Risk Sharing and Amplification in the Global Financial Network*

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Abstract

We estimate the price elasticities of cross-border loan supply and demand across 19 countries, using a structural model of the global financial network and balance sheet data of internationally-active banks. We find significant heterogeneity in the willingness and capacity of global banks to provide interbank and non-financial loans. We show that this heterogeneity is key to explaining the variation in risk sharing and shock propagation both across countries and over time. In particular, cross-border lending supply has become less elastic since the global financial crisis, resulting in a weakening of international risk sharing. We provide suggestive evidence that the tightening of macroprudential policy has contributed to the decline in risk sharing.

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1 Introduction

Global financial intermediaries are central to the international financial architecture. They intermediate approximately $30 trillion of cross-border capital flows annually and provide more than 20 percent of total private credit in the average developed economy, playing a key role in facilitating international risk sharing (Gabaix and Maggiori 2015, Miranda-Agrippino and Rey 2020).[1] At the same time, they propagate shocks across borders: during the Global Financial Crisis (GFC), global banks transmitted shocks to both banks and non-financial corporations (nonbanks) abroad, resulting in a freezing of the global interbank market and significant contraction of cross-border corporate lending.[2] These observations have prompted a growing strand of literature that analyzes how financial intermediaries propagate shocks globally; however, such analysis is typically conducted through the lens of models featuring one representative bank subject to frictions (see, e.g., Mendoza 2010, Dedola, Karadi, and Lombardo 2013, Bruno and Shin 2015, and Aoki, Benigno, and Kiyotaki 2016). In contrast, we show that *heterogeneity* in the willingness and capacity of global financial intermediaries to provide intermediary services, both across countries and over time, is key to explaining international risk sharing and shock propagation.

In this paper, we develop a structural model of the global financial system that features a two-tier network structure, incorporating both the global interbank network and the global credit network. The former network captures the bilateral cross-border lending relationships that global banks form with each other, and the latter network captures the relationships that the banks form with nonbanks (i.e. firms). These two networks make up what we define as the global financial network. The model centers on global banks' lending decisions across countries and the bank and nonbank sectors, jointly accounting for endogenous supply and demand of cross-border bank loans, as well as endogenous lending prices and exchange rates.

We estimate the model using balance sheet data of internationally active banks from 19 countries over the period 2005–2019 and provide, for the first time, time-varying bilateral

[1] As shown in Appendix Figure A.1, global banks have intermediated approximately $15 trillion of cross-border bank capital flows and $15 trillion of cross-border nonbank capital flows (i.e., cross-border capital to non-financial sectors) every year over the past decade.

[2] At the peak of the GFC, the LIBOR-OIS spread, a primary measure of interbank lending rates, increased to over 300 bps, in contrast to the pre-crisis level of less than 10 bps.

and aggregated estimates of supply and demand elasticities for cross-border interbank and nonbank lending. Our estimates reveals significant heterogeneity in global banks' willingness and capacity to lend across different countries in the global financial network. We show that this heterogeneity explains the variation in the amount of insurance different countries receive in response to a negative local funding shock, where insurance is defined as the extent of funding inflows relative to the size of the shock. Borrower countries with lower supply elasticities receive less insurance against local funding shocks because banks in the network are less willing to rebalance toward them or because the banks that are willing have lower capacity to do so. As such, our results show that heterogeneity in global financial intermediation is key to determining the extent of risk sharing across countries.

Moreover, our analysis reveals that the elasticity of cross-border loan supply has significantly declined since the GFC. As a result, the extent of insurance provision by banks in the global financial network has weakened to the extent that local funding shocks can get amplified in some countries that the network used to insure. We provide evidence suggesting that greater stringency of macroprudential policy instruments has contributed to the decline in international risk sharing.

Our study provides one of the first systematic analyses of the role of the global financial network in facilitating risk sharing and propagating shocks around the world. While the existing literature commonly analyzes these questions through the lens of models featuring one representative financial intermediary, we argue that the diverse, complex, and evolving bilateral relationships that banks form with the financial and non-financial sectors across different countries are important for a more comprehensive analysis. As such, we provide a general and unified theoretical framework that integrates multiple financial networks, sectors, and countries and thereby allows a joint analysis of shock propagation within and across countries and sectors as well as over time. The model can be readily applied to study a broad range of questions about spillover effects. In particular, our result on the tight link between heterogeneity in loan supply elasticities and insurance provision throughout the global financial network offers a novel way to understanding the role of global financial intermediaries in facilitating risk sharing. Our analysis is also one of the first that quantifies how the nature of international risk sharing has evolved since the GFC and connects its

evolution to changing stringency in macroprudential instruments.

Our analysis uses a portfolio-based approach to study how the global financial network contributes to risk sharing across countries and sectors. Building on the recent studies by Koijen and Yogo (2019) and Koijen and Yogo (2020), we model each banking sector's allocation of cross-border interbank and nonbank loans across countries as a function of observed and unobserved characteristics of the borrower countries and of the bilateral relations between the lender and borrower countries. Moreover, we incorporate two new elements in the model. First, we introduce a two-layer network structure in the banks' portfolio choice framework, allowing each bank to borrow funds from the interbank network and allocate assets across countries within the interbank network and the bank-firm credit network as well as across the two networks. This endogenizes each banking sector's assets under management (AUM). Second, we allow demand for loans to adjust endogenously with changes in prices. In equilibrium, the banking sector AUMs and lending prices, including interest rates and exchange rates, are endogenous and must adjust to ensure that the market value of loans supplied equals the market value of loans demanded in both the bank and nonbank sectors. Taken together, the estimated supply and demand curves, along with the market clearing conditions for loans in the bank and nonbank sectors, constitute the global financial network.

To estimate the network system, we compile a database of cross-border and domestic interbank and bank-nonbank lending using the Locational Banking Statistics (LBS) from the Bank for International Settlements (BIS). The cross-border lending data contain bilateral interbank and bank-nonbank flows between source and destination countries, allowing us to construct a complete global interbank and credit network for 19 sample countries. We supplement the database with corresponding data on loan prices and variables that capture characteristics of the borrowers, lenders, and their bilateral relationships from Bloomberg, statistical databases from central banks, the World Bank, and the IMF. Using the data set, we estimate supply and demand curves for cross-border interbank and bank-to-nonbank lending using an instrumental variable approach, following Koijen and Yogo (2020) and Jiang, Richmond, and Zhang (2020), as prices on loans may be endogenous to the latent supply and demand of the lenders. We also estimate the loan supply and demand curves

using 7-year rolling subsamples of the data in order to study the evolution of loan supply and demand over the sample period. We find that the price elasticities of cross-border interbank and nonbank loan supply average 89 and 36, respectively, across the borrower countries over the sample period. If translated to elasticity with respect to yield, our estimates indicate that a one percentage point increase in lending rate leads to a 22 (36) percent increase in the quantity of cross-border interbank (nonbank) loans supplied. The estimate of the elasticity of cross-border nonbank loan supply is comparable to that of cross-border long-term debt supply from Koijen and Yogo (2020).

Moreover, our estimation results reveal substantial variation in supply elasticities across the borrower countries, which highlights stark heterogeneity in the willingness and capacity of intermediaries to provide loans in the global financial network. To quantify the implications of the heterogeneity for international risk sharing, we conduct a series of counterfactual analysis to study the extent of insurance provided by the global financial network in response to local funding shocks using the estimated structural model. We propose a decomposition that dissects the aggregate effect of a negative local funding shock into a shock effect and three rebalancing effects. The shock effect captures all immediate effects of the funding shock, holding all banking sectors' portfolio allocations fixed. The three rebalancing effects—global interbank rebalancing, global credit rebalancing, and self-rebalancing—capture the effects from endogenous portfolio reallocation in response to the shock. Global interbank rebalancing captures the extent of fund reallocation toward or away from the banking sectors in response to a shock. Similarly, global credit rebalancing captures the extent of fund reallocation toward or away from the nonbank sectors in response to a shock. Self-rebalancing captures domestic banks' retrenchment of funding back to their respective home countries as well as their intermediation of foreign funding from global interbank rebalancing.

