive effects concerning the response of the unemployment rate. Interestingly, countries often supplement furlough policies with covenants that forbid affected firms and banks to pay out dividend to their shareholders or implement share repurchase plans. Again, as the current analysis shows, such an external shift in corporate payout policies on the level of individual firms is probably the right thing to do as it stabilizes the channel through which risk affects household income and consumption the most.

References

Andres, Christian, Markus Doumet, Erik Fernau, and Erik Theissen. 2015. "The Lintner model revisited: Dividends versus total payouts." *Journal of Banking & Finance*, 55: 56–69.

Artis, Michael J., and Mathias Hoffmann. 2008. "Financial Globalization, International Business Cycles and Consumption Risk Sharing*." *The Scandinavian Journal of Economics*, 110(3): 447–471.

Artis, Michael J., and Mathias Hoffmann. 2011. "The Home Bias, Capital Income Flows and Improved Long-Term Consumption Risk Sharing between Industrialized Countries." *International Finance*, 14(3): 481–505.

Asdrubali, Pierfederico, Bent E Sørensen, and Oved Yosha. 1996. "Channels of Interstate Risk Sharing: United States 1963-1990." *The Quarterly Journal of Economics*, 1081–1110.

Azariadis, Costas. 1975. "Implicit Contracts and Underemployment Equilibria." *Journal of Political Economy*, 83(6): 1183–1202.

Baily, Martin Neil. 1974. "Wages and Employment under Uncertain Demand." *The Review of Economic Studies*, 41(1): 37–50.

Becker, Sascha O., and Mathias Hoffmann. 2006. "Intra- and international risk-sharing in the short run and the long run." *European Economic Review*, 50(3): 777–806.

Brav, Alon, John R. Graham, Campbell R. Harvey, and Roni Michaely. 2005. "Payout policy in the 21st century." *Journal of Financial Economics*, 77(3): 483–527.

Budd, John W., Jozef Konings, and Matthew J. Slaughter. 2005. "Wages and International Rent Sharing in Multinational Firms." *Review of Economics and Statistics*, 87(1): 73–84.

Canova, Fabio, and Morten O. Ravn. 1996. "International consumption risk sharing." *International Economic Review*, 37(3): 573–601.

Carvalho, V, and X. Gabaix. 2013. "The Great Diversification and Its Undoing." *American Economic Review*, 103(5): 1697–1727.

Carvalho, Vasco M., and Basile Grassi. 2019. "Large Firm Dynamics and the Business Cycle." *American Economic Review*, 109(4): 1375–1425.

Coeurdacier, Nicolas, and Hélène Rey. 2013. "Home Bias in Open Economy Financial Macroeconomics." *Journal of Economic Literature*, 51(1): 63–115.

Covas, Francisco, and Wouter J. Den Haan. 2011. "The Cyclical Behavior of Debt and Equity Finance." *American Economic Review*, 101(2): 877–899.

Demyanyk, Yuliya, Charlotte Ostergaard, and Bent E. Sørensen. 2007. "U.S. Banking Deregulation, Small Businesses, and Interstate Insurance of Personal Income." *The Journal of Finance*, 62(6): 2763–2801.

Demyanyk, Yuliya, Charlotte Ostergaard, and Bent E. Sørensen. 2008. "Risk Sharing and Portfolio Allocation in EMU." European Economy 334.

di Giovanni, Julian, Andrei A. Levchenko, and Isabelle Mejean. 2014. "Firms, Destinations, and Aggregate Fluctuations." *Econometrica*, 82(4): 1303–1340.

di Giovanni, Julian, Andrei A. Levchenko, and Isabelle Mejean. 2018. "The Micro Origins of International Business-Cycle Comovement." *American Economic Review*, 108(1): 82–108.

Ellul, Andrew, Marco Pagano, and Fabiano Schivardi. 2017. "Employment and Wage Insurance within Firms: Worldwide Evidence." *The Review of Financial Studies*, 31(4): 1298–1340.

Fagereng, Andreas, Luigi Guiso, and Luigi Pistaferri. 2017. "Portfolio Choices, Firm Shocks, and Uninsurable Wage Risk." *The Review of Economic Studies*, 85(1): 437–474.

Fama, Eugene F, and Kenneth R French. 2001. "Disappearing dividends: changing firm characteristics or lower propensity to pay?" *Journal of Financial Economics*, 60(1): 3–43.

Favilukis, Jack, and Xiaoji Lin. 2016. "Does wage rigidity make firms riskier? Evidence from long-horizon return predictability." *Journal of Monetary Economics*, 78: 80–95.

Gabaix, Xavier. 2011. "The Granular Origins of Aggregate Fluctuations." *Econometrica*, 79(3): 733–772.

Gabaix, Xavier, and Ralph S.J. Koijen. 2019. "Granular Instrumental Variables." Available at SSRN: https://ssrn.com/abstract=3368612.

Grullon, Gustavo, and Roni Michaely. 2002. "Dividends, Share Repurchases, and the Substitution Hypothesis." *The Journal of Finance*, 57(4): 1649–1684.

Guiso, Luigi, and Luigi Pistaferri. 2020. "The insurance role of the firm." *The Geneva Risk and Insurance Review*, 45(1): 1–23.

Guiso, Luigi, Luigi Pistaferri, and Fabiano Schivardi. 2005. "Insurance within the Firm." *Journal of Political Economy*, 113(5): 1054 – 1087.

Guiso, Luigi, Luigi Pistaferri, and Fabiano Schivardi. 2013. "Credit within the Firm." *Review of Economic Studies*, 80(1): 211 – 247.

Hartman-Glaser, Barney, Hanno Lustig, and Mindy Z. Xiaolan. 2019. "Capital Share Dynamics When Firms Insure Workers." *The Journal of Finance*, 74(4): 1707–1751.

Heathcote, Jonathan, and Fabrizio Perri. 2004. "Financial Globalization and Real Regionalization." *Journal of Economic Theory*, 119(1): 207–243.

Heathcote, Jonathan, and Fabrizio Perri. 2013. "The International Diversification Puzzle Is Not as Bad as You Think." *Journal of Political Economy*, 121(6): 1108–1159.

Hoffmann, Mathias, and Iryna Shcherbakova-Stewen. 2011. "Consumption Risk Sharing over the Business Cycle: The Role of Small Firms' Access to Credit Markets." *Review of Economics and Statistics*, 93(4): 1403–1416.

Hoffmann, Mathias, Egor Maslov, Bent E. Sørensen, and Iryna Stewen. 2019. "Channels of Risk Sharing in the Eurozone: What Can Banking and Capital Market Union Achieve?" *IMF Economic Review*, 67(3): 443–495.

Huang-Meier, Winifred, and Mark C. Freeman. 2015. "Aggregate dividends and consumption smoothing." *International Review of Financial Analysis*, 42: 324–335.

Huang-Meier, Winifred, Mark C. Freeman, and Khelifa Mazouz. 2015. "Why are aggregate equity payouts pro-cyclical?" *Journal of Macroeconomics*, 44: 98–108.

Jagannathan, Murali, Clifford P Stephens, and Michael S Weisbach. 2000. "Financial flexibility and the choice between dividends and stock repurchases." *Journal of Financial Economics*, 57(3): 355–384.

Javakhadze, David, Stephen P. Ferris, and Nilanjan Sen. 2014. "An international analysis of dividend smoothing." *Journal of Corporate Finance*, 29: 200–220.

Jermann, Urban, and Vincenzo Quadrini. 2012. "Macroeconomic Effects of Financial Shocks." *American Economic Review*, 102(1): 238–271.

Kalemli-Ozcan, Sebnem, Bent Sørensen, and Vadym Volosovych. 2014. "Deep Financial Integration and Volatility." *Journal of the European Economic Association*, 12(6): 1558–1585.

Kalemli-Ozcan, Sebnem, Emiliano Luttini, and Bent Sørensen. 2014. "Debt Crises and Risk-Sharing: The Role of Markets versus Sovereigns." *The Scandinavian Journal of Economics*, 116(1): 253–276.

Knight, Frank H. 1921. *Risk, Uncertainty and Profit.* Boston, MA:Houghton Mifflin Co.

Kose, M. Ayhan, Eswar S. Prasad, and Marco E. Terrones. 2009. "Does financial globalization promote risk sharing?" *Journal of Development Economics*, 89(2): 258–270.

Leary, Mark T., and Michael R. Roberts. 2014. "Do Peer Firms Affect Corporate Financial Policy?" *The Journal of Finance*, 69(1): 139–178.

Leary, Mark T., and Roni Michaely. 2011. "Determinants of Dividend Smoothing: Empirical Evidence." *The Review of Financial Studies*, 24(10): 3197–3249.

Lewis, Karen K. 1996. "What Can Explain the Apparent Lack of International Consumption Risk Sharing?" *Journal of Political Economy*, 104(2): 267–297.

Lintner, John. 1956. "Distribution of Incomes of Corporations Among Dividends, Retained Earnings, and Taxes." *The American Economic Review*, 46(2): 97–113.

Miller, Merton H., and Franco Modigliani. 1961. "Dividend Policy, Growth, and the Valuation of Shares." *The Journal of Business*, 34(4): 411–433.

Obstfeld, Maurice. 1993. "Are Industrial-Country Consumption Risks Globally Diversified?" National Bureau of Economic Research Working Paper 4308.

Pagano, Marco. 2020. "Risk Sharing Within The Firm: A Primer." Centre for Economic Policy Research Discussion Paper 15046.

Skinner, Douglas J. 2008. "The evolving relation between earnings, dividends, and stock repurchases." *Journal of Financial Economics*, 87(3): 582 – 609.

Sørensen, Bent E., and Oved Yosha. 1998. "International Risk Sharing and European Monetary Unification." *Journal of International Economics*, 45(2): 211–238.

Sørensen, Bent E., Yi-Tsung Wu, Oved Yosha, and Yu Zhu. 2007. "Home bias and international risk sharing: Twin puzzles separated at birth." *Journal of International Money and Finance*, 26(4): 587–605.

Tables and Figures

Table 4.1. Compustat Data Summary Statistics

	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
`Asset`	132,561	2.493	12.789	0.00000	0.030	0.884	728.695
`Invest`	128,604	0.140	0.790	−0.289	0.001	0.040	34.272
`DivPay`	91,019	0.063	0.397	0.000	0.000	0.012	33.870
`Emp`	99,992	9.195	41.072	0.001	0.200	4.702	2,300.000
`Leverage`	132,220	0.361	12.240	0.000	0.038	0.355	3,770.000
`OpInc`	132,358	0.292	1.557	−14.319	0.001	0.102	103.205
`ShareRep`	94,637	0.046	0.531	0.000	0.000	0.00004	63.270
`Sale`	132,561	1.862	9.643	0.00000	0.025	0.770	466.834
`Tangibility`	132,512	0.283	0.252	0.000	0.073	0.436	2.413
`TotEqPay`	91,019	0.111	0.796	0.000	0.000	0.022	74.816
`ValAdd`	50,376	0.642	10.947	0.00000	0.010	0.227	2,389.178
`Wage`	33,614	50.842	157.671	0.00005	28.347	62.433	17,935.710
`LabPay`	50,435	0.358	10.759	0.00000	0.005	0.112	2,389.177
`OpExp`	132,485	1.571	8.409	−0.078	0.025	0.642	439.850
$\Delta \ln$ `Asset`	102,769	0.049	0.219	−0.684	−0.063	0.143	1.039
$\Delta \ln$ `Invest`	97,962	0.011	0.871	−9.173	−0.352	0.391	10.258
$\Delta \ln$ `DivPay`	31,313	0.056	0.585	−9.231	−0.027	0.192	7.218
$\Delta \ln$ `Emp`	73,672	0.022	0.145	−0.571	−0.041	0.086	0.565
$\Delta \ln$ `OpInc`	81,266	0.064	0.636	−7.762	−0.118	0.261	8.513
$\Delta \ln$ `ShareRep`	13,988	0.001	1.794	−12.351	−0.746	0.827	11.171
$\Delta \ln$ `Sale`	102,769	0.060	0.228	−0.858	−0.048	0.158	1.182
$\Delta \ln$ `TotEqPay`	38,910	0.042	1.078	−11.300	−0.143	0.301	11.573
$\Delta \ln$ `ValAdd`	36,978	0.055	0.233	−0.759	−0.056	0.167	0.883
$\Delta \ln$ `Wage`	23,412	0.021	0.154	−0.956	−0.044	0.084	1.152
$\Delta \ln$ `LabPay`	37,024	0.054	0.178	−0.603	−0.031	0.132	0.812
$\Delta \ln$ `OpExp`	102,680	0.053	0.231	−4.775	−0.048	0.150	4.598

NOTES: This table presents summary statistics for the following sample of filtered *Compustat* data between 1999 and 2019: North America: United States and Canada; Global: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdomm and Switzerland. All variables in levels are in billion euros, except `Emp` (thousands), `Wage` (thousand euros), `Leverage` (ratio), and `tangibility` (ratio). See main text Section 4.3.1 for details concerning variables definition. Source: *Compustat*.