Our analysis shows that the three margins of rebalancing serve as key mechanisms of insurance provision for the countries experiencing a local funding shock. In response to a one percent local funding shock, the network mitigates the shock effect by an average of 16 percent for each banking sector through global interbank rebalancing and by an average of 39 percent for each nonbank sector through global credit and self-rebalancing, with significant variation in the amount of insurance provision across countries. We show that the variation

in insurance provision is governed by the heterogeneity in the elasticities of interbank and nonbank loan supply. Borrower countries with lower supply elasticities receive less insurance against local funding shocks because banks in the network are less willing to rebalance toward that country's banks and firms, or the banks that are willing have lower capacity to do so.

In addition to studying the heterogeneity in loan supply elasticities in the cross section, we examine how these elasticities and thereby global insurance have evolved over time. We show that the elasticity of cross-border loan supply significantly declined after the GFC, indicating that loan supply has become less responsive to changes in prices. The supply elasticity of cross-border interbank and nonbank loans decreased by 92 percent and 36 percent, respectively, after 2010. The decline in the elasticities of cross-border loan supply has weakened the amount of insurance provision in the global financial network. The amount of insurance through global interbank rebalancing decreased from an average of 16 percent of the shock effect in 2010 to an average of 1 percent by the end of the sample period. Similarly, insurance through global credit rebalancing and self-rebalancing decreased from an average of 39 percent to an average of 30 percent.

When we study the effects of a one percent local funding shock in the present year based on extrapolated elasticities of cross-border loan supply and demand, we find that the insurance mechanism is fully dominated by forces of shock amplification for a few banking sectors. Local funding shocks are amplified for a few banking sectors through the margin of global interbank rebalancing, as foreign banks reallocate funding away from the banking sectors hit by local funding shocks.

Furthermore, in the scenario of a global funding shock similar to the GFC, we find that the insurance mechanisms in the global financial network break down as funding shocks increase in magnitude and scope. Moreover, in the event of a global funding shock of similar magnitude to that during the GFC, there would be less insurance in the global financial network in the post-GFC period compared to the GFC period.

Finally, we explore one potential explanatory factor for the decline in global insurance over the past decade—greater stringency in regulatory and macroprudential policies. We provide suggestive evidence that great stringency in macroprudential instruments has contributed to the decline in insurance provision in the network.

Related Literature Our paper is related to several strands of literature. First, it contributes to the literature on the role of banks in propagating shocks in financial systems and, more broadly, on (international) transmission of liquidity shocks.[3] Theoretical and reduced-form empirical papers have highlighted how bank credit supply shocks can lead to a significant decline in lending to other banks and firms both in a one-country setting (Holmstrom and Tirole 1997, Khwaja and Mian 2008, Gertler and Kiyotaki 2010) and in an international context (Peek and Rosengren 2000, Schnabl 2012, Hale 2012, Dedola et al. 2013, Kalemli-Ozcan, Papaioannou, and Peydro 2013, Kalemli-Ozcan, Papaioannou, and Perri 2013, Niepmann 2015, Bruno and Shin 2015, Amiti and Weinstein 2018, Miranda-Agrippino and Rey 2020, Hale, Kapan, and Minoiu 2020, Shen 2020). In particular, building on the closed-economy macro literature on channels of monetary policy transmission (Bernanke and Gertler 1995, Borio and Zhu 2012), the more recent international finance literature has tested for these transmission channels through global banks, including the bank-lending channel (Cetorelli and Goldberg 2012, Ivashina, Scharfstein, and Stein 2015, Temesvary, Ongena, and Owen 2018) and the risk-taking channel (Morais, Peydró, Roldán-Peña, and Ruiz-Ortega 2019, Correa, Paligorova, Sapriza, and Zlate 2021).

We contribute to this literature on four fronts. First, we provide a theoretical framework that integrates multiple financial networks, assets, sectors, and countries and thereby allows a joint analysis of shock propagation both within and across countries and sectors, whereas the existing literature mostly studies propagation through the lens of models with a single representative bank. To that end, our work is part of the recent literature that emphasizes the importance of heterogeneity in financial intermediaries for understanding questions of financial stability including Coimbra and Rey (2021). Second, we advance the existing literature, which tends to be either entirely theoretical or empirical, by connecting the theory to empirics as we formally estimate the elasticities of cross-border loan supply and demand in both the global interbank and credit networks, using data that fully map to the structure of the networks. To our knowledge, we provide the first estimates of supply elasticities for cross-border bank lending. Third, we offer new insights on the role of global financial intermediaries

[3]Besides the papers that we discuss in the subsequent paragraphs, see Buch and Goldberg (2020) for additional literature on the international transmission of liquidity shocks through banks.

in facilitating international risk sharing by revealing the tight link between heterogeneity in cross-border loan supply elasticities and insurance provision through different margins of loan rebalancing. Fourth, we are one of the first papers to quantify the changes in insurance provision in the global financial system since the GFC. In particular, while Shin (2014), Avdjiev, Gambacorta, Goldberg, and Schiaffi (2020), and Forbes and Warnock (2021) call attention to a de-globalization in global banking during the post-GFC era, we show that de-globalization has been concentrated in global interbank lending.

Our work also contributes to the literature on financial networks.[4] Allen and Gale (2000) and Freixas, Parigi, and Rochet (2000) provided some of the first models that formally characterize the relation of interconnected networks to the resilience and fragility of the financial system. More recent papers including Elliott, Golub, and Jackson (2014), Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015), and Cabrales, Gottardi, and Vega-Redondo (2017) revisit these arguments and highlight the trade-off between risk sharing and contagion in financial networks—a takeaway that is the broadly echoed by our results on the role of the global financial network in both providing insurance and inducing amplification. In particular, our finding that the insurance mechanism breaks down as a shock increases in scope is largely in line with the argument in Acemoglu et al. (2015). However, we arrive at our results using a completely different approach that integrates endogenous interactions among multiple financial networks and between the financial and non-financial sectors instead of focusing on interactions within a single static network in which all the nodes are symmetric. Moreover, our structural approach enables empirical estimations based on network structure, moving network analysis into a more empirical direction.

Our portfolio-based structural approach builds on the recent literature that uses portfolio-based models to study asset pricing and allocation, including Gabaix and Maggiori (2015), Koijen and Yogo (2019), Koijen and Yogo (2020), and Jiang et al. (2020). We also improve upon the recent work on demand system asset pricing by embedding a network structure into the model and incorporating both the demand and supply of assets into the structural model, which allows a more complete analysis of shock propagation in the global financial

[4]Besides the papers that we discuss in the subsequent paragraphs, see Glasserman and Young (2016) for additional work on financial networks.

system.

In the rest of the paper, we provide a structural model of the global financial network (Section 2) followed by a discussion of our model estimation procedure and the data (Section 3). In Section 4, we present the estimation results of the loan supply and demand elasticities, focusing on variations in the cross section, and analyze their implications for the extent of risk sharing across countries. In Section 5, we study the evolution of loan supply and demand elasticities over the sample period and the resulting implications. We also explore the role of macroprudential instruments in explaining the evolution of risk sharing in the global financial network. Section 6 concludes.

2 A Structural Model of the Global Financial Network

In this section, we present a structural model of the global financial network. The network is comprised of two sub-networks: (i) a global interbank network in which banking sectors around the world provide loans to each other; (ii) a global credit network in which banking sectors provide loans to foreign and domestic nonbank sectors. The model takes a portfolio-based view to study each banking sector's lending decisions across countries and sectors, motivated by the international banking literature including Walter (1981), Aviat and Coeurdacier (2007), and Bruno and Shin (2015) and building on the demand system approach by Koijen and Yogo (2019) and Koijen and Yogo (2020).

Setup. Time is discrete, and there exist N countries in the global financial network. As shown in Figure 1, each country contains a representative bank that allocates its total AUM to the bank and nonbank sectors of the countries in the network through the global interbank and credit networks. We index the bank and nonbank sectors by $\ell = 1, 2$, respectively. Each sector is comprised of $N + 1$ potential borrowers indexed by j, which denotes one representative borrower for each country plus an additional "outside" borrower indexed by $j = 0$. The outside borrower accounts for bank loans provided to destinations outside of the N countries in the global financial network.

We denote the local currency price of a loan to sector ℓ in country n at time t by $P_t(n, \ell)$.

Given that the bulk of international lending to firms is denominated in U.S. dollars rather than local currency, we allow for a spread between the U.S. dollar price and the local currency price for loans within the nonbank sector. We denote this spread as $SPRD_t(m, \ell)$. $E_{n,t}(m)$ denotes the exchange rate in terms of currency n per currency m. Within our framework, we allow exchange rates to move endogenously with interbank rates. We use lowercase letters to denote logs: $p_t(n, \ell) = \log(P_t(n, \ell))$.

Loan Supply and Demand. We model the country n bank's loan portfolio weight in country m in sector ℓ at time t as:

$$w_{n,t}(m, \ell) = w_{n,t}(m|\ell) w_{n,t}(\ell),$$

where $w_{n,t}(m|\ell)$ is the portfolio weight in country m within sector ℓ, and $w_{n,t}(\ell)$ is the portfolio weight in sector ℓ within the country n's bank's total loan portfolio. Thus, the total supply of loans that country n's bank provides to sector ℓ of country m is country n's bank's AUM multiplied by $w_{n,t}(m, \ell)$.

We model bank n's portfolio weight on country m in sector ℓ at time t as a logistic function:

$$w_{n,t}(m|\ell) = \frac{\delta_{n,t}(m, \ell)}{1 + \sum_k \delta_{n,t}(k, \ell)}, \tag{1}$$

where $\delta_{n,t}(m, \ell)$ captures the relative desirability of the lending opportunity in country m, sector ℓ and takes the functional form

$$\delta_{n,t}(m, \ell) = \exp\left(\beta_{\ell,t} p_{n,t}(m, \ell) + \gamma_{\ell,t} e_{n,t}(m) + \Theta'_{\ell,t} \mathbf{x}_{n,t}(m) + \kappa_{n,t}(m, \ell)\right). \tag{2}$$

where

$$p_{n,t}(m, \ell) = \begin{cases} p_t(m, \ell) + sprd_t(m, \ell), & \text{if } n \neq m \text{ and } \ell = 2 \\ p_t(m, \ell), & \text{otherwise} \end{cases}$$

$\mathbf{x}_{n,t}(m)$ is a set of borrower characteristics for sector ℓ in country m in year t. These characteristics can be borrower-specific (e.g., GDP) or bilateral (e.g., distance) in nature. We index the coefficients $\beta_{\ell,t}$, $\gamma_{\ell,t}$, and $\Theta_{\ell,t}$ by ℓ and t to allow for differences in loan supply

elasticity across sectors and time.

By construction, the sum of loan portfolio shares invested into each sector equals 1: $\sum_{k=0}^{N} w_{n,t}(k|\ell) = 1$. As a result, the portfolio weight in the outside asset in sector ℓ is given by

$$w_{n,t}(0|\ell) = \frac{1}{1 + \sum_k \delta_{n,t}(k,\ell)}. \tag{3}$$

We model the aggregate portfolio weight in sector ℓ at time t based on a nested logit structure. Bank n's portfolio weight in sector ℓ at time t is given by

$$w_{n,t}(\ell) = \frac{(1 + \sum_k \delta_{n,t}(k,\ell))^{\lambda_{\ell,t}} \exp(\alpha_\ell + \xi_{n,t}(\ell))}{\sum_j \left((1 + \sum_k \delta_{n,t}(k,j))^{\lambda_{j,t}} \exp(\alpha_j + \xi_{n,t}(j))\right)}, \tag{4}$$

where $\lambda_{\ell,t} \in [0,1]$ governs the degree of substitution in bank n's portfolio allocation across sectors. As lending opportunities to borrowers in sector ℓ as a whole become more desirable through changes in prices and characteristics, bank n shifts its aggregate loan portfolio toward sector ℓ. α_ℓ is a sector fixed effect, and $\xi_{n,t}(\ell)$ denotes sector-specific latent supply. Because the total amount of investment must equal the total AUM, there is only one degree of freedom in α_ℓ, and we normalize $\alpha_1 + \xi_{n,t}(1) = 0$ for interbank loans.

The total face value of loans provided to sector ℓ of country n is denoted by $Q_t(n,\ell)$, which can be interpreted as the demand for loans. We allow $Q_t(n,\ell)$ to adjust endogenously to changes in interest rates and business cycle conditions. The exact specification for loan demand is provided in Section 3.

The Interbank Network and AUM. To study the interaction of the structure of the global financial network with banks' portfolio allocation problem, we embed a network structure in our model. We allow banks to borrow funds in the interbank market and use these funds to extend loans to the nonbanking sectors. For each country n in period t, the total AUM of the banking sector in US dollars is given by

$$A_{n,t} = D_{n,t} + \sum_{m \neq n} A_{m,t} w_{m,t}(1) w_{m,t}(n|1),$$

where $D_{n,t}$ captures funding from domestic sources such as bank deposits, and the second term on the right-hand side captures the sum of international transfers, which is endogenous to assets in the banking sector in each country as well as the portfolio allocation problem of all banking sectors in the global financial network.

Market Clearing Conditions. Prices (i.e., interest rates and exchange rates) in the bank and nonbank sectors are endogenous and must adjust to satisfy market clearing conditions for loan supply. In the banking sector, the total value of cross-border loans extended to the banking sector of country n through the interbank network must equal the total value of loans demanded by the banking sector of country n:

$$\exp\left(p_t(m,\ell=1)+e_{m,t}(US)\right)Q_t(m,\ell=1)=D_{m,t}+\sum_{n\neq m}A_{n,t}w_{n,t}(\ell=1)w_{n,t}(m|\ell=1), \quad (5)$$

where the left-hand side is the market value of the country n banking sector's loans, and the right-hand side represents the sum of the loans extended by foreign banking sectors.

Similarly, the total par value for all loans extended (within and across borders) must equal the total demand for loans:

$$\begin{aligned}\exp\left(e_{m,t}(US)\right)Q_t(m,\ell=2)=&\frac{A_{n,t}w_{n,t}(\ell=2)w_{n,t}(n|\ell=2)}{\exp\left(p_t(n,\ell=2)\right)}+\\&\sum_{n\neq m}\frac{A_{n,t}w_{n,t}(\ell=2)w_{n,t}(m|\ell=2)}{\exp\left(p_t(m,\ell=2)+sprd_t(m,\ell=2)\right)}.\end{aligned} \quad (6)$$

Each country n's exchange rate relative to the U.S. dollar depends on differences in interbank rates and time fixed effects:

$$\Delta e_{n,t}(US)=\beta_e\Delta IRD_t^n+\xi_t+\varepsilon_{n,t} \quad (7)$$

where $IRD_t=-p_t(n,\ell=1)+p_t(US,\ell=1)$ is the interbank interest rate differential between country n and the United States at time t, and Δ denotes the first difference between time t and $t-1$. Within our structural model, we consider the current interest rate differential, $\beta_e\left(-p_t(n,\ell=1)+p_t(US,\ell=1)\right)$, to be an endogenous component of exchange rates, and

$\xi_t + \varepsilon_{n,t}$ as well as the time $t-1$ exchange rate and interest rate differential to be exogenous components of exchanges rates. Bilateral exchange rates for non-U.S. dollar currencies are calculated as the differences in these exchange rates relative to the U.S. dollar.

Ultimately, the market clearing conditions constitute a system of $2N$ equations that determine interest rates in the interbank and nonbank network, and an additional set of N equations that determines exchange rates.

3 Loan Supply and Demand Estimation

In this section, we discuss the estimation of the loan supply and demand curves that govern the allocation of bank funding within and across the bank and nonbank sectors in the global financial network. We present the estimation equations, the data, and the identification approach.

3.1 Estimation Equations

The estimation equation for loan supply within each sector is obtained by dividing equation (1) by equation (3), which yields

$$\log\left(\frac{w_{n,t}(m,\ell)}{w_{n,t}(0,\ell)}\right) = \beta_{\ell,t} p_{n,t}(m,\ell) + \gamma_{\ell,t} e_{n,t}(m) + \Theta'_{\ell,t}\mathbf{x}_{n,t}(m) + \kappa_{n,t}(m,\ell). \tag{8}$$

Equation (8) is estimated separately for each sector ℓ. It asserts that the supply of lending to banks or firms of one country relative to banks or firms of another country is a function of their relative prices and characteristics. The coefficients on log price determine the price elasticities of loan supply within each sector. We discuss the exact translation to elasticities in the subsequent section.