Table 4.2. Eurostat Data Summary Statistics

	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
$\texttt{ValAdd}^{\texttt{nf}}$	500	266.050	385.259	3.154	24.826	258.763	1,935.517
$\texttt{OpInc}^{\texttt{nf}}$	500	106.380	146.311	1.417	12.652	112.023	740.798
$\texttt{OpInc}^{\texttt{hh}}$	500	78.239	114.536	0.515	6.670	68.025	417.505
$\texttt{Inc}^{\texttt{hh}}$	500	359.954	540.110	3.254	27.948	292.541	2,521.100
$\texttt{DispInc}^{\texttt{hh}}$	500	382.152	563.890	3.889	30.357	321.683	2,508.702
$\texttt{Saving}^{\texttt{hh}}$	500	39.560	69.697	−8.278	2.911	33.343	396.892
$\texttt{LabPay}^{\texttt{nf}}$	500	156.388	237.845	1.727	14.334	148.066	1,209.830
$\texttt{LabPay}^{\texttt{hh}}$	500	241.693	360.721	2.482	20.091	219.068	1,771.278
$\texttt{DivPay}^{\texttt{nf}}_{adj}$	500	42.052	68.083	−19.995	3.937	40.579	338.680
$\texttt{DivPay}^{\texttt{nf}}$	500	45.510	71.655	0.140	4.207	44.288	334.962
$\texttt{DivPay}^{\texttt{hh}}$	500	23.305	51.654	0.005	1.050	13.660	268.424
$\texttt{Output}^{\texttt{nf}}$	500	641.532	894.389	8.237	75.490	629.568	4,453.299
$\texttt{Cons}^{\texttt{hh}}$	500	350.077	509.949	3.690	28.708	297.910	2,171.482
$\texttt{Cons}^{real,\texttt{hh}}$	500	388.730	562.157	6.587	29.750	295.660	2,098.753
$\texttt{Invest}^{\texttt{nf}}$	500	58.099	79.641	0.855	6.514	60.617	405.929
$\Delta \ln \texttt{ValAdd}^{\texttt{nf}}$	475	0.047	0.067	−0.222	0.021	0.077	0.429
$\Delta \ln \texttt{OpInc}^{\texttt{nf}}$	475	0.047	0.089	−0.292	0.005	0.089	0.608
$\Delta \ln \texttt{OpInc}^{\texttt{hh}}$	475	0.035	0.067	−0.282	0.009	0.063	0.558
$\Delta \ln \texttt{Inc}^{\texttt{hh}}$	475	0.041	0.057	−0.258	0.017	0.064	0.274
$\Delta \ln \texttt{DispInc}^{\texttt{hh}}$	475	0.042	0.052	−0.208	0.018	0.062	0.234
$\Delta \ln \texttt{Saving}^{\texttt{hh}}$	440	0.038	0.344	−2.280	−0.052	0.128	1.774
$\Delta \ln \texttt{LabPay}^{\texttt{nf}}$	475	0.047	0.065	−0.318	0.019	0.076	0.345
$\Delta \ln \texttt{LabPay}^{\texttt{hh}}$	475	0.044	0.059	−0.277	0.019	0.069	0.326
$\Delta \ln \texttt{DivPay}^{\texttt{nf}}_{adj}$	464	0.066	0.268	−1.696	−0.068	0.186	1.509
$\Delta \ln \texttt{DivPay}^{\texttt{nf}}$	475	0.069	0.253	−1.591	−0.039	0.159	1.471
$\Delta \ln \texttt{DivPay}^{\texttt{hh}}$	475	0.051	0.324	−3.859	−0.038	0.132	2.197
$\Delta \ln \texttt{Output}^{\texttt{nf}}$	475	0.049	0.074	−0.282	0.016	0.085	0.271
$\Delta \ln \texttt{Cons}^{\texttt{hh}}$	475	0.042	0.052	−0.219	0.021	0.062	0.263
$\Delta \ln \texttt{Cons}^{real,\texttt{hh}}$	475	0.020	0.047	−0.251	0.004	0.039	0.199
$\Delta \ln \texttt{Invest}^{\texttt{nf}}$	475	0.038	0.132	−0.736	−0.011	0.099	0.585
$\Delta \ln \texttt{HICP}$	476	0.022	0.019	−0.027	0.011	0.030	0.131

NOTES: This table presents summary statistics for the following sample of variables in log-differences from *Eurostat* sectoral accounts data between 1999 and 2019: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom. All variables in levels are in billion euros. Superscripts refer to non-financial firms (`nf`) and households (`hh`). See main text Section 4.3.2 or *Eurostat* manual (*ESA2010*) for details concerning variables definition. Source: *Eurostat*.

Table 4.3. Shock Transmission within the Firm (Value-Added)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.27^{***}	0.15^{***}	0.14^{***}	2.22^{***}	0.72^{***}	0.75^{***}	0.42^{***}
	(0.01)	(0.01)	(0.01)	(0.03)	(0.05)	(0.05)	(0.03)
Observations	31,347	20,596	20,596	27,895	11,010	11,468	29,984
Panel B: PERMANENT							
ValAdd†	0.42^{***}	0.07^{***}	0.36^{***}	2.07^{***}	1.13^{***}	1.16^{***}	0.97^{***}
	(0.02)	(0.03)	(0.02)	(0.08)	(0.16)	(0.20)	(0.12)
Observations	16,036	10,562	10,562	14,579	6,012	6,272	15,388
F-stat (1 st.)	956.6	1209.3	1209.3	577.2	790.4	744.7	937.6
Panel C: TRANSITORY							
ValAdd†	0.22^{***}	0.37^{***}	-0.09^{**}	2.85^{***}	-0.19	-0.36	0.09
	(0.03)	(0.05)	(0.04)	(0.20)	(0.45)	(0.47)	(0.23)
Observations	22,007	14,123	14,123	19,836	8,080	8,416	21,062
F-stat (1 st.)	233.4	187.8	187.8	70.4	88.2	88.5	194.1
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. Country sample: Europe-25-plus (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom; plus Switzerland, United States and Canada). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Compustat.*

Table 4.4. Shock Transmission within the Firm (Sales)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
Sale	0.39^{***}	0.10^{***}	0.20^{***}	1.73^{***}	0.61^{***}	0.62^{***}	0.64^{***}
	(0.01)	(0.01)	(0.005)	(0.02)	(0.03)	(0.06)	(0.02)
Observations	31,385	20,607	60,771	66,295	25,791	31,404	79,642
Panel B: PERMANENT							
$\text{Sale}^{\dagger}$	0.53^{***}	0.02	0.43^{***}	1.89^{***}	0.82^{***}	0.83^{***}	1.16^{***}
	(0.02)	(0.03)	(0.01)	(0.06)	(0.09)	(0.14)	(0.06)
Observations	18,807	12,355	34,828	40,051	16,522	19,414	46,210
F-stat (1 st.)	4881.6	2826.3	3803.2	18082.6	8837.4	12468.1	5747.0
Panel C: TRANSITORY							
$\text{Sale}^{\dagger}$	0.07	0.75^{***}	-0.54^{***}	0.60	-0.91^{*}	0.29	-0.77^{**}
	(0.10)	(0.20)	(0.08)	(0.50)	(0.54)	(0.82)	(0.31)
Observations	24,326	15,610	45,030	51,248	20,530	24,450	60,259
F-stat (1 st.)	34.6	28.4	47.3	9.9	25.6	40.6	20.5
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (Sale)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. Country sample: Europe-25-plus (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom; plus Switzerland, United States and Canada). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Compustat.*

Table 4.5. Shock Transmission within the Country (Value-Added)

	(1) $\texttt{LabPay}^{\texttt{nf}}$	(2) $\texttt{OpInc}^{\texttt{nf}}$	(3) $\texttt{DivPay}^{\texttt{nf}}_{adj}$	(4) $\texttt{LabPay}^{\texttt{hh}}$	(5) $\texttt{DivPay}^{\texttt{hh}}$	(6) $\texttt{Inc}^{\texttt{hh}}$	(7) $\texttt{Cons}^{\texttt{hh}}$	(8) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED								
$\texttt{ValAdd}^{\texttt{nf}}$	0.73***	1.22***	1.13***	0.69***	0.77***	0.65***	0.59***	0.57***
	(0.10)	(0.07)	(0.23)	(0.09)	(0.26)	(0.09)	(0.08)	(0.08)
Observations	475	475	464	475	475	475	475	475
Panel B: PERMANENT								
$\texttt{ValAdd}^{\texttt{nf},\dagger}$	0.90***	1.07***	0.90***	0.83***	0.47	0.75***	0.70***	0.67***
	(0.10)	(0.08)	(0.31)	(0.09)	(0.45)	(0.09)	(0.08)	(0.08)
Observations	425	425	416	425	425	425	425	425
F-stat (1 st.)	754.7	754.7	1032.7	754.7	754.7	754.7	754.7	754.7
Panel C: TRANSITORY								
$\texttt{ValAdd}^{\texttt{nf},\dagger}$	0.80***	1.23***	0.01	0.62***	1.38	0.65***	0.63***	0.66***
	(0.19)	(0.20)	(0.99)	(0.18)	(1.11)	(0.16)	(0.15)	(0.15)
Observations	450	450	440	450	450	450	450	450
F-stat (1 st.)	50.8	50.8	45.7	50.8	50.8	50.8	50.8	50.8
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm sector's value-added using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector value-added ($\texttt{ValAdd}^{\texttt{nf}}$)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various country-sector outcomes in (i) aggregate non-financial firms sector: labor expense ($\texttt{LabPay}^{\texttt{nf}}$), sum of operating and mixed income ($\texttt{OpInc}^{\texttt{nf}}$), and adjusted dividends paid (i.e., less reinvested earnings) ($\texttt{DivPay}^{\texttt{nf}}_{adj}$); and (ii) aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), dividend income ($\texttt{DivPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat.*

TABLE 4.6. SHOCK TRANSMISSION FROM FIRMS TO HOUSEHOLDS (LABOR PAYOUT)

	(1) $\texttt{LabPay}^{\texttt{hh}}$	(2) $\texttt{Inc}^{\texttt{hh}}$	(3) $\texttt{DispInc}^{\texttt{hh}}$	(4) $\texttt{Saving}^{\texttt{hh}}$	(5) $\texttt{Cons}^{\texttt{hh}}$	(6) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED						
$\texttt{LabPay}^{\texttt{nf}}$	0.90***	0.78***	0.71***	1.57***	0.69***	0.64***
	(0.01)	(0.03)	(0.03)	(0.38)	(0.03)	(0.04)
Observations	475	475	475	440	475	475
Panel B: PERMANENT						
$\texttt{LabPay}^{\texttt{nf},\dagger}$	0.92***	0.78***	0.71***	1.80***	0.71***	0.65***
	(0.02)	(0.03)	(0.04)	(0.62)	(0.04)	(0.05)
Observations	425	425	425	393	425	425
F-stat (1 st.)	1307.8	1307.8	1307.8	877.7	1307.8	1307.8
Panel C: TRANSITORY						
$\texttt{LabPay}^{\texttt{nf},\dagger}$	0.86***	0.73***	0.54***	2.00*	0.73***	0.77***
	(0.05)	(0.08)	(0.11)	(1.16)	(0.09)	(0.13)
Observations	450	450	450	417	450	450
F-stat (1 st.)	36.8	36.8	36.8	13.5	36.8	36.8
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm labor compensation using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector labor compensation ($\texttt{LabPay}^{\texttt{nf}}$)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat*.

Table 4.7. Shock Transmission within the Household (Labor Payout)

	(1) $\texttt{Inc}^{\texttt{hh}}$	(2) $\texttt{DispInc}^{\texttt{hh}}$	(3) $\texttt{Saving}^{\texttt{hh}}$	(4) $\texttt{Cons}^{\texttt{hh}}$	(5) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED					
$\texttt{LabPay}^{\texttt{hh}}$	0.88***	0.81***	1.96***	0.78***	0.72***
	(0.02)	(0.03)	(0.41)	(0.03)	(0.04)
Observations	475	475	440	475	475
Panel B: PERMANENT					
$\texttt{LabPay}^{\texttt{hh},\dagger}$	0.85***	0.78***	1.85***	0.77***	0.70***
	(0.03)	(0.03)	(0.63)	(0.04)	(0.05)
Observations	425	425	393	425	425
F-stat (1 st.)	1241.1	1241.1	687.8	1241.1	1241.1
Panel C: TRANSITORY					
$\texttt{LabPay}^{\texttt{hh},\dagger}$	0.83***	0.65***	1.70	0.86***	0.85***
	(0.06)	(0.09)	(1.19)	(0.09)	(0.15)
Observations	450	450	417	450	450
F-stat (1 st.)	29.2	29.2	11.1	29.2	29.2
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate household labor income using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate household labor income ($\texttt{LabPay}^{\texttt{hh}}$)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat*.

Table 4.8. Shock Transmission from Firms to Households (Dividend Payout)

	(1) $\texttt{DivPay}^{\texttt{hh}}$	(2) $\texttt{Inc}^{\texttt{hh}}$	(3) $\texttt{DispInc}^{\texttt{hh}}$	(4) $\texttt{Saving}^{\texttt{hh}}$	(5) $\texttt{Cons}^{\texttt{hh}}$	(6) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED						
$\texttt{DivPay}^{\texttt{nf}}_{adj}$	0.49^{**}	0.04^{***}	0.03^{***}	0.15^{**}	0.02^{***}	0.02^{***}
	(0.20)	(0.01)	(0.01)	(0.06)	(0.01)	(0.01)
Observations	464	464	464	429	464	464
Panel B: PERMANENT						
$\texttt{DivPay}^{\texttt{nf},\dagger}_{adj}$	0.29	0.13^{***}	0.13^{***}	0.70^{**}	0.10^{***}	0.09^{***}
	(0.28)	(0.04)	(0.04)	(0.35)	(0.03)	(0.03)
Observations	412	412	412	380	412	412
F-stat (1 st.)	38.2	38.2	38.2	36.7	38.2	38.2
Panel C: TRANSITORY						
$\texttt{DivPay}^{\texttt{nf},\dagger}_{adj}$	0.50	−0.02	−0.04	−0.21	−0.02	−0.01
	(0.45)	(0.03)	(0.03)	(0.28)	(0.02)	(0.02)
Observations	438	438	438	405	438	438
F-stat (1 st.)	72.6	72.6	72.6	24.9	72.6	72.6
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm dividend payments using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector adjusted dividend payments ($\texttt{DivPay}^{\texttt{nf}}_{adj}$)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: dividend income ($\texttt{DivPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat.*

Table 4.9. Shock Transmission within the Household (Dividend Payout)

	(1) $\texttt{Inc}^{\texttt{hh}}$	(2) $\texttt{DispInc}^{\texttt{hh}}$	(3) $\texttt{Saving}^{\texttt{hh}}$	(4) $\texttt{Cons}^{\texttt{hh}}$	(5) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED					
$\texttt{DivPay}^{\texttt{hh}}$	0.04***	0.03***	0.39***	0.02***	0.02***
	(0.01)	(0.01)	(0.05)	(0.01)	(0.01)
Observations	475	475	440	475	475
Panel B: PERMANENT					
$\texttt{DivPay}^{\texttt{hh},\dagger}$	0.09**	0.07*	0.75	0.06	0.07*
	(0.04)	(0.04)	(0.46)	(0.04)	(0.04)
Observations	425	425	393	425	425
F-stat (1 st.)	41.0	41.0	9.1	41.0	41.0
Panel C: TRANSITORY					
$\texttt{DivPay}^{\texttt{hh},\dagger}$	0.03*	0.02	0.23	0.01	0.01
	(0.02)	(0.02)	(0.29)	(0.01)	(0.01)
Observations	450	450	417	450	450
F-stat (1 st.)	82.2	82.2	17.6	82.2	82.2
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate household dividend income using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate household dividend income** ($\texttt{DivPay}^{\texttt{hh}}$). The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat*.