The estimation equation for cross-sector loan supply is obtained by dividing equation (4) for the banking sector ($\ell = 1$) by the same equation for the nonbank sector ($\ell = 2$) and then plugging in equation (3):

$$\log\left(\frac{w_{n,t}(\ell=1)}{w_{n,t}(\ell=2)}\right) = \lambda_{1,t}\log\left(w_{n,t}(0|\ell=1)\right) - \lambda_{2,t}\log\left(w_{n,t}(0|\ell=2)\right) + \alpha_{2,t} + \xi_{n,t}(1). \tag{9}$$

Equation (9) states that the supply of interbank loans relative to nonbank loans depends on their relative characteristics and the degree of substitution between the two sectors. As characteristics of interbank bank lending become more attractive, lenders will shift more loans to the interbank sector from the nonbank sector, and vice versa.

In order to study the evolution of loan supply curves, we allow for time variation in the regression coefficients. To this end, we estimate regressions (8) and (9) using 7-year rolling subsamples of the data.[5] Given that our sample starts in 2005Q1, the first subsample consists of data from 2005Q1 to 2012Q1. The results from this estimation are taken to characterize the supply curves for all quarters between 2005Q1 and 2012Q1. The last subsample consists of data from 2012Q4 to 2019Q4. In this paper, we denote supply curves based on the midpoint period of the subsample (e.g., the *2010Q4* supply curve denotes the supply curve estimated using the subsample from 2007Q2 to 2014Q2, and the *2016Q2* supply curve denotes that estimated using the subsample from 2012Q4 to 2019Q4).

The estimation equation for the demand for cross-border loans is given by

$$\log Q_t(n,\ell) = q_t(n,\ell) = \beta_\ell^d p_t(n,\ell) + \theta_\ell^d \log GDP_{t-1}(n) + \tau_t + \nu_t^d(n,\ell), \tag{10}$$

which states that the log quantity of loans demanded through the global interbank and credit network is governed by changes in loan prices ($p_t(n,\ell)$), changes in borrower countries' lagged business cycle conditions ($GDP_{t-1}(n)$), and time fixed effects (τ_t). This specification is motivated by the empirical evidence that demand for credit tends to vary systematically across the business cycle (Jermann and Quadrini 2012). We estimate the demand for interbank loans using 7-year rolling regressions, as we did for the supply of interbank loans. As for the demand for cross-border nonbank loans, we estimate equation (10) once using the full data sample.[6]

We estimate the regressions using an instrumental variable approach, where we construct instruments for $p_t(m,\ell)$ and $w_{n,t}(0,\ell)$ from equations (8), (9), and (10). We discuss the identification approach in detail in Section 3.3, after a brief description of the data used for

[5] We choose 7 years for the rolling subsample to allow for ample time series variation for the regressions.

[6] We keep the estimation of the demand for cross-border nonbank lending simple by design because the focus of the analysis is on lending decisions by the banking sectors.

the estimation in Section 3.2.

3.2 Data

Our main data source for estimating loan supply is the BIS LBS database. This data is uniquely appropriate for our study because it contains bank lending information that perfectly maps to our framework of the global financial network. The data contains quarterly information on the aggregate cross-border and local claims of all banks domiciled in the reporting countries, broken down by reporting (source) and counterparty (destination) country pairs as well as by type of counterparty, including bank and nonbank counterparty sectors.[7] We use the data to construct measures of cross-border interbank lending as well as cross-border and domestic bank-nonbank lending. Our sample runs from 2005Q1 to 2019Q4 and consists of 19 countries, including two financial centers, 13 advanced economies, and four emerging market economies, as listed in Appendix Table A.1.

Table 1 reports the quarterly mean and variance of cross-border lending and total funding to the bank sector and nonbank sector of the 19 countries in the global financial network over two subsample periods, 2005Q1–2012Q1 (left panel) and 2012Q4–2019Q4 (right panel), corresponding to the first and last subsample for the loan supply curve estimations. Evidently, there is notable heterogeneity in funding across countries and between the two sample periods. Cross-border lending and total funding to the bank and nonbank sectors are highest in the United States and the United Kingdom, followed by France and Germany, while they are substantially lower in emerging markets. Appendix Figure A.2 illustrates the global interbank network and the global credit network for the reporting countries in 2005Q1 and 2019Q4. Each country is a node in the network, and each edge connecting a dyad (pair of nodes) represents total cross-border bank claims (Panels A and C) or total cross-border nonbank claims (Panels B and D) between a source country and a destination country. The

[7] An alternative to the LBS is the BIS consolidated banking statistics (CBS), which aggregate claims by the banks' nationality rather than their location and exclude cross-border intragroup positions. For our purpose, the LBS data are more appropriate, as they reveal a more direct link between portfolio allocation decisions of the banking sectors in the source countries and their resultant cross-border portfolio adjustments, which are likely to include changes in intragroup positions. Furthermore, the CBS have a number of drawbacks from a technical standpoint, as they are not adjusted for exchange rate fluctuations and are prone to breaks in the series that are difficult to adjust.

edges are more numerous for countries with more interbank or credit relationships and thicker for dyads with greater bilateral cross-border banking and credit flows. The positioning of countries in the network graphs is closely related to their relative eigenvector centralities, as shown in Appendix Table A.2. In each network, a group of countries with close and more numerous interbank and credit relationships with other countries, often known as the core, is clustered around the center of the network, and the countries less central to the global financial network lie at the periphery of the network. In both the global interbank and credit networks, the core is made up of mostly financial centers and advanced economies, while the periphery is made up of emerging market economies.

To estimate equation (8), we combine the bank lending data with information about the characteristics of the borrower, lender, and their bilateral relationships. Specifically, we use variables that capture differences in expected returns and risks across countries, including log nominal GDP, log GDP per capita, stock price volatility, monetary policy rate, index of macroprudential regulation, monetary policy rate, bilateral import and export exposures, and geographical distance between the lender and borrower countries. Appendix Table A.3 lists the characteristic variables and the corresponding data sources. In the regression estimations, we also include an indicator for a domestic loan to capture potential home bias and fixed effects for the borrower country's MSCI classification.

3.3 Estimation Approach

The main identification challenge to consistently estimate within-sector and across-sector loan supply according to equations (8) and (9), respectively, is that lending prices may be endogenous to the latent supply of the lenders. As more bank capital flows into a country, the lending rates in that country are likely to decrease, which would bias the coefficient on $p_{n,t}(m, \ell)$ in (8) upward. On the demand side, greater loan demand is likely to drive up interest rates, which would bias the coefficients on price from equation (10) downward. Moreover, changes in interbank rates also affect the endogenous exchange rates. To address the issue, we apply the identification strategy used in Koijen and Yogo (2020) and Jiang et al. (2020).

Estimating loan supply. To estimate loan supply curves, we first compute instruments for $w_{n,t}(0|\ell)$ in order to consistently estimate cross-sector loan supply based on equation (9). Then, using the estimates from equation (9) and market clearing conditions, we construct implied instruments for prices $p_t(m|\ell)$ and exchange rates $e_{n,t}(m)$ and estimate equation (8).

More specifically, the estimation proceeds in four steps. First, we estimate a version of equation (8) using only borrower and bilateral characteristics ($\mathbf{x}_{n,t}(m)$) that are plausibly exogenous to the global financial network:

$$\log\left(\frac{w_{n,t}(m,\ell)}{w_{n,t}(0,\ell)}\right) = \Theta'_{\ell,t}\mathbf{x}_{n,t}(m) + \kappa_{n,t}(m,\ell). \tag{11}$$

The characteristics we use include historical regional waves of social unrest based on the measure from Acemoglu, Naidu, Restrepo, and Robinson (2019), historical population, bilateral distance, and an own-country indicator variable. The exogeneity assumption is that these borrower and bilateral characteristics are uncorrelated with the contemporaneous latent supply. Naturally, this exclusion restriction is mostly likely satisfied by variables that are exogenous to the economic conditions of the lender countries or do not vary with time. Using these characteristics, we generate predicted values $\hat{\delta}_{n,t}(m,\ell)$ based on equation (11).

In the second step, we compute an instrument for within-sector portfolio weights, $\hat{w}_{n,t}(0|\ell)$, using the predicted values $\hat{\delta}_{n,t}(m,\ell)$, in order to estimate across-sector loan supply:

$$\hat{w}_{n,t}(0|\ell) = \frac{1}{1+\sum_k \hat{\delta}_{n,t}(k,\ell)}.$$

By constructing $\hat{w}_{n,t}(0|\ell)$ in this manner, we identify the variation in the banks' portfolio weights that is exogenous to lending prices. We then use the predicted portfolio weights $\hat{w}_{n,t}(0|\ell)$ as instruments for $w_{n,t}(0|\ell=1)$ and $w_{n,t}(0|\ell=2)$ and estimate $\hat{\lambda}_{\ell,t}$ and $\hat{\alpha}_{\ell,t}$ according to equation (9).

In the third step, we construct a predicted weight, $\hat{w}_{n,t}(m,\ell)$, for country n and sector ℓ

at time t, using the predicted values $\hat{\delta}_{n,t}(m,\ell)$, $\hat{\lambda}_{\ell,t}$, and $\hat{\alpha}_{\ell,t}$:

$$\hat{w}_{n,t}(m,\ell) = \frac{\hat{\delta}_{n,t}(m,\ell)}{1+\sum_k \hat{\delta}_{n,t}(k,\ell)} \frac{\left(1+\sum_k \hat{\delta}_{n,t}(k,\ell)\right)^{\hat{\lambda}_{\ell,t}} \exp\left(\hat{\alpha}_\ell + \xi_{n,t}(\ell)\right)}{\sum_j \left(\left(1+\sum_k \hat{\delta}_{n,t}(k,j)\right)^{\hat{\lambda}_{j,t}} \exp\left(\hat{\alpha}_j + \xi_{n,t}(j)\right)\right)}.$$

These predicted weights capture the exogenous part of the portfolio weights that depend only on plausibly exogenous shifters of loan supply. We then compute counterfactual lending prices and exchange rates that clear lending markets in both the bank and nonbank sectors according to the market clearing conditions (5) and (6) and satisfy the exchange rate determination equation (7) at the predicted weights. The instrument for the interbank lending price and exchange rate clears the global interbank market at the predicted weights, and the instrument for the nonbank lending price and exchange rate clears the global credit market at the predicted weights:

$$\begin{aligned}
\hat{p}_t(m,\ell=1) &= \log\left(\frac{D_{m,t-1} + \sum_{n\neq m} A_{n,t-1}\hat{w}_{n,t}(m,\ell=1)}{Q_{t-1}(m,\ell=1)}\right) - \hat{e}_{m,t}(US), \\
\hat{p}_t(m,\ell=2) &= \log\left(\frac{A_{m,t-1}\hat{w}_{m,t}(m,\ell=2) + \sum_{n\neq m}\left(A_{n,t-1}\hat{w}_{n,t}(m,\ell=2)/SPRD_t(m,\ell=2)\right)}{Q_{t-1}(m,\ell=2)}\right) \\
&\quad - \hat{e}_{m,t}(US), \\
\Delta\hat{e}_{n,t}(US) &= \hat{\beta}_e \Delta\left(\hat{p}_t(n,\ell=1) + \hat{p}_t(US,\ell=1)\right) + \hat{\xi}_t + \hat{\varepsilon}_{n,t}.
\end{aligned}$$

In the fourth step, we estimate within-sector loan supply based on equation (8) using the above-specified instruments for lending prices and the exchange rate. The key intuition underlying the instruments is that countries that happen to be geographically closer to other countries, more populous, located in regions that experienced less social unrest, or located near large banking sectors, as well as those that have lower average loan demand, tend to have higher prices and lower interest rates.

Estimating loan demand. To estimate loan demand (10), we apply a standard instrumental variable approach. We instrument $p_{m,t}(n,\ell)$ with historical regional waves of democratization and regional waves of social unrest based on the measures from Acemoglu et al.

(2019). The identifying assumption is that these variables are uncorrelated with contemporaneous latent demand for capital flows.

4 Global Financial Intermediation Across Countries

In this section, we report the estimation results of loan supply and demand in the global financial network and analyze their implications. We first characterize the key features of the loan supply and demand curves over the whole sample period. We uncover significant variation in elasticities of loan supply across countries, reflecting heterogeneity in the willingness and capacities of bank sectors to provide intermediaries services. We then conduct a counterfactual analysis to study the implications of such heterogeneity for international risk sharing. In particular, we quantify the variations in insurance provided by banks in the global financial network in response to country-specific funding shocks.

4.1 Estimates of Bank Supply and Demand Elasticities

Within-sector supply. Table 2 shows the estimates for within-sector loan supply curves over the whole sample period, based on equation (8). The coefficients on price for both cross-border interbank lending and nonbank lending are negative, which indicates that as the lending price increases (interest rate decreases) for a given borrower, banks are less likely to extend loans to that borrower. The coefficients on the borrower characteristic variables are intuitive as well. Banks prefer extending loans to larger and wealthier countries and countries that are closer in terms geography and trade relationships. Finally, the last row of Table 3 shows there is strong home bias in lending in the nonbank sectors.[8]

The estimated coefficients on log price determine the elasticities for interbank and nonbank lending across different countries in the global financial network. In Appendix Section A, we derive expressions for bilateral elasticities of loan supply with respect to price and aggregate loan supply elasticities for each borrower country. Loan supply elasticities differ

[8]Appendix Table A.5 provides estimates for within-sector loan supply curves using ordinary least squares (OLS). The coefficients on price are larger in Table A.5 compared to the estimates obtained using the instrumental variables approach, which suggest an upward bias in OLS estimates.

for each lender-borrower pair because supply curve estimations account for bilateral characteristics. We show that the aggregate loan supply elasticity for each borrower country can be computed as the weighted sum of the supply elasticities of each individual lender country:

$$-\frac{\partial \hat{q}_t(m,\ell)}{\partial p_t(m,\ell)} = \frac{1}{\sum_k A_{k,t} w_{k,t}(m,\ell)} \sum_n \underbrace{\left(-\frac{\partial \hat{q}_{n,t}(m,\ell)}{\partial p_t(m,\ell)}\right) w_{n,t}(m,\ell)}_{\text{Willingness to Lend}} \underbrace{A_{n,t}}_{\text{Capacity to Lend}}, \tag{12}$$

where $\hat{q}_t(m,\ell)$ is the log quantity of loans extended to country m from all countries, and $\hat{q}_{n,t}(m,\ell)$ is the log quantity of loans extended to country m from country n's bank sector.

Equation (12) shows that the aggregate loan supply elasticity to a given borrower in country m can be conveniently decomposed into two components: each lender's *willingness* and *capacity* to lend to country m. The willingness of lender n to provide loans to country m in sector ℓ captures how much a lender adjusts its loan portfolio in response to interest rate changes, expressed as a share of the lender's total portfolio size. This willingness to lend term depends on the estimated supply curve as well as current portfolio weights. As an example, Figure 2 shows the willingness of the U.S. bank sector to lend to different destination countries as a function of the existing portfolio weight of each borrower country in the U.S. loan portfolio on average.[9] As shown through this example, the U.S. bank sector is most willing to lend to U.K. banks and nonbanks, followed by those of Japan and Canada. More generally, it reveals that each lender's willingness to lend to a given borrower is largely captured by observed portfolio shares, which is determined by the characteristics of borrowers and of the corresponding bilateral relationships.

The extent to which borrower countries can obtain loans also depends on the capacity of each lender to provide loans, as captured by the lender's AUM, $A_{n,t}$. As an example, Figure 3 plots each lender country's willingness and capacity to lend to the United Kingdom as a function their willingness to lend to the United Kingdom. Panel (a) shows that even though both Spain and the United States are similarly willing to lend to banks in the United Kingdom, the United States has much larger capacity to do so and is thereby more important for determining the U.K. aggregate loan supply elasticity than Spain.