Table 4.10. Shock Transmission within the Household (Entrepreneurial Income)

	(1) $\texttt{Inc}^{\texttt{hh}}$	(2) $\texttt{DispInc}^{\texttt{hh}}$	(3) $\texttt{Saving}^{\texttt{hh}}$	(4) $\texttt{Cons}^{\texttt{hh}}$	(5) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED					
$\texttt{OpInc}^{\texttt{hh}}$	0.63***	0.57***	1.34***	0.54***	0.51***
	(0.05)	(0.05)	(0.34)	(0.06)	(0.05)
Observations	475	475	440	475	475
Panel B: PERMANENT					
$\texttt{OpInc}^{\texttt{hh},\dagger}$	0.75***	0.67***	1.53***	0.68***	0.62***
	(0.05)	(0.05)	(0.54)	(0.04)	(0.05)
Observations	425	425	393	425	425
F-stat (1 st.)	597.3	597.3	1758.2	597.3	597.3
Panel C: TRANSITORY					
$\texttt{OpInc}^{\texttt{hh},\dagger}$	0.77***	0.59***	1.50	0.87***	0.74***
	(0.14)	(0.16)	(1.59)	(0.15)	(0.16)
Observations	450	450	417	450	450
F-stat (1 st.)	19.8	19.8	11.4	19.8	19.8
Country FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate household entrepreneurial income using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate household entrepreneurial income ($\texttt{OpInc}^{\texttt{hh}}$)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat.*

Table 4.11. Shock Transmission from Firms to Households Using the Identification from the Firm-Level Data (Labor Payout)

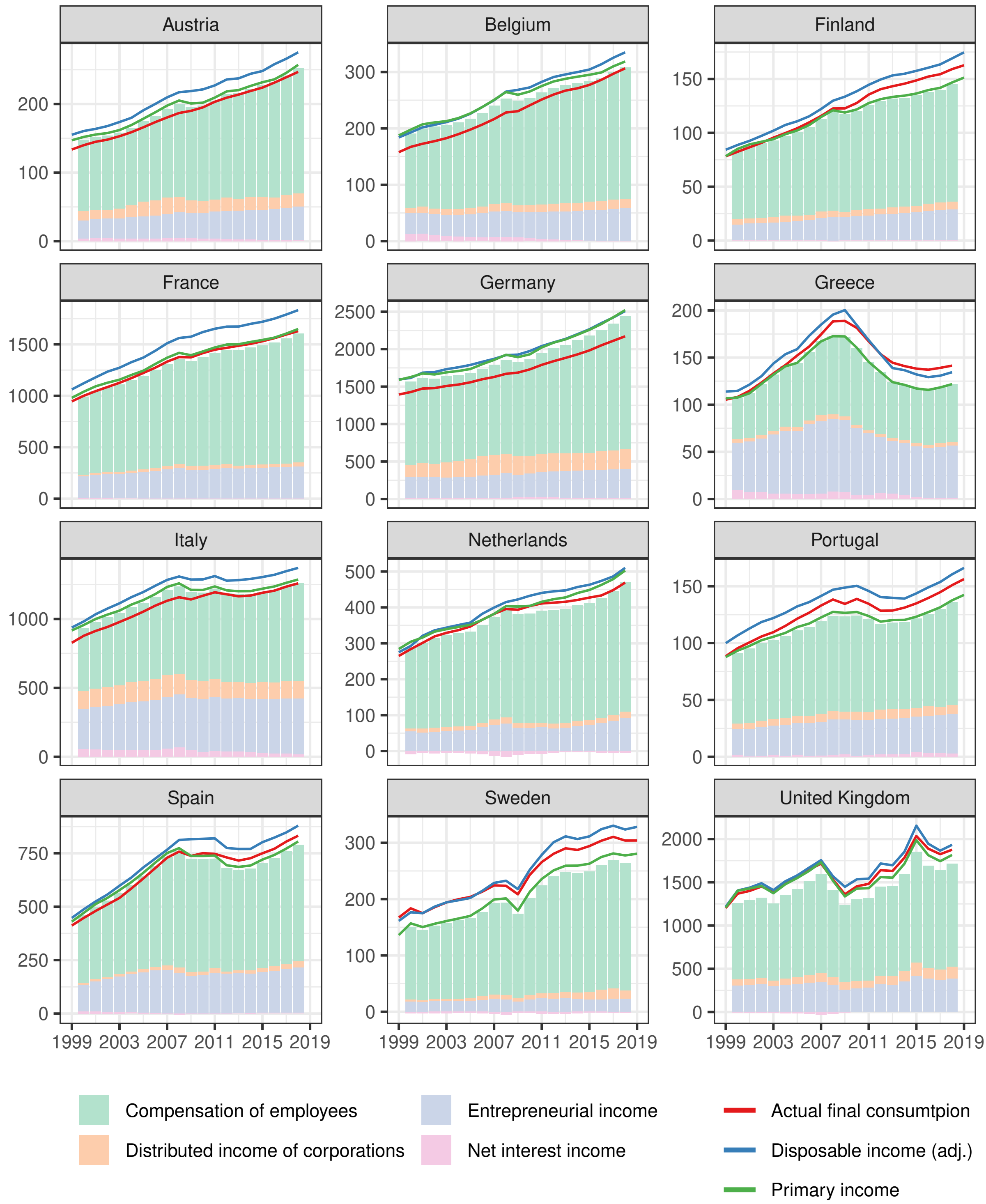
	(1) $\texttt{LabPay}^{\texttt{nf}}$	(2) $\texttt{LabPay}^{\texttt{hh}}$	(3) $\texttt{Inc}^{\texttt{hh}}$	(4) $\texttt{DispInc}^{\texttt{hh}}$	(5) $\texttt{Saving}^{\texttt{hh}}$	(6) $\texttt{Cons}^{\texttt{hh}}$	(7) $\texttt{Cons}^{real,\texttt{hh}}$
Panel A: COMBINED							
$\widetilde{\texttt{LabPay}}$	0.45*						
	(0.24)						
$\texttt{LabPay}^{\texttt{nf},\dagger}$		0.97**	0.86*	0.63	−5.00	0.99**	0.98**
		(0.48)	(0.48)	(0.41)	(3.22)	(0.43)	(0.43)
Observations	312	312	312	312	293	312	312
Panel B: PERMANENT							
$\widetilde{\texttt{LabPay}}$	0.91***						
	(0.31)						
$\texttt{LabPay}^{\texttt{nf},\dagger}$		1.79*	1.85*	1.16	−5.68	1.92**	1.87**
		(1.05)	(1.04)	(1.03)	(10.08)	(0.92)	(0.92)
Observations	246	246	246	246	235	246	246
F-stat (1 st.)	–	33.4	33.4	33.4	31.1	33.4	33.4
Panel C: TRANSITORY							
$\widetilde{\texttt{LabPay}}$	0.45*						
	(0.24)						
$\texttt{LabPay}^{\texttt{nf},\dagger}$		9.30	8.00	6.98	80.96	3.89	3.64
		(15.92)	(14.82)	(13.41)	(155.55)	(9.44)	(9.66)
Observations	312	277	277	277	264	277	277
F-stat (1 st.)	–	0.2	0.2	0.2	0.2	0.2	0.2
Country FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the instrumented-variables estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm labor compensation using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

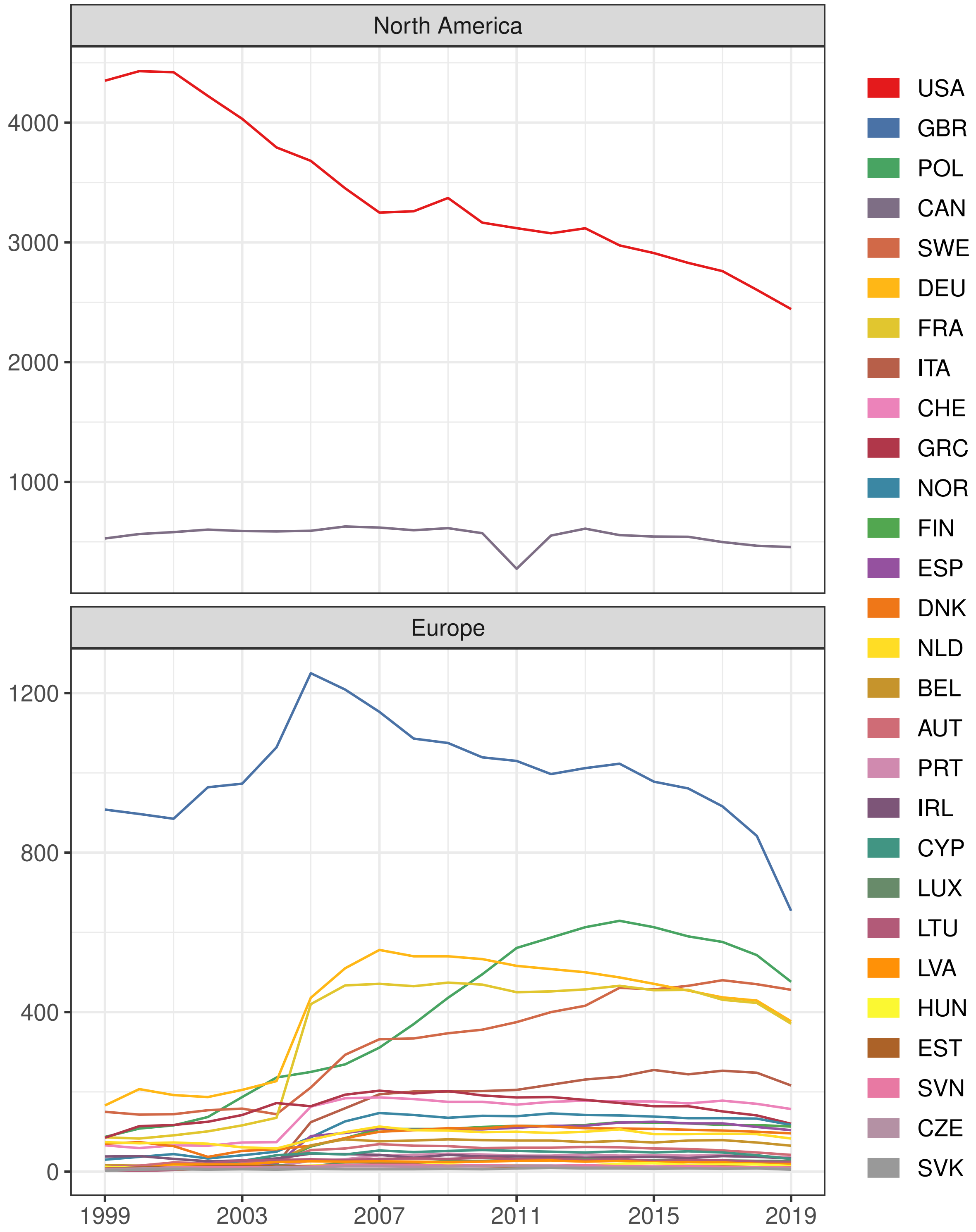
where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector labor compensation ($\texttt{LabPay}^{\texttt{nf}}$)**. I use an instrument for $\texttt{LabPay}^{\texttt{nf}}$, denoted z_{ct}, constructed as granular residual of $\texttt{LabPay}$ from the firm-level dataset as follows: $z_{ct} := \mathtt{g}_{Sct} - \mathtt{g}_{Ect}$, where $\mathtt{g}_{ict}$ are idiosyncratic shocks obtained by projecting out firm effects, country-sector-time effects and controls: growth rate of lagged firm total assets, lagged change in leverage, and lagged change in tangibility (see main text for details). I denote the fitted values from this stage as $\widetilde{g_{ct}} = \widetilde{\texttt{LabPay}}_{ct}$. The combined effects are estimated with simple OLS; permanent effects—by instrumenting $\widetilde{g_{ct}}$ with $\left(\widetilde{g_{ct-1}} + \widetilde{g_{ct}} + \widetilde{g_{ct+1}}\right)$ and transitory effects—by instrumenting $\widetilde{g_{ct}}$ with $\widetilde{g_{ct+1}}$. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: *Eurostat*.

Figure 4.1. Households Income and Consumption



NOTES: The figure plots main components of aggregate households' income: primary income (`Inc`), adjusted disposable income (`DispInc`), sum of operating and mixed income, or "entrepreneurial income" (`OpInc`), compensation of employees (`LabPay`), distributed income of corporations (`DivPay`), and net interest income ($\texttt{Int}^{recv} - \texttt{Int}^{paid}$); and actual final consumption (`Cons`). Panels correspond to 12 European countries: Austria, Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, and United Kingdom. Years are on the x-axis. All data are in billion euros. Source: *Eurostat*.

Figure 4.2. Number of Firms in Compustat Sample by Country



NOTES: The figure plots the number of firms with non-missing observations for `Sale` for a sample of *Compustat North America* and *Compustat Global* firms over time, with fiscal years (`fyear`) are on the x-axis. Countries in the legend are sorted by the number of firms in 2019. Source: *Compustat*.