[9]Loan supply elasticities change over time due to changes in characteristics and prices. For the cross-sectional results in this section, we present the averages of the elasticities over time.

Based on equation (12), we derive the average elasticities of cross-border interbank and nonbank loan supply using results from Table 2. We find that the supply of cross-border interbank and nonbank loans in total funding declines by 7.5 and 4.4 percent, respectively, per one percent increase in their respective lending price. Given that the maturity of interbank and nonbank loans is 0.25 and 1 year, respectively, our estimates translate to a supply elasticity with respect to yield of 1.9 and 4.4. That is, the contribution of cross-border interbank and nonbank loan supply to total funding decreases by 1.9 percent and 4.4 percent per one percentage point increase in the interbank and nonbank lending rates, respectively. By comparison, Koijen and Yogo (2020) estimate a price elasticity with respect to yield of 42 for long-term debt investment. Note that the elasticity estimates from Koijen and Yogo (2020) are computed as averages of the bilateral elasticities of cross-border investment, whereas our measures, computed according to equation (12), are based on weighted sums of bilateral elasticities that incorporate both cross-border and domestic loan values in the weighting. After adjusting for this difference, our estimation implies an average interbank (nonbank) loan supply elasticity with respect to yield of 22.4 (35.7). Thus, our estimate of the elasticity for cross-border nonbank loan supply is slightly smaller than but broadly comparable to the elasticity estimate from Koijen and Yogo (2020).

Figure 4 shows the aggregate loan supply elasticities for each borrower country averaged over the entire sample period in both the bank and non-bank sectors.[10] Panel (a) and (b) illustrate the cross-border interbank and nonbank loan supply elasticities, respectively, across the borrower countries, reflecting the decline in cross-border loans supplied to each borrower country in percent given a one percentage point decrease in interest rates. Panel (c) illustrates the total funding supply elasticities in the nonbank sector, which reflect changes in both cross-border lending from foreign banks and lending from domestic banks in response to a one percentage point decrease in interest rates. Relative to the estimates from Panel (b), those from Panel (c) show that the total supply of loans is more responsive to changes in interest rates than cross-border lending alone, indicating that domestic banks tend to be more willing to provide additional loans in response to funding shortfalls than foreign

[10]Because we estimate the supply curves using rolling subsamples of the data, supply elasticities vary over time. Figure 4 illustrates the average supply elasticities across all subsamples.

banks.[11] In particular, the largest differences in supply elasticities between the two panels are within advanced economies, which shows that their bank sectors tend to have the greatest willingness and capacity to lend when yields increase.

Overall, Figure 4 reveals substantial variation in supply elasticities across the borrower countries, which reflects stark heterogeneity in the willingness and capacity of intermediaries to provide loans in the global financial networks.

Across-sector supply. Appendix Table A.6 reports the estimation results for cross-sector loan supply based on equation (9). The estimates for λ_ℓ capture the degree of substitutability in lending between the bank and nonbank sector. They should fall between 0 and 1, which implies some substitutability between the two sectors when the relative value of lending to one sector changes.[12] As shown in column (1), our estimates for λ_ℓ average 0.7 for the bank sector (λ_1) and 0.7 for the nonbank sector (λ_2) over the sample period, indicating substantial substitutability in lending between the two sectors. In addition, the estimate for $\alpha_{2,t}$ captures the relative desirability of lending to the nonbank sector. On average, we find a positive estimate for α_2, indicating a relatively stronger desirability of directly lending to the nonbank sector than the bank sector.

Demand. Appendix Table A.7 provides estimates of loan demand curves based on equation (10). In both the bank and non-bank sectors, the coefficients on price are positive, which indicate that both banks and non-banks demand more loans as interest rates decline. Between the two point estimates, the coefficient on price in the bank sector is larger in magnitude, indicating that bank demand for cross-border interbank funding is more responsive to changes in loan prices. Compared to the corresponding coefficient from the supply curve estimation in Table 2, the coefficient on price for nonbank lending demand is notably smaller in absolute value, which shows that the demand for nonbank loans tends to be more elastic

[11] The difference in estimates between Panels (b) and (c) is also driven by the fact that the vast majority of lending to each borrower country's nonbanks is provided by its domestic bank sector.

[12] By contrast, $\lambda_\ell = 0$ implies no substitutability in lending between the two sectors, and the allocation of bank funding to borrowers from the bank or non-bank sector would remain constant when the relative value of lending to the other sector changes.

than loan supply.[13] The coefficients on GDP are positive, indicating that loan demand tends to be procyclical across countries.

Additional estimation results. Appendix Table A.8 reports the results of estimating exchange rates based on equation (7). The estimate of -0.57 for β_e indicates that an increase in the country n interbank rate is associated with an appreciation in currency n contemporaneously. This result is consistent with existing estimates of exchange rate movements in response to high frequency monetary policy shocks (e.g., Zhang 2021).

4.2 Counterfactual Analysis: Insurance Across Countries

What are the implications of the heterogeneity in loan supply elasticities for international risk sharing and shock propagation? We proceed to conduct a counterfactual analysis to study the extent of insurance provided by the global financial network in response to local funding shocks using the estimated structural model. Insurance is defined as the increase in funding inflows relative to the size of the shock. In the analysis, a local funding shock represents a decline in available funding for banks to lend out, which could be driven by a decline in deposits if taken literally or, more generally, any policy or preference change that restricts the amount of capital banks are willing to use to fund loans. For example, more stringent capital reserve requirements, contractionary monetary policy, or liquidity preference shocks all could induce banks to hold greater amounts of cash and lower loan provision, which would ultimately translate to a decline in local funding ($D_{n,t}$) in our structural model.

The analysis in this section is based on the 2007Q2–2014Q2 subsample of the data.[14] Columns (1) and (2) of Table 3 provide estimates of the loan supply curve in both the bank and nonbank sectors using data from this subsample. In the following, we refer to this subsample by its midpoint period, 2010Q4, or simply "the 2010 subsample."

[13] To our knowledge, these are the first estimates of demand elasticities for loans or any given asset class in the literature.

[14] We are focusing on the 2007Q2–2014Q2 subsample here because estimates of loan supply elasticities based on this subsample are the highest across all subsamples. In the subsequent section, we study the evolution of loan supply and demand curves over the sample period.

A specific case: U.S. local funding shock. To introduce the key mechanisms of shock propagation, we first dissect the effects of a negative local funding shock in the context of a one percent decline in U.S. local funding ($D_{n,t}$) on funding in the United States.[15]

Figure 6 illustrates the effects of the shock on cross-border interbank lending (Panel a) and total (cross-border and domestic) nonbank funding (Panel b) to the United States. Focusing first on the interbank market, a one percent local funding shock results in a 0.9 percent decline in total funding in the U.S. bank sector, amounting to $97 billion. This "total effect" can be decomposed into two components: a "shock effect" and a "global interbank rebalancing effect."

The shock effect captures the immediate impact of the funding shock before global banks rebalance their loan portfolios. For the interbank sector, there are two channels for the shock effect: a direct decline in domestic funding and a higher-order effect driven by a decline in foreign funding to the U.S. bank sector due to the U.S. funding shock. As an example, the U.S. funding shock lowers cross-border lending from the United States to the German bank sector, which in turn lowers cross-border lending to U.S. banks based on its existing portfolio weight on the U.S. bank sector. The interbank rebalancing effect captures banks' endogenous reallocation of funding within and across networks in response to the shock. Continuing with the above example, German banks could reallocate funding from other bank or nonbank sectors toward U.S. banks, or away from U.S. banks toward other bank or nonbank sectors, in response to the shock.

As shown in Panel (a) of Figure 6, the U.S. local funding shock induces a shock effect of -0.9 percent, which translates to a decline of $112.7 billion in cross-border interbank lending. At the same time, banks in the global financial network actively reallocate toward the U.S. bank sector, mitigating the shock effect by 14 percent. This shows that the interbank rebalancing effect—*global interbank rebalancing*— serves as a source of insurance to the U.S. bank sector in this subsample period.

Panel (b) of Figure 6 illustrates the effects of the U.S. shock on funding in the U.S. nonbank sector. Overall, total nonbank funding declines by 0.5 percent in response to the

[15]To be precise, to examine the effects of a one percent local funding shock in a particular period, we set all the exogenous variables in the structural model to values from that period and impose the one percent negative shock on local funding.

shock. This total effect can also be decomposed into a "shock effect," a "global credit rebalancing effect" and a "self-rebalancing effect." As in the bank sector, the shock effect captures the immediate change in lending to nonbanks in the United States holding all countries' loan portfolio weights fixed. The global credit rebalancing effect captures reallocation of cross-border lending by non-U.S. banks to or from the U.S. nonbank sector in response to the shock. The self-rebalancing effect is specific to the nonbank sector, capturing the reallocation of loans by U.S. banks.

The U.S. funding shock generates a shock effect of -0.8 percent in the nonbank sector, which translates to a decline of 89.9 billion dollars in lending to U.S. nonbanks. Non-U.S. banks actively reallocate funding toward the U.S. nonbank sector to take advantage of the unmet demand for loans, reversing 12 percent of the shock effect. Furthermore, domestic U.S. banks provide additional funding to U.S. nonbanks through retrenchment of their own funding and intermediation of funding from global interbank rebalancing, reversing an additional 27 percent of the shock effect.[16]

In sum, global credit rebalancing and self-rebalancing serve as mechanisms of insurance for U.S. nonbanks in response to a local funding shock, reversing about half of the losses from the shock effect. Taking together with the result on global interbank rebalancing, our results show that banks in the global financial network provide a significant amount of insurance to U.S. banks and nonbanks in response to a U.S. domestic funding shock through the three margins of rebalancing.

Global Insurance and Loan Supply Elasticities. We now generalize the one percent local funding shock for each country in the network and study the variation in insurance provision through the three margins of rebalancing.

Table 6 shows the amount of shock effect (column 1) in the interbank market and the share of global interbank rebalancing relative to the shock effect (column 2) in response to the local funding shock for each origin country. For all countries, global credit rebalancing

[16]More specifically, the self-rebalancing effect encompasses both a retrenchment effect—endogenous reallocation of funding by U.S. banks—and an indirect global interbank effect—U.S. banks' intermediation of foreign funding from global interbank rebalancing). Panel (a) of Appendix Figure A.5 decomposes the self-rebalancing effect into the two components. Evidently, most the self-rebalancing effect results from indirect global interbank rebalancing.

mitigates direct shock effects, like in the case of the U.S. local funding shock. Moreover, there is a significant amount of variation in the degree of insurance through global interbank rebalancing, ranging from 8 to 47 percent, as illustrated in Panel (a) of Figure 7.

Table 7 presents the results of the effects of a one percent decline in local funding on nonbanks in each origin country. As before, column (1) shows the shock effect, and columns (2) and (3) show the share of global credit rebalancing and self-rebalancing relative to the shock effect, respectively. The shares of global credit rebalancing are all positive, indicating that banks from the non-shocked countries tend to actively reallocate funding toward the nonbank sectors of the country experiencing the local funding shock and thus mitigate the negative shock effect. Domestic banks from the shocked countries provide additional funding to the nonbanks from their home country through self-balancing, further reversing the shock effect. Like insurance through interbank rebalancing, there is also a significant amount of variation in the degree of insurance through global credit rebalancing and self-rebalancing across countries, ranging from 3 to 19 percent for the former margin and 12 to 52 percent for the latter. Panels (b) and (c) of Figure 7 illustrate the corresponding variations.

What governs these variations? We show that they are governed by the aggregate supply elasticities of each country and sector, which are determined by prices and characteristics of borrowers and borrower-lender relationships. As shown in Figure 8, countries with more elastic cross-border interbank loan supply, cross-border nonbank loan supply, and total nonbank loan supply receive greater insurance provision, as measured by the share of global interbank rebalancing, global credit rebalancing, and self-rebalancing relative to the shock effect, respectively, when they face a local funding shock. This is because banks in the global financial network are more willing and have greater capacity to provide lending to these countries when their interest rates increase.

The results in Figure 8 provide a novel illustration of heterogeneity in risk sharing in the global financial network. They also imply that the heterogeneity in the willingness and capacity of global financial intermediaries to provide intermediary services ultimately affects how sensitive countries are to fluctuations in funding conditions and business cycles.[17]

[17]The three margins of rebalancing also apply when analyzing spillover effects of local funding shocks. However, instead of serving as insurance mechanisms, they serve as margins of propagation from the perspective of the destination countries experiencing the spillover effects. Appendix Section B provides a discussion of

5 Global Financial Intermediation Over Time

In this section, we study the evolution of loan supply elasticities and global insurance. We also explore a potential driver of the observed change in insurance provision by the global financial network over time—bank regulation and macroprudential policies.

5.1 Supply Elasticities Over Time

Table 3 reports the estimates of within-sector loan supply curves based on equation (8) for two subsamples of data. As discussed earlier, columns (1) and (2) show estimates for 2010 supply curves for banks and nonbanks based on the 2007Q2–2014Q2 subsample of the data. Columns (3) and (4) provide estimates based on the 2012Q4–2019Q4 subsample. We refer to this second subsample as the 2016Q2 or 2016 subsample. Our results indicate that loan supply in both the bank and nonbank sectors has become less responsive to interest rate fluctuations over time. The magnitude of the coefficient on price governing interbank loans has decreased substantially from -367.1 based on the 2010 subsample to -20.6 based on the 2016 subsample. Similarly, the coefficient on price governing loans to the nonbank sectors has decreased in magnitude from -41.3 to -24.5.

To observe the full evolution of within-sector supply curves over the sample period, we plot the time series of the average loan supply elasticities from each subsample in Figure 5. Panel (a) shows that the decline in cross-border interbank and nonbank loan supply elasticities from 2010 to 2019 is part of a longer-term trend, not simply a reflection of the two endpoints of the sample. Panel (b) plots the total funding supply elasticity for the nonbank sector. It reveals that both cross-border and domestic lending to nonbanks have become less elastic in the latter half of the sample period.[18]

Altogether, our results show that loan supply in the global financial network has become less responsive to changes in price over time. Increases in interest rates on loans are met with

the spillover effects of a U.S. local funding shock across different destination countries. In particular, our counterfactual analysis based on the estimated structural model shows that emerging markets experience a greater outflow of foreign capital in response to a U.S. local funding shock. This result is consistent with established facts and thus provides a validation of our model estimation.

[18] Appendix Figure A.3 shows the evolution of interbank loan demand elasticities over the sample period, revealing a decline in these elasticities as well.

smaller increases in cross-border lending. On the one hand, this change suggests that cross-border funding has become more stable. On the other hand, funding shortages in individual countries are met with smaller inflows of international capital.

We also observe a notable change in loan substitution across the two sectors over time. Columns (2) and (3) of Appendix Table A.6 report the estimates for cross-sector loan supply based on equation (9) using the 2010 and 2016 subsamples of the data, respectively. For both the bank and nonbank sectors, we observe a decline in the degree of substitutability in lending to the other sector, as captured by the decline in λ_ℓ. Moreover, we observe an increase in the relative desirability of lending to the nonbank sector, as captured by the estimates for α_2. This result suggests that banks have become more willing to directly lend to the nonbank sector over the sample period. This trend of greater cross-sector substitutability toward direct nonbank lending partly explains why the decline in the elasticity of cross-border nonbank loan supply is more muted than the decline in cross-border interbank loan supply elasticity.

5.2 Counterfactual Analysis: Changes in Insurance Over Time

To understand the implications of the changes in supply and demand elasticities for international risk sharing and shock propagation, we conduct counterfactual analysis and study the changes in the three margins of insurance provision over time. As in Section 4.2, we first delve into the effects of a local funding shock from a specific country, the United States, and then examine the effects of such a shock from each of the origin countries on total funding in its bank and nonbank sectors. Overall, our results indicate a weakening of insurance provision in the global financial network.