Appendix

4A Additional Tables

Table 4A.1. Shock Transmission within the Firm (Value-Added, Europe-25)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.27^{***}	0.15^{***}	0.14^{***}	2.21^{***}	0.72^{***}	0.76^{***}	0.42^{***}
	(0.01)	(0.01)	(0.01)	(0.03)	(0.06)	(0.05)	(0.04)
Observations	26,913	16,800	16,800	23,897	9,238	9,247	25,631
Panel B: PERMANENT							
ValAdd†	0.42^{***}	0.07^{**}	0.36^{***}	2.07^{***}	1.35^{***}	1.35^{***}	0.96^{***}
	(0.02)	(0.03)	(0.03)	(0.09)	(0.16)	(0.17)	(0.14)
Observations	13,537	8,389	8,389	12,268	4,945	4,945	12,920
F-stat (1 st.)	781.0	879.8	879.8	459.2	618.6	618.6	772.7
Panel C: TRANSITORY							
ValAdd†	0.23^{***}	0.37^{***}	-0.07^{*}	2.86^{***}	-0.73	-0.69	0.15
	(0.03)	(0.06)	(0.04)	(0.22)	(0.52)	(0.46)	(0.25)
Observations	18,729	11,318	11,318	16,845	6,728	6,730	17,837
F-stat (1 st.)	190.4	131.7	131.7	55.1	67.8	67.8	156.0
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}'_{it}\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.2. Shock Transmission within the Firm (Sales, Europe-25)

	(1) `LabPay`	(2) `Wage`	(3) `Emp`	(4) `OpInc`	(5) `DivPay`	(6) `TotEqPay`	(7) `Invest`
Panel A: COMBINED							
`Sale`	0.38^{***}	0.09^{***}	0.26^{***}	1.53^{***}	0.73^{***}	0.73^{***}	0.74^{***}
	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.04)	(0.04)
Observations	26,948	16,811	25,942	38,259	13,722	13,732	42,224
Panel B: PERMANENT							
`Sale`†	0.52^{***}	0.01	0.50^{***}	1.71^{***}	1.16^{***}	1.17^{***}	1.19^{***}
	(0.02)	(0.03)	(0.02)	(0.07)	(0.11)	(0.11)	(0.09)
Observations	16,132	10,027	15,938	24,006	8,972	8,973	26,015
F-stat (1 st.)	4155.4	2441.6	3442.1	19601.0	3114.4	3114.4	17063.9
Panel C: TRANSITORY							
`Sale`†	0.12	0.64^{***}	-0.75^{***}	0.17	-2.94^{**}	-2.86^{**}	-1.38^{*}
	(0.09)	(0.19)	(0.21)	(0.68)	(1.21)	(1.18)	(0.71)
Observations	20,930	12,701	19,707	30,242	11,163	11,166	32,928
F-stat (1 st.)	37.5	36.1	25.5	6.8	20.5	20.5	19.2
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (`Sale`)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (`LabPay`), wages (`Wage`), number of employees (`Emp`), operating income before depreciation (`OpInc`), dividends (`DivPay`), total equity payout (`TotEqPay`), and fixed capital expenditures (`Invest`). Time sample: 1999–2019. **Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.3. Shock Transmission within the Firm (Value-Added, Europe-10)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.26^{***}	0.13^{***}	0.13^{***}	2.36^{***}	0.84^{***}	0.85^{***}	0.41^{***}
	(0.01)	(0.01)	(0.01)	(0.04)	(0.07)	(0.07)	(0.05)
Observations	13,756	8,365	8,365	12,321	4,407	4,407	12,973
Panel B: PERMANENT							
ValAdd†	0.41^{***}	0.05	0.37^{***}	2.04^{***}	1.67^{***}	1.67^{***}	0.84^{***}
	(0.02)	(0.04)	(0.04)	(0.12)	(0.25)	(0.25)	(0.17)
Observations	7,808	4,741	4,741	7,105	2,661	2,661	7,379
F-stat (1 st.)	612.3	315.2	315.2	391.3	617.0	617.0	642.4
Panel C: TRANSITORY							
ValAdd†	0.17^{***}	0.37^{***}	-0.13^{**}	3.66^{***}	−0.83	−0.86	0.48
	(0.05)	(0.08)	(0.06)	(0.40)	(0.62)	(0.62)	(0.34)
Observations	10,219	5,942	5,942	9,252	3,465	3,465	9,633
F-stat (1 st.)	154.1	191.1	191.1	24.3	80.6	80.6	109.3
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-10 (Austria, Belgium, Germany, Greece, Finland, France, Italy, Netherlands, Portugal, and Spain)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.4. Shock Transmission within the Firm (Sales, Europe-10)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
Sale	0.38^{***}	0.10^{***}	0.28^{***}	1.56^{***}	0.73^{***}	0.73^{***}	0.75^{***}
	(0.01)	(0.02)	(0.01)	(0.05)	(0.07)	(0.07)	(0.06)
Observations	13,777	8,368	12,061	17,319	5,900	5,901	18,577
Panel B: PERMANENT							
$\texttt{Sale}^{\dagger}$	0.49^{***}	-0.01	0.53^{***}	1.70^{***}	1.29^{***}	1.28^{***}	1.16^{***}
	(0.02)	(0.04)	(0.03)	(0.11)	(0.18)	(0.18)	(0.13)
Observations	8,762	5,392	7,847	11,309	4,034	4,035	12,038
F-stat (1 st.)	5739.4	1034.1	1379.5	4410.1	860.8	860.8	5916.0
Panel C: TRANSITORY							
$\texttt{Sale}^{\dagger}$	0.31^{***}	0.97^{***}	-0.88^{***}	0.07	-5.50	-5.55	-0.88
	(0.12)	(0.30)	(0.31)	(1.21)	(3.58)	(3.61)	(0.83)
Observations	11,013	6,504	9,387	13,982	4,963	4,964	14,883
F-stat (1 st.)	17.7	13.7	18.2	8.4	4.1	4.1	45.2
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (Sale)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-10 (Austria, Belgium, Germany, Greece, Finland, France, Italy, Netherlands, Portugal, and Spain)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.5. Shock Transmission within the Firm (Value-Added, Europe-14)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.27^{***}	0.14^{***}	0.14^{***}	2.24^{***}	0.73^{***}	0.76^{***}	0.43^{***}
	(0.01)	(0.01)	(0.01)	(0.03)	(0.06)	(0.05)	(0.04)
Observations	23,443	15,792	15,792	20,771	8,795	8,802	22,335
Panel B: PERMANENT							
ValAdd†	0.43^{***}	0.07^{**}	0.37^{***}	2.08^{***}	1.35^{***}	1.35^{***}	0.95^{***}
	(0.02)	(0.03)	(0.03)	(0.10)	(0.16)	(0.16)	(0.14)
Observations	12,024	7,941	7,941	10,886	4,712	4,712	11,460
F-stat (1 st.)	1437.0	750.5	750.5	820.3	636.2	636.2	1391.3
Panel C: TRANSITORY							
ValAdd†	0.22^{***}	0.35^{***}	−0.06	3.05^{***}	−0.82	−0.79	0.31
	(0.04)	(0.06)	(0.04)	(0.27)	(0.54)	(0.48)	(0.27)
Observations	16,482	10,678	10,678	14,801	6,413	6,414	15,693
F-stat (1 st.)	319.0	114.6	114.6	57.4	63.7	63.7	201.7
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}'_{it}\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-14 (Austria, Belgium, Germany, Greece, Finland, France, Italy, Netherlands, Portugal, Spain, Denmark, Norway, Sweden, and United Kingdom)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.6. Shock Transmission within the Firm (Sales, Europe-14)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
Sale	0.40^{***}	0.09^{***}	0.26^{***}	1.61^{***}	0.74^{***}	0.74^{***}	0.76^{***}
	(0.01)	(0.01)	(0.01)	(0.03)	(0.05)	(0.04)	(0.04)
Observations	23,467	15,796	23,972	31,371	12,918	12,926	34,890
Panel B: PERMANENT							
Sale†	0.53^{***}	0.002	0.51^{***}	1.73^{***}	1.17^{***}	1.18^{***}	1.32^{***}
	(0.02)	(0.03)	(0.02)	(0.08)	(0.12)	(0.11)	(0.09)
Observations	14,010	9,422	14,671	19,458	8,396	8,397	21,191
F-stat (1 st.)	6563.6	2792.7	3599.2	9512.0	3098.7	3098.7	19548.0
Panel C: TRANSITORY							
Sale†	0.18^{*}	0.66^{***}	-0.81^{***}	0.33	-3.28^{**}	-3.18^{**}	-1.15
	(0.11)	(0.20)	(0.24)	(1.35)	(1.37)	(1.33)	(0.88)
Observations	18,153	11,926	18,169	24,620	10,479	10,481	27,012
F-stat (1 st.)	37.5	31.4	24.5	4.3	17.6	17.6	12.1
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (Sale)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-14 (Austria, Belgium, Germany, Greece, Finland, France, Italy, Netherlands, Portugal, Spain, Denmark, Norway, Sweden, and United Kingdom)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.7. Shock Transmission within the Firm (Value-Added, Europe-14-plus)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.28***	0.14***	0.14***	2.25***	0.73***	0.76***	0.43***
	(0.01)	(0.01)	(0.01)	(0.03)	(0.05)	(0.05)	(0.03)
Observations	27,877	19,588	19,588	24,769	10,567	11,023	26,688
Panel B: PERMANENT							
ValAdd†	0.43***	0.07***	0.37***	2.09***	1.12***	1.15***	0.97***
	(0.02)	(0.03)	(0.03)	(0.09)	(0.16)	(0.20)	(0.13)
Observations	14,523	10,114	10,114	13,197	5,779	6,039	13,928
F-stat (1 st.)	1694.7	1114.0	1114.0	994.8	800.2	749.6	1583.4
Panel C: TRANSITORY							
ValAdd†	0.21***	0.36***	−0.08**	3.01***	−0.25	−0.42	0.22
	(0.04)	(0.05)	(0.04)	(0.24)	(0.46)	(0.48)	(0.25)
Observations	19,760	13,483	13,483	17,792	7,765	8,100	18,918
F-stat (1 st.)	408.1	169.3	169.3	77.4	83.5	83.7	263.2
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}'_{it}\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-14-plus (Austria, Belgium, Germany, Greece, Finland, France, Italy, Netherlands, Portugal, Spain, Denmark, Norway, Sweden, and United Kingdom; plus Switzerland, United States, and Canada)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.8. Shock Transmission within the Firm (Sales, Europe-14-plus)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
Sale	0.41***	0.10***	0.20***	1.81***	0.62***	0.62***	0.63***
	(0.01)	(0.01)	(0.005)	(0.03)	(0.03)	(0.06)	(0.02)
Observations	27,904	19,592	58,801	59,407	24,987	30,598	72,308
Panel B: PERMANENT							
Sale†	0.54***	0.01	0.43***	1.93***	0.81***	0.83***	1.22***
	(0.02)	(0.03)	(0.01)	(0.06)	(0.09)	(0.15)	(0.07)
Observations	16,685	11,750	33,561	35,503	15,946	18,838	41,386
F-stat (1 st.)	6956.5	3160.3	3401.9	11066.0	8193.6	12331.0	4011.8
Panel C: TRANSITORY							
Sale†	0.10	0.78***	−0.56***	0.88	−0.96*	0.33	−0.62*
	(0.12)	(0.21)	(0.08)	(0.66)	(0.56)	(0.84)	(0.32)
Observations	21,549	14,835	43,492	45,626	19,846	23,765	54,343
F-stat (1 st.)	31.4	24.6	42.9	5.5	22.3	35.7	17.0
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (Sale)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. **Country sample: Europe-14-plus (Austria, Belgium, Germany, Greece, Finland, France, Italy, Netherlands, Portugal, Spain, Denmark, Norway, Sweden, and United Kingdom; plus Switzerland, United States, and Canada)**. Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.9. Shock Transmission within the Firm (Value-Added, Firm and Country-Sector-Year Fixed Effects)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.27***	0.16***	0.14***	2.32***	0.65***	0.68***	0.46***
	(0.01)	(0.02)	(0.01)	(0.05)	(0.15)	(0.17)	(0.06)
Observations	17,121	11,549	11,549	15,073	5,864	6,170	16,412
Panel B: PERMANENT							
$\text{ValAdd}^{\dagger}$	0.47***	0.05	0.47***	1.96***	1.30*	1.82*	1.22***
	(0.05)	(0.08)	(0.08)	(0.19)	(0.69)	(1.03)	(0.33)
Observations	7,565	5,169	5,169	6,825	2,761	2,927	7,264
F-stat (1 st.)	225.1	142.2	142.2	205.1	155.4	109.6	210.7
Panel C: TRANSITORY							
$\text{ValAdd}^{\dagger}$	0.26***	0.40***	−0.12	3.03***	−1.54	−1.77	0.15
	(0.05)	(0.10)	(0.08)	(0.34)	(1.30)	(1.53)	(0.36)
Observations	11,124	7,380	7,380	9,937	3,968	4,186	10,663
F-stat (1 st.)	123.8	111.7	111.7	107.4	9.6	12.5	107.4
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year-sector FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}'_{it}\gamma + \mu_i + \mu_{cst} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{cst} is a **country-sector-year fixed effect**; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. Country sample: Europe-25-plus (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom; plus Switzerland, United States and Canada). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.10. Shock Transmission within the Firm (Sales, Firm and Country-Sector-Year Fixed Effects)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
Sale	0.37^{***}	0.09^{***}	0.16^{***}	1.78^{***}	0.47^{***}	0.41^{***}	0.54^{***}
	(0.02)	(0.02)	(0.01)	(0.03)	(0.08)	(0.13)	(0.03)
Observations	19,967	13,410	48,553	48,966	19,178	24,456	60,948
Panel B: PERMANENT							
$\texttt{Sale}^{\dagger}$	0.59^{***}	-0.04	0.39^{***}	1.81^{***}	0.71^{***}	0.46	1.11^{***}
	(0.04)	(0.07)	(0.02)	(0.11)	(0.27)	(0.39)	(0.11)
Observations	10,930	7,352	26,022	27,531	11,514	14,180	32,849
F-stat (1 st.)	1011.3	617.1	3956.0	8028.7	1806.5	2094.8	2366.9
Panel C: TRANSITORY							
$\texttt{Sale}^{\dagger}$	0.22^{*}	0.61^{***}	-0.35^{***}	1.89^{***}	0.35	0.66	-0.51^{*}
	(0.12)	(0.23)	(0.07)	(0.42)	(0.63)	(1.00)	(0.31)
Observations	14,769	9,697	34,792	36,409	14,679	18,315	44,382
F-stat (1 st.)	44.7	23.3	328.7	25.4	61.5	112.1	72.7
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year-sector FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{cst} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{cst} is a **country-sector-year fixed effect**; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (Sale)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). Time sample: 1999–2019. Country sample: Europe-25-plus (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom; plus Switzerland, United States and Canada). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.11. Shock Transmission within the Firm (Value-Added, 2005–2019)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
ValAdd	0.27***	0.14***	0.14***	2.22***	0.77***	0.76***	0.41***
	(0.01)	(0.01)	(0.01)	(0.03)	(0.05)	(0.05)	(0.04)
Observations	28,559	18,250	18,250	25,415	9,701	10,072	27,333
Panel B: PERMANENT							
ValAdd†	0.41***	0.07**	0.36***	2.09***	1.18***	1.18***	0.94***
	(0.02)	(0.03)	(0.03)	(0.09)	(0.16)	(0.20)	(0.13)
Observations	14,923	9,697	9,697	13,549	5,496	5,708	14,340
F-stat (1 st.)	876.3	987.6	987.6	548.2	912.0	963.4	866.8
Panel C: TRANSITORY							
ValAdd†	0.22***	0.36***	−0.08**	2.74***	−0.21	−0.35	0.16
	(0.03)	(0.05)	(0.04)	(0.19)	(0.39)	(0.45)	(0.23)
Observations	20,229	12,667	12,667	18,230	7,237	7,506	19,385
F-stat (1 st.)	253.3	176.9	176.9	86.2	88.5	90.9	212.5
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}_{it}'\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm value-added (ValAdd)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (LabPay), wages (Wage), number of employees (Emp), operating income before depreciation (OpInc), dividends (DivPay), total equity payout (TotEqPay), and fixed capital expenditures (Invest). **Time sample: 2014–2019**. Country sample: Europe-25-plus (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom; plus Switzerland, United States and Canada). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.12. Shock Transmission within the Firm (Sales, 2005–2019)

	(1) LabPay	(2) Wage	(3) Emp	(4) OpInc	(5) DivPay	(6) TotEqPay	(7) Invest
Panel A: COMBINED							
Sale	0.38^{***}	0.10^{***}	0.20^{***}	1.74^{***}	0.63^{***}	0.65^{***}	0.64^{***}
	(0.01)	(0.01)	(0.005)	(0.03)	(0.04)	(0.06)	(0.03)
Observations	28,590	18,258	50,943	57,075	22,278	26,741	67,709
Panel B: PERMANENT							
Sale†	0.52^{***}	0.02	0.43^{***}	1.87^{***}	0.92^{***}	0.90^{***}	1.16^{***}
	(0.02)	(0.03)	(0.01)	(0.06)	(0.09)	(0.15)	(0.07)
Observations	17,449	11,298	29,600	34,550	14,368	16,659	39,471
F-stat (1 st.)	6129.5	2587.4	5655.8	18192.7	1619.8	3453.6	13294.7
Panel C: TRANSITORY							
Sale†	0.12	0.63^{***}	-0.40^{***}	0.91^{**}	-1.12^{*}	-0.16	-0.80^{**}
	(0.09)	(0.16)	(0.06)	(0.44)	(0.58)	(0.78)	(0.31)
Observations	22,291	13,933	37,799	44,189	17,823	20,860	51,313
F-stat (1 st.)	45.0	39.6	44.2	19.1	33.1	44.0	28.5
Firm FE	Y	Y	Y	Y	Y	Y	Y
Country-year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to firms' value-added using the following specification:

$$\Delta y_{it} = \beta g_{it} + \mathbb{X}'_{it}\gamma + \mu_i + \mu_{ct} + \varepsilon_{it},$$

where μ_i is a firm fixed effect; μ_{ct} is a country-year fixed effect; the vector of controls includes lagged growth rate of firm total assets, lagged change in leverage, and lagged change in tangibility; and the residual g_{it} measures the unexplained growth in **firm sales (`Sale`)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{it} with $(g_{it-1} + g_{it} + g_{it+1})$ and transitory effects—by instrumenting g_{it} with g_{it+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to various firm outcomes in log-differences: staff expenses (`LabPay`), wages (`Wage`), number of employees (`Emp`), operating income before depreciation (`OpInc`), dividends (`DivPay`), total equity payout (`TotEqPay`), and fixed capital expenditures (`Invest`). **Time sample: 2005–2019**. Country sample: Europe-25-plus (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom; plus Switzerland, United States and Canada). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Compustat.

Table 4A.13. Shock Transmission within the Country (Output)

	(1) $\texttt{LabPay}^{\texttt{nf}}$	(2) $\texttt{OpInc}^{\texttt{nf}}$	(3) $\texttt{DivPay}^{\texttt{nf}}_{adj}$	(4) $\texttt{LabPay}^{\texttt{hh}}$	(5) $\texttt{DivPay}^{\texttt{hh}}$	(6) $\texttt{Inc}^{\texttt{hh}}$	(7) $\texttt{Cons}^{\texttt{hh}}$	(8) $\texttt{Cons}^{\texttt{hh},real}$
Panel A: COMBINED								
$\texttt{Output}^{\texttt{nf}}$	0.82***	0.95***	0.69**	0.75***	0.87***	0.72***	0.64***	0.62***
	(0.07)	(0.12)	(0.29)	(0.07)	(0.26)	(0.06)	(0.06)	(0.06)
Observations	475	475	464	475	475	475	475	475
Panel B: PERMANENT								
$\texttt{Output}^{\texttt{nf},\dagger}$	0.93***	0.98***	0.94**	0.84***	0.65	0.77***	0.72***	0.68***
	(0.08)	(0.12)	(0.39)	(0.07)	(0.45)	(0.07)	(0.06)	(0.06)
Observations	425	425	416	425	425	425	425	425
F-stat (1 st.)	2184.2	2184.2	1576.1	2184.2	2184.2	2184.2	2184.2	2184.2
Panel C: TRANSITORY								
$\texttt{Output}^{\texttt{nf},\dagger}$	0.61***	1.48***	0.16	0.44***	0.94	0.45***	0.53***	0.58***
	(0.17)	(0.36)	(1.05)	(0.17)	(1.30)	(0.15)	(0.13)	(0.15)
Observations	450	450	440	450	450	450	450	450
F-stat (1 st.)	47.7	47.7	18.0	47.7	47.7	47.7	47.7	47.7
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm sector's output using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the unexplained growth in **aggregate firm-sector output ($\texttt{Output}^{\texttt{nf}}$)**. The combined effects are estimated with simple OLS; permanent effects—by instrumenting g_{ct} with $(g_{ct-1} + g_{ct} + g_{ct+1})$ and transitory effects—by instrumenting g_{ct} with g_{ct+1}. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various country-sector outcomes in (i) aggregate non-financial firms sector: labor expense ($\texttt{LabPay}^{\texttt{nf}}$), sum of operating and mixed income ($\texttt{OpInc}^{\texttt{nf}}$), and adjusted dividends paid (i.e., less reinvested earnings) ($\texttt{DivPay}^{\texttt{nf}}_{adj}$); and (ii) aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), dividend income ($\texttt{DivPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Eurostat.

Table 4A.14. Shock Transmission from Firms to Households Using the Identification from the Firm-Level Data (Value-Added)

	(1) $\texttt{ValAdd}^{\texttt{nf}}$	(2) $\texttt{LabPay}^{\texttt{nf}}$	(3) $\texttt{OpInc}^{\texttt{nf}}$	(4) $\texttt{DivPay}^{\texttt{nf}}_{adj}$	(5) $\texttt{LabPay}^{\texttt{hh}}$	(6) $\texttt{DivPay}^{\texttt{hh}}$	(7) $\texttt{Inc}^{\texttt{hh}}$	(8) $\texttt{Cons}^{\texttt{hh}}$	(9) $\texttt{Cons}^{\texttt{hh},real}$
Panel A: COMBINED									
$\widetilde{\texttt{ValAdd}}$	0.05								
	(0.20)								
$\texttt{ValAdd}^{\texttt{nf},\dagger}$		0.81	1.88	−12.08	0.08	6.61	−0.87	0.25	−0.45
		(3.90)	(5.74)	(16.47)	(3.54)	(9.96)	(3.46)	(3.37)	(3.32)
Observations	312	312	312	304	312	312	312	312	312
Panel B: PERMANENT									
$\widetilde{\texttt{ValAdd}}$	0.07								
	(0.25)								
$\texttt{ValAdd}^{\texttt{nf},\dagger}$		−6.22	12.10	−16.54	−9.56	−19.73	−9.45	−5.28	−6.07
		(10.22)	(14.36)	(39.41)	(9.77)	(33.48)	(9.51)	(8.77)	(9.34)
Observations	246	246	246	240	246	246	246	246	246
F-stat (1 st.)	–	106.0	106.0	99.7	106.0	106.0	106.0	106.0	106.0
Panel C: TRANSITORY									
$\widetilde{\texttt{ValAdd}}$	0.05								
	(0.20)								
$\texttt{ValAdd}^{\texttt{nf},\dagger}$		41.02	1.30	80.88	43.65	71.29	31.62	31.12	27.85
		(29.27)	(22.91)	(85.95)	(30.44)	(77.09)	(26.90)	(23.65)	(22.40)
Observations	312	277	277	270	277	277	277	277	277
F-stat (1 st.)	–	6.7	6.7	6.3	6.7	6.7	6.7	6.7	6.7
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the instrumented-variables estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm-value added using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector value-added ($\texttt{ValAdd}^{\texttt{nf}}$)**. I use an instrument for $\texttt{ValAdd}^{\texttt{nf}}$, denoted z_{ct}, constructed as granular residual of $\texttt{ValAdd}$ from the firm-level dataset as follows: $z_{ct} := \texttt{ValAdd}_{Sct} - \texttt{ValAdd}_{Ect}$, where $\mathbf{g}_{ict}$ are idiosyncratic shocks obtained by projecting out firm effects, country-sector-time effects and controls: growth rate of lagged firm total assets, lagged change in leverage, and lagged change in tangibility (see main text for details). I denote the fitted values from this stage as $\widetilde{g_{ct}} = \widetilde{\texttt{ValAdd}}_{ct}$. The combined effects are estimated with simple OLS; permanent effects—by instrumenting $\widetilde{g_{ct}}$ with $\left(\widetilde{g_{ct-1}} + \widetilde{g_{ct}} + \widetilde{g_{ct+1}}\right)$ and transitory effects—by instrumenting $\widetilde{g_{ct}}$ with $\widetilde{g_{ct+1}}$. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Eurostat.

Table 4A.15. Shock Transmission from Firms to Households Using the Identification from the Firm-Level Data (Sales / Output)

	(1) $\texttt{Output}^{\texttt{nf}}$	(2) $\texttt{LabPay}^{\texttt{nf}}$	(3) $\texttt{OpInc}^{\texttt{nf}}$	(4) $\texttt{DivPay}^{\texttt{nf}}_{adj}$	(5) $\texttt{LabPay}^{\texttt{hh}}$	(6) $\texttt{DivPay}^{\texttt{hh}}$	(7) $\texttt{Inc}^{\texttt{hh}}$	(8) $\texttt{Cons}^{\texttt{hh}}$	(9) $\texttt{Cons}^{\texttt{hh},real}$
Panel A: COMBINED									
$\widetilde{\texttt{Sale}}$	−0.46								
	(0.28)								
$\texttt{Output}^{\texttt{nf},\dagger}$		1.06	1.38	−1.92	1.14*	−2.58	1.40**	1.29**	1.13**
		(0.66)	(1.00)	(2.70)	(0.61)	(2.30)	(0.61)	(0.57)	(0.56)
Observations	364	364	364	356	364	364	364	364	364
Panel B: PERMANENT									
$\widetilde{\texttt{Sale}}$	−0.94**								
	(0.37)								
$\texttt{Output}^{\texttt{nf},\dagger}$		1.03	0.89	−1.12	1.25	1.71	1.67*	1.35	0.61
		(1.16)	(1.48)	(5.27)	(1.10)	(4.60)	(1.02)	(0.90)	(0.91)
Observations	306	306	306	300	306	306	306	306	306
F-stat (1 st.)	–	103.8	103.8	106.9	103.8	103.8	103.8	103.8	103.8
Panel C: TRANSITORY									
$\widetilde{\texttt{Sale}}$	−0.46								
	(0.28)								
$\texttt{Output}^{\texttt{nf},\dagger}$		−27.53	−5.98	−121.84	−28.83	−141.03	−33.93	−27.90	−18.69
		(45.32)	(20.85)	(213.37)	(47.30)	(200.52)	(53.59)	(44.20)	(31.50)
Observations	364	334	334	327	334	334	334	334	334
F-stat (1 st.)	–	0.9	0.9	0.7	0.9	0.9	0.9	0.9	0.9
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the instrumented-variables estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm output using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector output ($\texttt{Output}^{\texttt{nf}}$)**. I use an instrument for $\texttt{Output}^{\texttt{nf}}$, denoted z_{ct}, constructed as granular residual of $\texttt{Sale}$ from the firm-level dataset as follows: $z_{ct} \coloneqq \texttt{Sale}_{Sct} - \texttt{Sale}_{Ect}$, where $\mathtt{g}_{ict}$ are idiosyncratic shocks obtained by projecting out firm effects, country-sector-time effects and controls: growth rate of lagged firm total assets, lagged change in leverage, and lagged change in tangibility (see main text for details). I denote the fitted values from this stage as $\widetilde{g_{ct}} = \widetilde{\texttt{Sale}}_{ct}$. The combined effects are estimated with simple OLS; permanent effects—by instrumenting $\widetilde{g_{ct}}$ with $\left(\widetilde{g_{ct-1}} + \widetilde{g_{ct}} + \widetilde{g_{ct+1}}\right)$ and transitory effects—by instrumenting $\widetilde{g_{ct}}$ with $\widetilde{g_{ct+1}}$. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Eurostat.

Table 4A.16. Shock Transmission from Firms to Households Using the Identification from the Firm-Level Data (Dividend Income)

	(1) $\texttt{DivPay}^{\texttt{nf}}_{adj}$	(2) $\texttt{DivPay}^{\texttt{hh}}$	(3) $\texttt{Inc}^{\texttt{hh}}$	(4) $\texttt{DispInc}^{\texttt{hh}}$	(5) $\texttt{Saving}^{\texttt{hh}}$	(6) $\texttt{Cons}^{\texttt{hh}}$	(7) $\texttt{Cons}^{\texttt{hh},real}$
Panel A: COMBINED							
$\widetilde{\texttt{DivPay}}$	0.09						
	(0.15)						
$\texttt{DivPay}^{\texttt{nf},\dagger}_{adj}$		0.85	−0.19	−0.08	−0.75	−0.07	−0.09
		(2.92)	(0.30)	(0.30)	(2.04)	(0.28)	(0.28)
Observations	222	222	222	222	216	222	222
Panel B: PERMANENT							
$\widetilde{\texttt{DivPay}}$	-0.30^{**}						
	(0.13)						
$\texttt{DivPay}^{\texttt{nf},\dagger}_{adj}$		−3.46	−0.41	−0.19	0.42	−0.02	0.10
		(3.64)	(0.77)	(0.73)	(4.14)	(0.62)	(0.66)
Observations	171	171	171	171	169	171	171
F-stat (1 st.)	–	44.1	44.1	44.1	43.9	44.1	44.1
Panel C: TRANSITORY							
$\widetilde{\texttt{DivPay}}$	0.09						
	(0.15)						
$\texttt{DivPay}^{\texttt{nf},\dagger}_{adj}$		4.94	−1.35	−0.97	18.40	−1.92	−1.01
		(9.97)	(3.46)	(3.20)	(22.20)	(3.57)	(3.23)
Observations	222	192	192	192	190	192	192
F-stat (1 st.)	–	8.5	8.5	8.5	8.4	8.5	8.5
Country FE	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y
Country clusters	Y	Y	Y	Y	Y	Y	Y

NOTES: This table reports the results of the instrumented-variables estimation of the effect of permanent, transitory and combined shocks to aggregate non-financial firm dividends using the following specification:

$$\Delta y_{ct} = \beta g_{ct} + \mu_c + \mu_t + \varepsilon_{ct},$$

where μ_c is a country fixed effect; μ_t is a year fixed effect; and the residual g_{ct} measures the growth in **aggregate firm-sector dividends ($\texttt{DivPay}^{\texttt{nf}}_{adj}$)**. I use an instrument for $\texttt{DivPay}^{\texttt{nf}}_{adj}$, denoted z_{ct}, constructed as granular residual of $\texttt{DivPay}$ from the firm-level dataset as follows: $z_{ct} := \texttt{DivPay}_{Sct} - \texttt{DivPay}_{Ect}$, where $\texttt{g}_{ict}$ are idiosyncratic shocks obtained by projecting out firm effects, country-sector-time effects and controls: growth rate of lagged firm total assets, lagged change in leverage, and lagged change in tangibility (see main text for details). I denote the fitted values from this stage as $\widetilde{g_{ct}} = \widetilde{\texttt{DivPay}}_{ct}$. The combined effects are estimated with simple OLS; permanent effects—by instrumenting $\widetilde{g_{ct}}$ with $\left(\widetilde{g_{ct-1}} + \widetilde{g_{ct}} + \widetilde{g_{ct+1}}\right)$ and transitory effects—by instrumenting $\widetilde{g_{ct}}$ with $\widetilde{g_{ct+1}}$. The "dagger" in the "shock" variable refers to the fact that a two-step IV estimation procedure is used in the corresponding panels. Columns refer to log-differences in various outcomes for the aggregate household sector: labor income ($\texttt{LabPay}^{\texttt{hh}}$), total primary income ($\texttt{Inc}^{\texttt{hh}}$), adjusted disposable income ($\texttt{DispInc}^{\texttt{hh}}$), adjusted saving ($\texttt{Saving}^{\texttt{hh}}$), total actual consumption ($\texttt{Cons}^{\texttt{hh}}$), and total actual real consumption ($\texttt{Cons}^{real,\texttt{hh}}$) using all-items HICP with base year 2015. Time sample: 1999–2019. Country sample: Europe-25 (Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, and United Kingdom). Standard errors are clustered by country and are reported in parentheses. Also reported are number of observations and the F-statistic from the first stage. Source: Eurostat.

Appendix: Chapter 3

Channels of Risk Sharing in the Eurozone:

What Can Banking and Capital Market Union Achieve?

A3.1 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, Sørensen and Yosha (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, Sørensen and Yosha (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 A3.1 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 A3.1, 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, Maslov and Sørensen (2017).[22] In the United States, banks consolidated across state borders following deregulation and started to operate internal (within-bank) capital markets. Morgan, Rime and Strahan (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, Ostergaard and Sørensen (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, Sørensen and Yosha (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).[23] An important contribution of this paper is that it provides a quantitative-theoretical

[22]Kalemli-Ozcan, Papaioannou and Peydro (2010) document that *de facto* legal implementation of financial integration was uneven after the inception of the euro.

[23]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, Kehoe and Kydland (1992); see for example Heathcote and Perri (2004), Corsetti, Dedola and Leduc (2008), Coeurdacier, Rey and Winant (2015), and many others. This large body of work has delivered many theoretical insights.

underpinning of the decomposition suggested by Asdrubali, Sørensen and Yosha (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, Papaioannou and Peydro (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.

Kalemli-Ozcan, Papaioannou and Perri (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, Papaioannou and Perri (2013), our model incorporates global and local banks but as in Hoffmann, Maslov and Sørensen (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.

A3.2 Channels of Risk Sharing in the Eurozone

A3.2.1 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

$$\Delta \log \frac{C_t^k}{C_t^*} = \beta_U \left[\Delta \log \frac{GDP_t^k}{GDP_t^*} \right] + \tau_{Ut} + \delta_U^k + \varepsilon_{Ut}^k, \tag{A3.1}$$

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.[24] 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, Sørensen and Yosha (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, Sørensen and Yosha (1996) is based on a decomposition of the cross-sectional variance of state output growth. To derive this decomposition, we rewrite country output growth as

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

where $\widetilde{gdp}$, $\widetilde{gni}$, $\widetilde{nni}$, and $\widetilde{nndi}$ denote the logarithms of gross domestic product, gross national income (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

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

[24] 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 (A3.1) 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.[25]

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.

[25] 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.

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

$$\begin{aligned}
\Delta\widetilde{gdp}_t^k - \Delta\widetilde{gni}_t^k &= \beta_I \Delta\widetilde{gdp}_t^k + \tau_{It} + \delta_I^k + \varepsilon_{It}^k, \\
\Delta\widetilde{gni}_t^k - \Delta\widetilde{nni}_t^k &= \beta_D \Delta\widetilde{gdp}_t^k + \tau_{Dt} + \delta_D^k + \varepsilon_{Dt}^k, \\
\Delta\widetilde{nni}_t^k - \Delta\widetilde{nndi}_t^k &= \beta_F \Delta\widetilde{gdp}_t^k + \tau_{Ft} + \delta_F^k + \varepsilon_{Ft}^k, \qquad \text{(A3.2)} \\
\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k &= \beta_C \Delta\widetilde{gdp}_t^k + \tau_{Ct} + \delta_C^k + \varepsilon_{Ct}^k, \\
\Delta\widetilde{c}_t^k &= \beta_U \Delta\widetilde{gdp}_t^k + \tau_{Ut} + \delta_U^k + \varepsilon_{Ut}^k,
\end{aligned}$$

where the coefficients δ_X^k and τ_{Xt} capture country-specific and time fixed effects (for $X = I, D, F, C, U$, respectively).[26] Note that the last equation is just the basic risk sharing regression (A3.1). Each of the channels can be estimated separately by least squares with the same results as a system regression because the equations constitute a "seemingly unrelated regression system" with identical regressors.

The set of regressions (A3.2) 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

$$\beta_{Xt}^k = a_X + b_X \times \left(TB_{t-1}^k - \overline{TB}_{t-1}\right), \qquad \text{(A3.3)}$$

where TB_{t-1}^k 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_{t-1}^k 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, $a_I + b_I \times \left(TB_{t-1}^k - \overline{TB}_{t-1}\right)$ measures the amount of income smoothing obtained by country k in period t with total cross-border lending TB_{t-1}^k. The parameter b_I measures how much higher-than-average bank lending increases the amount of income smoothing obtained. Technically, the first term in (A3.3) 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 $\left(TB_{t-1}^k - \overline{TB}_{t-1}\right)$.

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.

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

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, Luttini and Sørensen (2014) and linearize $\Delta\widetilde{nndi}_t^k - \Delta\widetilde{c}_t^k \approx \Delta\widetilde{\left(\frac{S}{C}\right)}$. Because this expression is linear in 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.

A3.2.2 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.[27] 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.

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

[27] 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.

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.[28]

A3.2.3 Empirical results

Table A3.1 displays the results from estimating the channels decomposition (A3.2), 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

[28] 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.

sharing, we find that the drop in consumption smoothing, 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.[29] 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 A3.1 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 A3.2: 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 A3.2 and A3.3.

Table A3.2 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 (A3.3). 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 (A3.3), 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.

[29] 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.

The regressions presented in the first three columns of Table A3.2 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 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, Ostergaard and Sørensen (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 A3.2 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 A3.2 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 A3.2 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 A3.3 compares the impact of banking flows on risk sharing to that of equity.

The first three columns of Table A3.3 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).[30] 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 A3.3 imply economically important effects of banking and equity market integration 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 A3.2 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 A3.3, 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.

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

A3.2.4 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 A3.4, 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.[31]

The results in Table A3.4 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, this pattern

[31] 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, Luttini and Sørensen (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.

corroborates and extends (on a longer post-crisis sample) the findings of Kalemli-Ozcan, Luttini and Sørensen (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 A3.1 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 A3.1 and A3.2, 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.[32]

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

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

[32]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.

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 A3.3 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 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.

A3.3 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 A3.4 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).[33] Dividends are defined as:

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

[33] 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).

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.[34]

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 $L_t = \phi\left(W_t N_t + I_t\right)$ are one-period bank loans and $F_t = (1-\phi)\left(W_t N_t + I_t\right)$ 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.[35] For tractability, we assume that a fixed fraction τ of total loan 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

[34]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).

[35]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, 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.

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, Papaioannou and Perri (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:

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

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}):

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

where $r_t^{h,\text{LB}}$ 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, $\varphi_t^{\text{LB}} = \frac{1}{2}\varphi^{\text{LB}} \left(\frac{M_t - M}{M}\right)^2$. 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 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}):

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

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 $\mu^{\mathrm{GB}^*} = 1 - \mu^{\mathrm{GB}}$.[36]

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

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

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.[37]

The model implies that interest rates are as follows:

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

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

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

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

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

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:

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

[37] 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.

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

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

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, $(1-\lambda)\text{DIV}_t$, dividend payments from holding the diversified portfolio of firms, $\mu(\lambda\text{DIV}_t + \lambda^*\text{DIV}_t^*)$, and total profits from local and global banks, $\Pi_{t-1}^{\text{LB}} + \mu^{\text{GB}}\Pi_{t-1}^{\text{GB}}$. The household can smooth consumption over time by taking loans from global and local banks: $H_t = H_t^{\text{GB}} + H_t^{\text{LB}}$.

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, $H_t^{\text{GB}} = \kappa H_t$, and satisfy the rest by loans from local banks, $H_t^{\text{LB}} = (1-\kappa) H_t$. The effective household borrowing rate, r_t^h, thus arises as a weighted average of global lending rates, $r_t^{h,\text{GB}}$, and local lending rates, $r_t^{h,\text{LB}}$: $r_t^h = \kappa r_t^{h,\text{GB}} + (1-\kappa) r_t^{h,\text{LB}}$. 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.[38] 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

[38] 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.

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.

Mapping the data to the model

We calibrate our model to replicate the channels of risk sharing regressions as estimated in Table A3.1.

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, $\eta_t,\ \eta_t^{lbs},\ \eta_t^{gbs} \overset{i.i.d.}{\sim} \mathcal{N}(0,\ 1)$, 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 A3.5. The business cycle properties of the calibrated model are given in Table A3.7. 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 A3.6. 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.[39]

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 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.

[39] 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.

A3.4 Model results

A3.4.1 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

$$\frac{C_t}{\text{INC}_t} = (1-\beta)\left(-\frac{H_{t-1}}{\text{INC}_t}\left(1+r^h_{t-1}\right) + \sum_{s=0}^{\infty}\mathbb{E}_t\left[\frac{\text{INC}_{t+s}}{\text{INC}_t}\times\prod_{j=1}^{s}\left(1+r^h_{t+j-1}\right)^{-1}\right]\right) \tag{A3.4}$$

where INC denotes household income and is defined as follows:

$$\text{INC}_t = \text{LABINC}_t + (1-\lambda)\text{DIV}_t + \mu(\lambda\text{DIV}_t + \lambda^*\text{DIV}^*_t) + \text{BANKINC}_t, \tag{A3.5}$$

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.[40]

Equation A3.4 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

[40] 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.

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.

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 (A3.4). 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 A3.3, 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.

A3.4.2 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 A3.1 on model-generated data calibrated to tranquil times (the benchmark) and crisis times. The results are presented in Table A3.8, 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 A3.1. 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 A3.9, 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 A3.2. According to Table A3.9, 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 A3.2. 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.[41] In columns (10)-(12) of Table A3.9, 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 A3.2—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

[41] 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.

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 A3.10, 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 A3.13 and A3.14. The results are in the appendix (Tables A3.15 and A3.16) 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 A3.4 and Figure A3.3 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 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 A3.4, except that we do not model the government sector, for the two subgroups of countries. The results are displayed in Table A3.11. 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 A3.4 is slightly larger). In the model, income risk sharing in the crisis, see the second row of Table A3.11, 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 A3.12, 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 A3.5, 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 A3.6, 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 A3.4 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 A3.11, 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.

A3.5 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, Sørensen and Yosha (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.

References

Artis, Michael J., and Mathias Hoffmann. 2011. "The Home Bias, Capital Income Flows and Improved Long-Term Consumption Risk Sharing between Industrialized Countries." *International Finance*, 14(3): 481–505.

Asdrubali, Pierfederico, Bent E. Sørensen, and Oved Yosha. 1996. "Channels of Interstate Risk Sharing: United States 1963-1990." *Quarterly Journal of Economics*, 111 (4): 1081–1110.

Backus, David K., and Gregor W. Smith. 1993. "Consumption and real exchange rates in dynamic economies with non-traded goods." *Journal of International Economics*, 35(3-4): 297–316.

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland. 1992. "International Real Business Cycles." *Journal of Political Economy*, 100(4): 745–775.

Baxter, Marianne, and Mario J Crucini. 1995. "Business Cycles and the Asset Structure of Foreign Trade." *International Economic Review*, 36(4): 821–854.

Becker, Sascha O., and Mathias Hoffmann. 2006. "Intra- and international risk-sharing in the short run and the long run." *European Economic Review*, 50(3): 777–806.

Blanchard, Olivier, and Jordi Galí. 2007. "Real Wage Rigidities and the New Keynesian Model." *Journal of Money, Credit and Banking*, 39: 35–65.

Bruno, Valentina, and Hyun Song Shin. 2015. "Cross-Border Banking and Global Liquidity." *Review of Economic Studies*, 82(2): 535–564.

Canova, Fabio, and Morten O. Ravn. 1996. "International Consumption Risk Sharing." *International Economic Review*, 37(3): 573–601.

Cochrane, John H. 1991. "A Simple Test of Consumption Insurance." *Journal of Political Economy*, 99 (5): 957–76.

Coeurdacier, Nicolas, Hélène Rey, and Pablo Winant. 2015. "Financial Integration and Growth in a Risky World." C.E.P.R. Discussion Papers CEPR Discussion Papers 11009.

Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc. 2008. "International Risk Sharing and the Transmission of Productivity Shocks." *Review of Economic Studies*, 75(2): 443–473.

Demyanyk, Yuliya, Charlotte Ostergaard, and Bent E. Sørensen. 2007. "U.S. Banking Deregulation, Small Businesses, and Interstate Insurance of Personal Income." *Journal of Finance*, LXII, No. 6: 2763–2801.

Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti. 2010. "Credit and Banking in a DSGE Model of the Euro Area." *Journal of Money, Credit and Banking*, 42: 107–141.

Hale, Galina, and Maurice Obstfeld. 2014. "The euro and the geography of international debt flows." Federal Reserve Bank of San Francisco Working Paper Series 2014-10.

Heathcote, Jonathan, and Fabrizio Perri. 2004. "Financial globalization and real regionalization." *Journal of Economic Theory*, 119(1): 207–243.

Heathcote, Jonathan, and Fabrizio Perri. 2013. "The International Diversification Puzzle Is Not as Bad as You Think." *Journal of Political Economy*, vol. 121(6): 1108–1159.

Hoffmann, Mathias, and Iryna Shcherbakova-Stewen. 2011. "Consumption Risk Sharing over the Business Cycle: The Role of Small Firms' Access to Credit Markets." *The Review of Economics and Statistics*, 93(4): 1403–1416.

Hoffmann, Mathias, Egor Maslov, and Bent E. Sørensen. 2017. "Small Firms and Domestic Bank Dependence in Europe's Great Recession." University of Zurich.

Kalemli-Ozcan, Sebnem, Bent E. Sørensen, and Oved Yosha. 2005. "Asymmetric Shocks and Risk Sharing in a Monetary Union: Updated Evidence and Policy Implications for Europe."

Kalemli-Ozcan, Sebnem, Elias Papaioannou, and Fabrizio Perri. 2013. "Global banks and crisis transmission." *Journal of International Economics*, 89(2): 495 – 510.

Kalemli-Ozcan, Sebnem, Elias Papaioannou, and José-Luis Peydro. 2010. "What lies beneath the euro's effect on financial integration? Currency risk, legal harmonization, or trade?" *Journal of International Economics*, 81(1): 75 – 88.

Kalemli-Ozcan, Sebnem, Emiliano Luttini, and Bent E. Sørensen. 2014. "Debt Crises and Risk-Sharing: The Role of Markets versus Sovereigns." *The Scandinavian Journal of Economics*, 116(1): 253–276.

Kollmann, Robert. 1995. "Consumption, real exchange rates and the structure of international asset markets." *Journal of International Money and Finance*, 14(2): 191–211.

Lane, Philip R. 2012. "The European Sovereign Debt Crisis." *Journal of Economic Perspectives*, 26(3): 49–68.

Lane, Philip R., and Gian Maria Milesi-Ferretti. 2007. "The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970-2004." *Journal of International Economics*, 73(2): 223–250.

Lewis, Karen K. 1996. "What Can Explain the Apparent Lack of International Consumption Risk Sharing?" *Journal of Political Economy*, 104(2): 267–297.

Mace, Barbara. 1991. "Full Insurance in the Presence of Aggregate Uncertainty." *Journal of Political Economy*, 99 (5): 928–56.

Martin, Philippe, and Thomas Philippon. 2017. "Inspecting the Mechanism: Leverage and the Great Recession in the Eurozone." *American Economic Review*, 107(7): 1904–1937.

Morgan, Donald P., Bertrand Rime, and Philip E. Strahan. 2004. "Bank Integration and State Business Cycles." *Quarterly Journal of Economics*, 119 (4): 1555–85.

Neumeyer, Pablo A., and Fabrizio Perri. 2005. "Business Cycles in Emerging Economies: The Role of Interest Rates." *Journal of Monetary Economics*, 52(2): 345–380.

Obstfeld, Maurice. 1993. "Are Industrial-Country Consumption Risks Globally Diversified?" National Bureau of Economic Research, Inc NBER Working Papers 4308.

Petersen, Mitchell A., and Raghuram G. Rajan. 1994. "The Benefits of Lending Relationships: Evidence from Small Business Data." *The Journal of Finance*, 49(1): 3–37.

Schmitt-Grohé, Stephanie, and Martín Uribe. 2003. "Closing Small Open Economy Models." *Journal of International Economics*, 61(1): 163–185.

Sharpe, Steven A. 1990. "Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships." *The Journal of Finance*, 45(4): pp. 1069–1087.

Sørensen, Bent E., and Oved Yosha. 1998. "International risk sharing and European monetary unification." *Journal of International Economics*, 45(2): 211–238.

Sørensen, Bent E., Yi-Tsu Wu, Oved Yosha, and Yu Zhu. 2007. "Home Bias and International Risk Sharing: Twin Puzzles Separated at Birth." *Journal of International Money and Finance*, 26: 587–605.

Townsend, Robert M. 1994. "Risk and Insurance in Village India." *Econometrica*, 62: 539–91.

Whelan, Karl. 2014. "TARGET2 and central bank balance sheets." *Economic Policy*, 29(77): 79–137.

Whelan, Karl. 2017. "Should we be concerned about TARGET balances?" European Parliament.

Tables and Figures

TABLE A3.1. 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 A3.2. 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 A3.3. 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 A3.4. 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	$\Delta\widetilde{\mathrm{gdp}}_t^k$	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	$\Delta\widetilde{\mathrm{gdp}}_t^k$	−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 A3.5. 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 A3.6.

Table A3.6. 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:

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

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

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

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., $X_c^* = \sum_{j \neq c} \frac{\mathrm{GDP}_j}{\mathrm{GDP}_c^*} \times X_j$, where X_c is one of: $\mathrm{B2B}_c$, $\mathrm{B2N}_c$, τ_c, and κ_c; c is a country index. For equity, we assume $\text{Equity}_c^* = \text{Equity}^{EMU}$.

Table A3.7. 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 A3.8. 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 A3.9. 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 $\Delta x_t = \beta_X^k(t)\Delta\widetilde{gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \boldsymbol{c}_X'\boldsymbol{z}_t^k + \varepsilon_{Xt}^k$ 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 A3.10. 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 A3.11. 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)

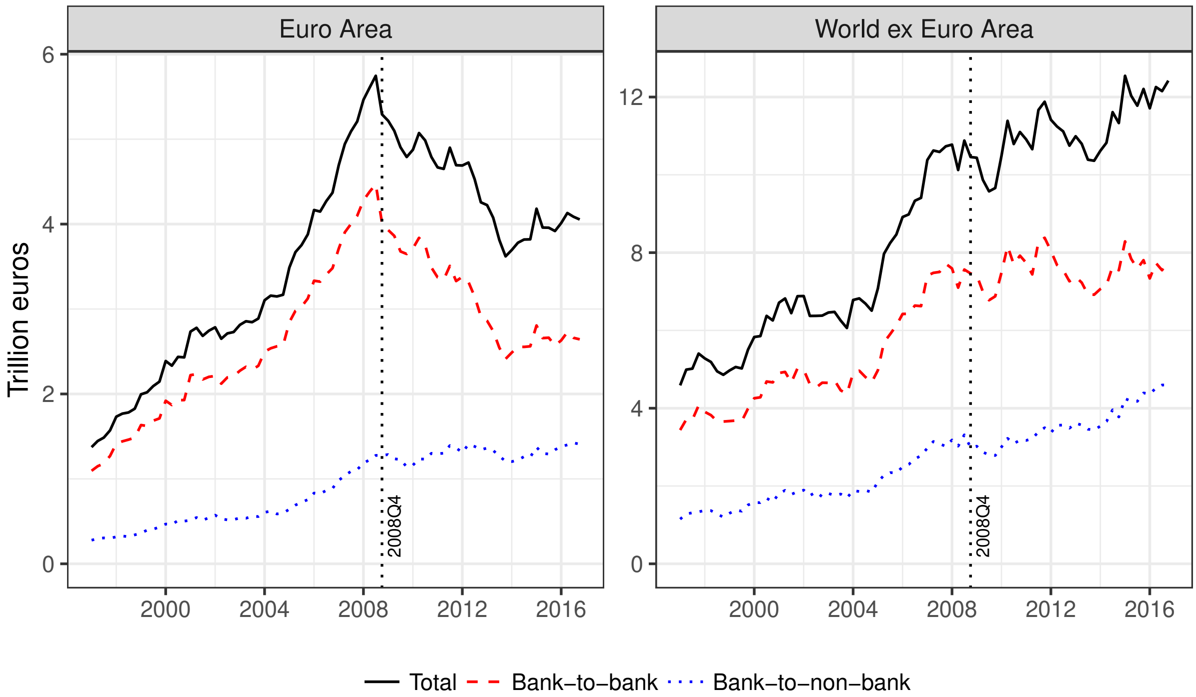
NOTES: The table reports the model simulation results of the panel OLS regressions $\Delta x_t^k = \beta_X \Delta\widetilde{gdp}_t^k + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ with $x = \widetilde{gdp} - \widetilde{gni}$, $\widetilde{nni} - \widetilde{c}$, $\widetilde{c}$ for I, 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 A3.12. 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.

Figure A3.1. Cross-Border Bank Lending in the Eurozone and Other Advanced Countries

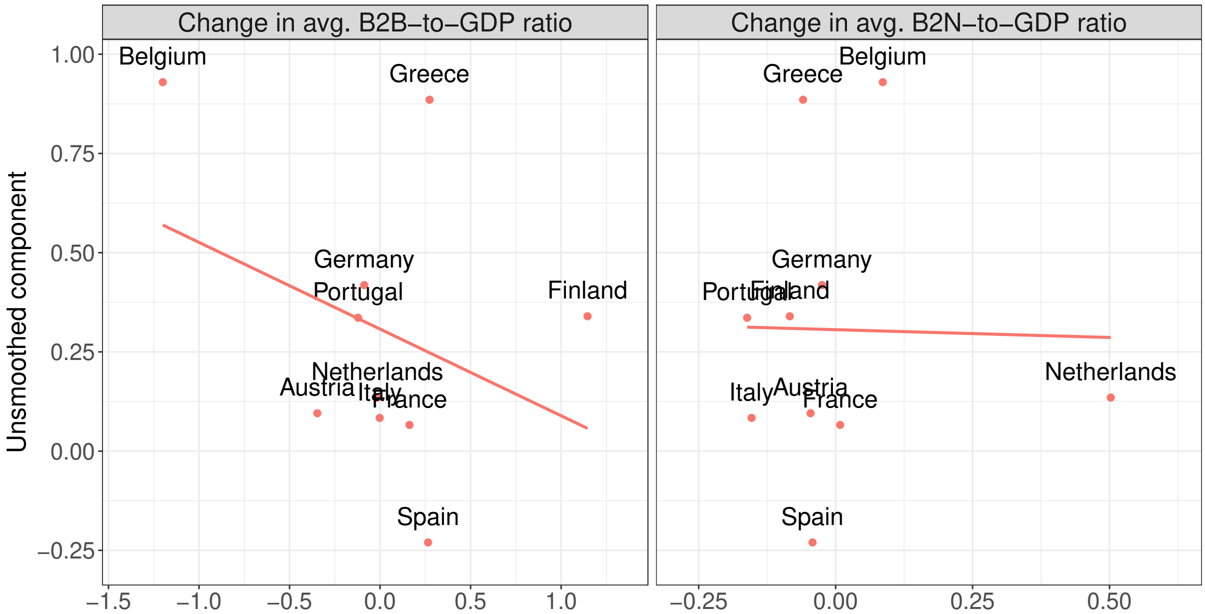


NOTES: The figure plots cross-border lending by foreign banks to 19 eurozone economies ("Euro Area") and a sample of 118 other advanced and developing countries ("World ex Euro Area"). The black solid line shows total lending, the red dashed line shows lending by foreign banks to domestic banks, and 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 A3.2. Income and Consumption Smoothing, 1999–2013

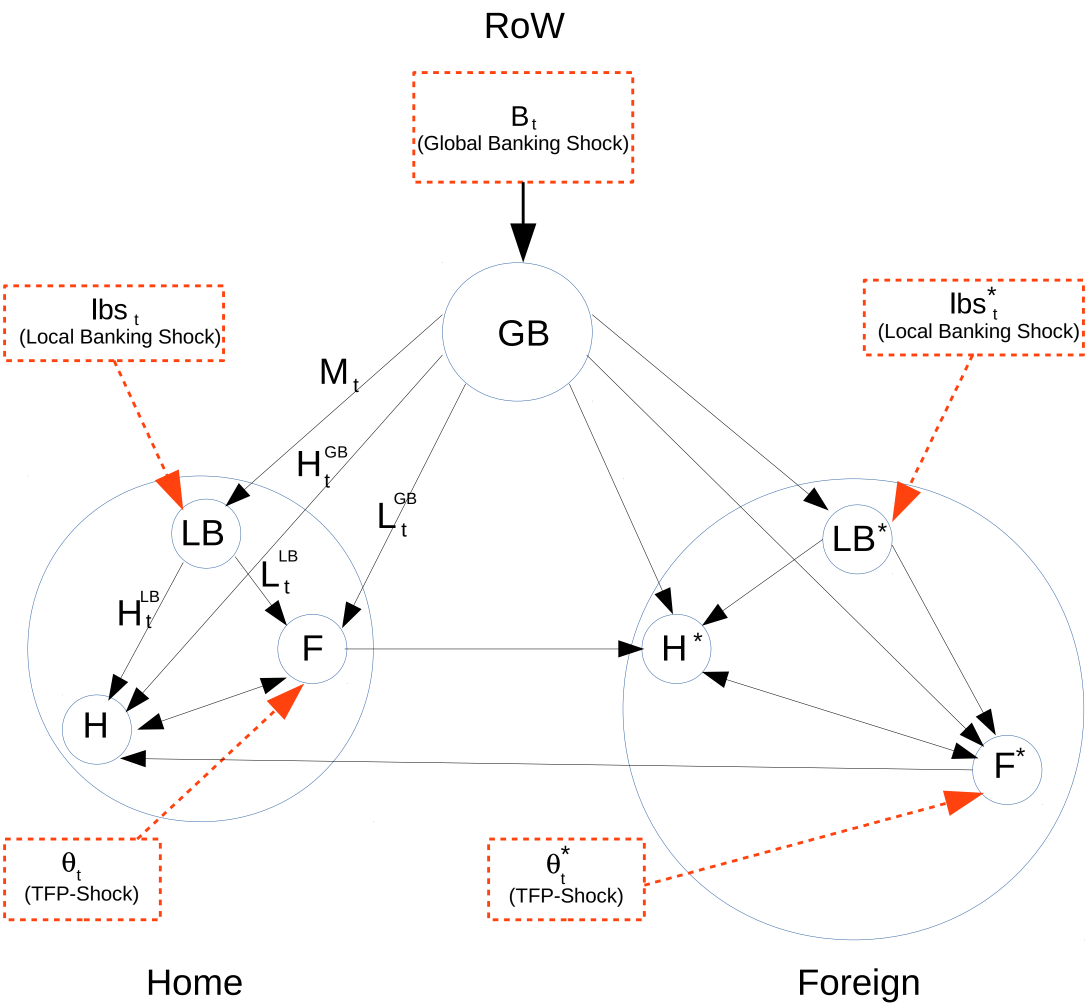
NOTES: The figure plots the degree of income smoothing ($\beta_I(t)$, green dot-dashed line) and consumption smoothing ($\beta_C(t)$, red long-dashed line). The coefficients $\beta_I(t)$ and $\beta_C(t)$ are estimated from cross-sectional regressions $\widetilde{\Delta gdp_t^k} - \widetilde{\Delta gni_t^k}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

FIGURE A3.3. CHANGE IN COUNTRY-SPECIFIC RISK SHARING VS. CHANGE IN BANKING INTEGRATION



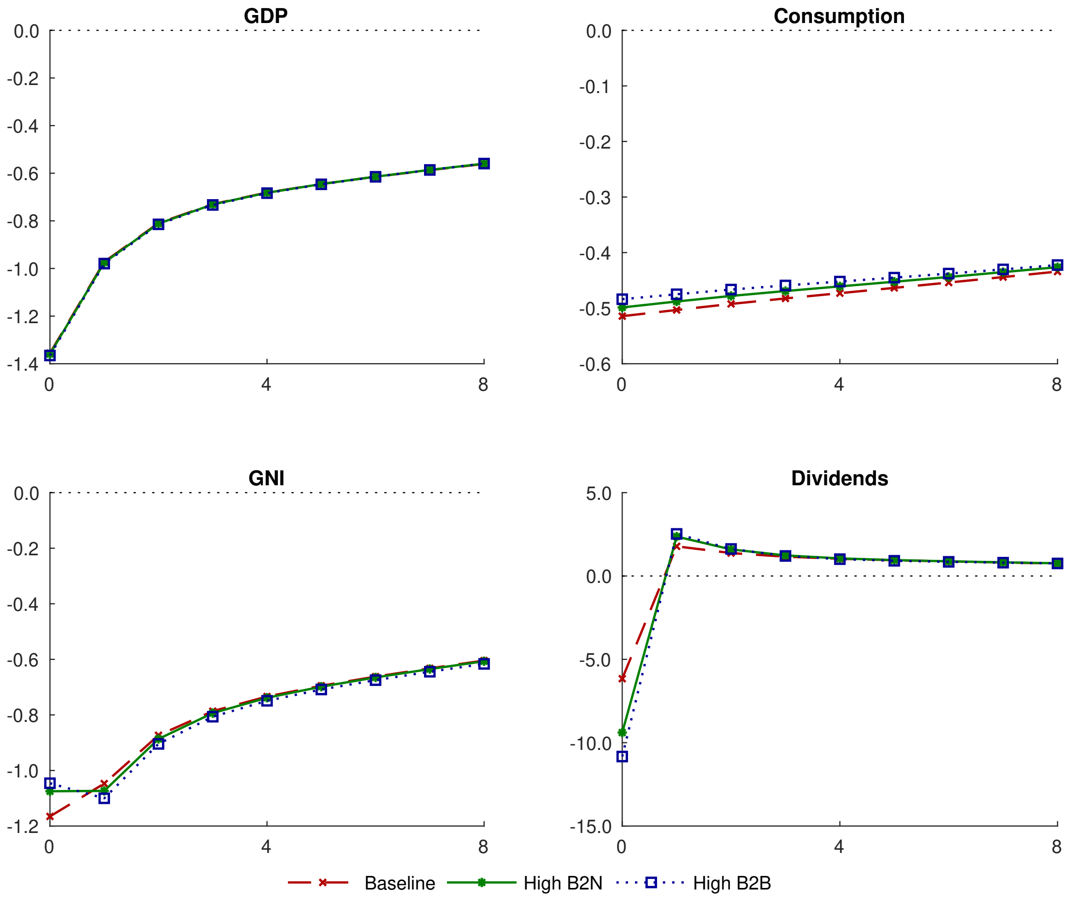
NOTES: The figure displays on the y-axis the post-2008 minus the pre-2008 coefficient to consumption growth in a regression on GDP growth, controlling for time fixed effects, interpreted as the amount of GDP shocks not smoothed (the fraction of risk not shared) estimated country-by-country—see the main 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 A3.4. Model Economy



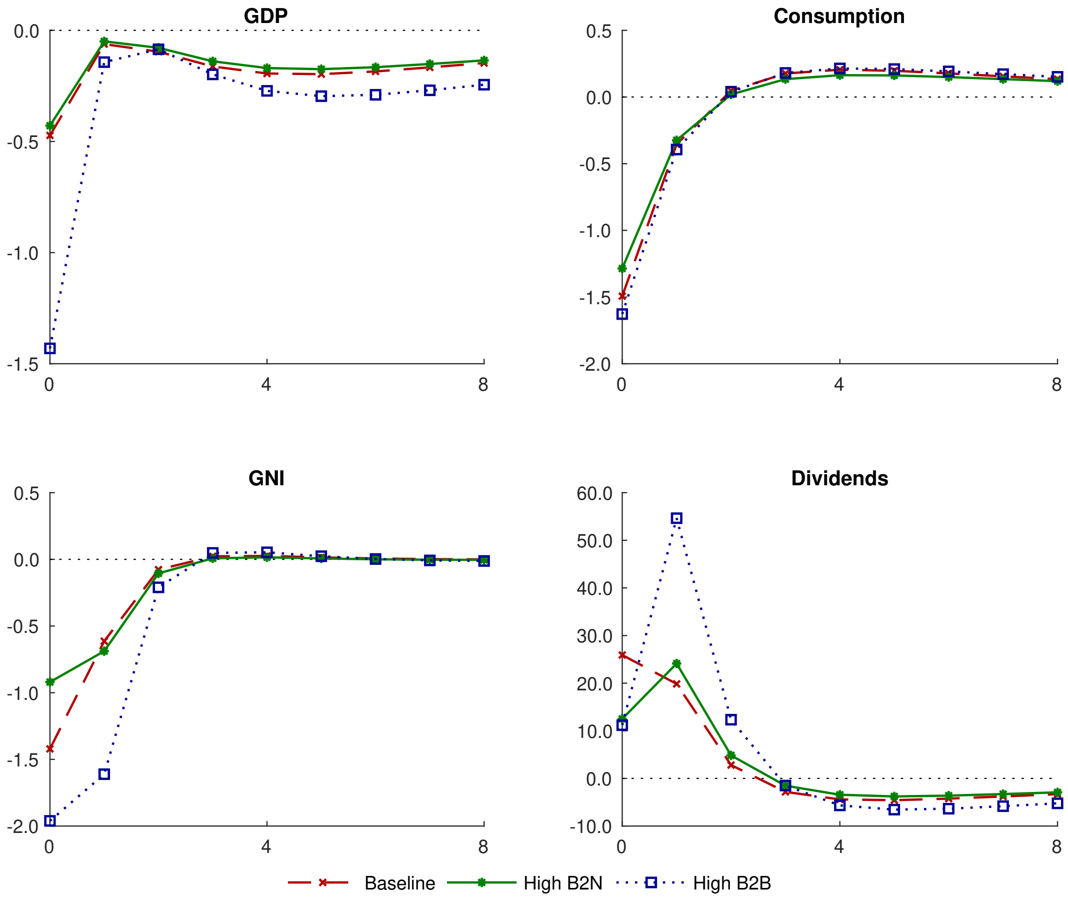
NOTES: The figure outlines the structure of our model. GB refers to global banks. The circle to the left is the domestic economy while the larger circle to the right is the rest of the eurozone. Apart from size, the foreign and the domestic economies are symmetric. LB denotes local banks, H denotes households, 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 A3.5. Model Impulse Response Functions to a Domestic TFP Shock



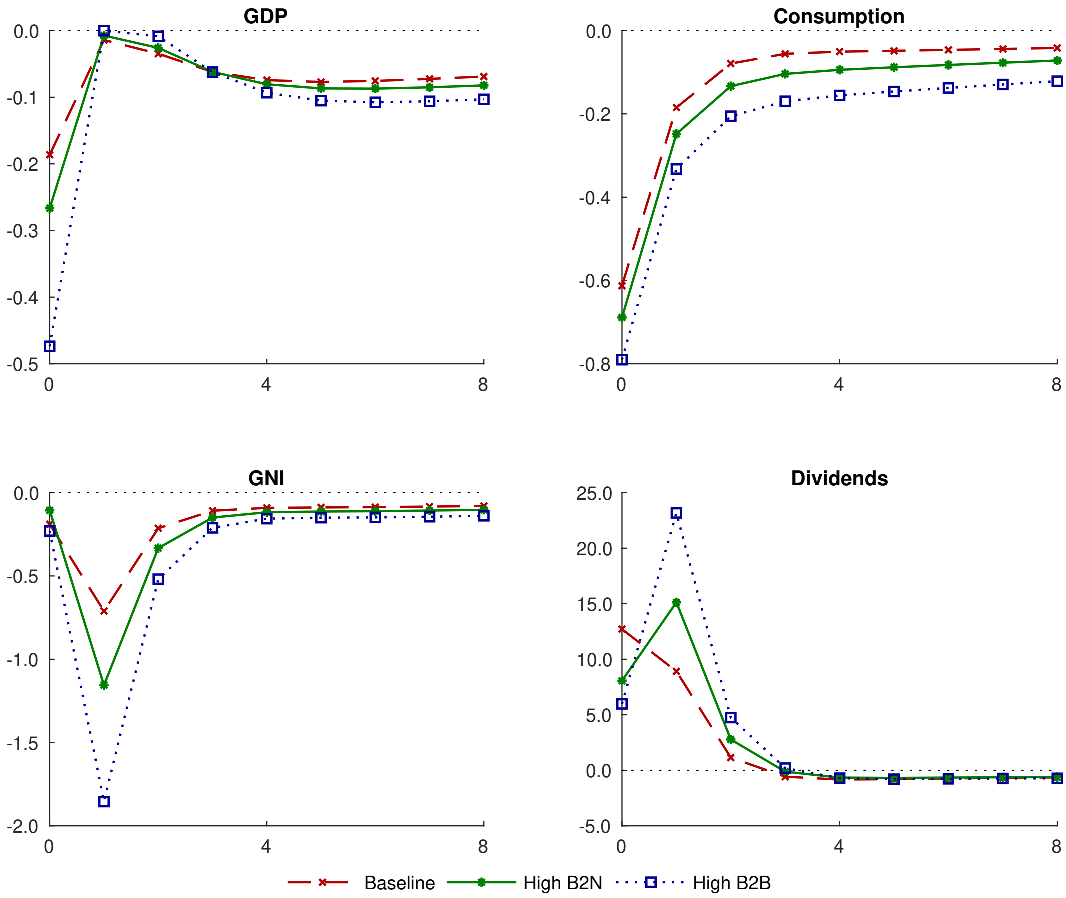
NOTES: The figure plots the model impulse response functions for GDP, Consumption, GNI, and firm dividends to a domestic TFP shock. Three scenarios are presented: (1) Baseline, in which all variables are set to average values: dashed red line with (*); (2) High B2N, in which direct bank-to-nonbank lending 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 A3.6. 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 A3.7. 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.

Appendix

See Tables A3.13, A3.14, A3.15 and A3.16.

Table A3.13. 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
$\widetilde{\Delta \mathrm{gdp}_t^k}$	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)
$\widetilde{\frac{\mathrm{TB}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \widetilde{\Delta \mathrm{gdp}_t^k}$	0.10	−0.12	0.01									
	(0.71)	(−0.59)	(0.05)									
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \widetilde{\Delta \mathrm{gdp}_t^k}$				0.11	−0.15	0.02				0.10	−0.16	0.05
				(0.66)	(−0.62)	(0.12)				(0.55)	(−0.57)	(0.36)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \widetilde{\Delta \mathrm{gdp}_t^k}$							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 $\Delta x_t^k = \beta_X \widetilde{\Delta gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \varepsilon_{Xt}^k$ 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 A3.14. 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
$\Delta\widetilde{\mathrm{gdp}_t^k}$	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)
$\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	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)			
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				0.01	−0.16	0.11						
				(0.10)	(−0.68)	(1.61)						
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.03	−0.23	0.35			
							(0.08)	(−0.44)	(1.16)			
$\left(\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} + \widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}}\right) \times \Delta\widetilde{\mathrm{gdp}_t^k}$										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 $\Delta x = \Delta\left(\widetilde{\frac{S_{Public}}{C}}\right)$ or $\Delta x = \Delta\left(\widetilde{\frac{S_{Priv}}{C}}\right)$, where S_{Public} and S_{Priv} are public and private saving, respectively and $S_{Public} + S_{Priv} = S = NNDI - C$. $\boldsymbol{d}_{Xt}^k$ contains country and time fixed effects. Standard errors are in parentheses and clustered by country.
EMU10: Belgium, Germany, Finland, Italy, Greece, Spain, France, Netherlands, Austria, and Portugal. Time period is 2009Q1-2013Q4.

Table A3.15. 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 A3.16. 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
$\Delta\widetilde{\mathrm{gdp}_t^k}$	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)
$\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$	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)			
$\widetilde{\frac{\mathrm{B2B}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$				–0.11	–0.02	0.17				–0.00	–0.14	0.16
				(–0.36)	(–0.06)	(1.01)				(–0.00)	(–0.37)	(1.04)
$\widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} \times \Delta\widetilde{\mathrm{gdp}_t^k}$							0.73	–1.09	0.19			
							(0.29)	(–0.36)	(0.10)			
$\left(\widetilde{\frac{\mathrm{E}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}} + \widetilde{\frac{\mathrm{B2N}_{t-1}^k}{\mathrm{GDP}_{t-1}^k}}\right) \times \Delta\widetilde{\mathrm{gdp}_t^k}$										0.50	–0.78	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 $\Delta x_t = \beta_X^k(t)\Delta\widetilde{gdp_t^k} + \boldsymbol{d}_{Xt}^{k\prime}\mathbf{1} + \boldsymbol{c}_X'\boldsymbol{z}_t^k + \varepsilon_{Xt}^k$ 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).

Curriculum Vitae

EGOR MASLOV

Born May 11^{th} 1989
in Russian Federation
Russian national

Education

08/2014 – 10/2020	SFI PhD Program in Finance – University of Zurich, Swiss Finance Institute, URPP FinReg
08/2012 – 10/2014	MA in Economics – University of Zurich, Department of Economics
09/2006 – 06/2011	Specialist in International Relations – Lomonosov Moscow State University, Faculty of Global Studies

Professional experience

08/2015 – present	Research and Teaching Assistance – University of Zurich, Department of Economics, Chair of Prof. Dr. Mathias Hoffmann
03/2013 – 08/2015	Research Assistance – University of Zurich, Department of Economics, Chair of Prof. Dr. Mathias Hoffmann

August, 2020