A specific case: U.S. local funding shock. Panels (c) and (d) of Figure 6 compare the magnitude of the global interbank rebalancing, global credit rebalancing, and self-rebalancing between 2010Q4 and 2016Q2 in the case of a one percent local funding shock in the United States. To highlight the degrees of insurance provision and shock amplification as a result of these rebalancing mechanisms, we normalize each of the rebalancing effects, as well as

the total effect, by the magnitude of the shock effect.[19] Focusing first on the cross-border interbank lending, Panel (c) shows that, compared to the results based on the 2010Q4 supply and demand curves, there is a greater decline in total cross-border interbank lending to the United States in response to the U.S. local funding shock using the 2016Q2 subsample. This is driven by the decline in the interbank rebalancing effect, as non-U.S. banks no longer reallocate funding toward U.S. banks in response to the shock.

Panel (d) of Figure 6 illustrates the effects of the U.S. local funding shock on total funding to U.S. nonbanks based on the 2010 and 2016 supply and demand curves. It reveals a pattern similar to interbank lending: the amount of insurance provision through global credit rebalancing and self-rebalancing declined from 39 percent of the shock effect in 2010 to 26 percent in 2016. This decline in insurance provision primarily results from a decline in self-rebalancing due to the decline in indirect global interbank rebalancing. As a result, the U.S. nonbank sector experiences a greater decline in total funding in response to the local funding shock in more recent periods relative to start of the sample period.

Generalization. Having highlighted the key changes in the effects of a specific local funding shock over time, we turn to assess such changes more broadly by comparing the effects of a one percent local funding shock on insurance provision for each origin country in the network between the 2010Q4 and 2016Q2 subsamples.

Figure 9 summarizes the changes in global interbank rebalancing, global credit rebalancing, and self-rebalancing across all origin countries over time. Panel (a) plots the amount of global interbank insurance received by each country's bank sector through global interbank rebalancing under the 2010 (x-axis) and 2016 (y-axis) loan supply and demand curves, as well as a 45-degree line. Points below the 45-degree line indicate that the country's bank sector received less global interbank insurance in 2016, whereas points above the 45-degree line indicate the country received more global insurance. The figure shows that all countries received less interbank insurance in 2016. Columns (3)–(4) of Table 6 present corresponding values in insurance provision as measured by the share of global interbank rebalancing relative to the shock effect. This result is consistent with the fact that the elasticity of cross-

[19]This normalization also allows us to abstract from differences in the magnitude of shock effects under different supply and demand curves.

border interbank loan supply declined substantially over the sample period, which greatly weakened the risk-sharing mechanism in the global interbank network.

Panels (b)–(d) of Figure 9 highlight a similar decline in risk sharing in the global credit network. While global credit rebalancing in the nonbank sector did not significantly change (Panel b), the degree of self-insurance declined in 2016 relative to 2010 (Panel c). Panel (d) shows that almost all countries received less total nonbank insurance in 2016 compared to 2010.

We further conduct an extrapolation exercise to examine how the effects of a one percent local funding shock would have evolved after 2019 if the elasticities of cross-border loan supply and demand continue down the existing trends. We predict the supply and demand elasticities for 2022 based on their existing time trends, as presented in Panel (b) of Figure 5. We then conduct our counterfactual analysis of a one percent local funding shock using loan supply and demand curves estimated based on the predicted elasticities, and compare the results to those based on 2010Q4 supply and demand curves. As shown in Appendix Figure A.8, insurance provision further declines in the global interbank and credit networks. In particular, the insurance mechanism is fully dominated by forces of shock amplification for a few banking sectors. Local funding shocks are now amplified for a number of banking sectors through the margin of interbank rebalancing, as foreign banks reallocate funding away from the banking sector hit by local funding shocks.

5.3 Global Funding Shock

Having examined the implications of the heterogeneity in supply elasticities for international risk sharing in the context of local funding shocks, we proceed to study how the amount of risk sharing and shock amplification evolves as the scope and magnitude of a funding shock increases. We simulate a regional funding shock and a GFC funding shock using observed declines in local funding during the GFC period. The regional shock is based on funding declines in the United States and United Kingdom, and the GFC shock is based on funding declines in six advanced economies–the United States, the United Kingdom, Japan, Germany, France, and Spain. We then quantify the effects of the global funding shock on cross-border lending and total funding in the global financial network.

Panels (a) and (b) of Figure 10 illustrate the effects of the regional and GFC shock on the total amount of insurance provision for the countries experiencing the respective shocks, as measured by the total change in cross-border interbank funding and total nonbank funding, respectively, normalized by the shock effect. The normalization is such that values greater than -100 imply mitigation or reversal of the shock effect (or positive insurance), and values less than -100 imply amplification of the shock effect. Panels (c) and (d) of Figure 10 illustrate the rebalancing effects that drive the overall effects. Panel (c) shows the share of interbank rebalancing normalized by the shock effect, and Panel (d) shows the share of credit balancing and retrenchment normalized by the shock effect.

We focus first on the results based on the 2010 supply and demand curves. Panel (a) shows that the amount of insurance provision provided to the banking sectors of the shocked countries is notably lower in the case of the GFC shock compared to the regional shock. As illustrated in Panel (c), insurance through interbank rebalancing mitigates the shock effect in response to the regional shock to a much greater extent than in response to the GFC shock. The same pattern is seen in the nonbank sectors of the shocked countries. While the global financial network provides positive insurance through credit rebalancing and retrenchment, the amount of insurance provided is smaller in the case of a GFC shock.

Thus, in contrast to the earlier result that the global financial network provides a significant amount of insurance in response to an idiosyncratic shock through a systemic rebalancing of bank loans toward the country hit by the shock, this insurance mechanism gradually breaks down as the magnitude of the funding shock and the number of countries hit directly by the shock increases. When a global funding shock hits multiple countries, global insurance provision through interbank and credit rebalancing significantly declines relative to the size of the direct shock effects.

These results are consistent with a significant decline in cross-border lending and total funding observed during the GFC period. They also echo the argument in some of the literature on networks, such as Acemoglu et al. (2015), that sufficiently large shocks or sufficiently many shocks to different counterparties can lead to fragility in densely connected financial networks. Nevertheless, we arrive at our results using a completely different approach that integrates endogenous interactions among multiple financial networks, whereas the network

literature is mostly theory-based and focuses on a static network.

We next compare the amount of insurance provision estimated based on the 2010Q4 supply and demand curves to the those estimates based on the 2016 supply and demand curves. In both the bank and nonbank sectors, insurance provision is lower under the 2016 supply and demand curves in response to both the regional and GFC shocks. In particular, the shock effect is significantly amplified for the bank sectors of the shocked countries in the case of the GFC shock, as banks from the non-shocked countries reallocate funds away from them, resulting in negative interbank rebalancing (or negative insurance). Overall, these results reveal that in the event of a global funding shock of the same magnitude as the GFC, there would be less insurance in the global financial network in the post-GFC period compared to the GFC period.[20]

5.4 The Role of Regulation

In this section, we explore one potential explanation for the change in loan supply elasticity and risk sharing in the global financial network over time. Prompted by the GFC, a number of countries heightened regulatory oversight of their financial sector by introducing new or more stringent regulatory standard and macroprudential policy. From a theoretical perspective, stricter bank regulation could reduce the likelihood of banks' distress. At the same time, regulations like higher capital requirements can reduce liquidity in a financial network and prevent flows of capital.

We capture changes in regulatory oversight using the IMF's Integrated Macroprudential Policy (iMaPP) Database, which provides indicator-type variables to denote the tightening and loosening of various policy instruments, with each tightening event coded as +1 and each loosening event coded as -1. For each lender country, we compute a regulatory strictness index using the cumulative sum of policy instruments implemented by the country up to each quarter starting from 2000Q1. On average, we observe significant tightening in different policy instruments. The average liquidity coverage ratio index across the lender countries increased from 0.1 in 2010 to 3.9 by the end of the sample period. The average capital

[20]Appendix Figure A.9 illustrates the effects of the regional and GFC shocks on the total amount of insurance provision for the countries not directly experiencing the respective shocks.

requirement index increased from 0.1 to 2.6.

Panel (a) of Figure 11 plots the changes in the elasticities of cross-border interbank loan supply as a function of the changes in the liquidity coverage ratio index, which captures the component of the bank regulation that is most relevant for interbank lending. Panel (a) shows that more stringent liquidity requirements are associated with less elastic loan supply in the interbank network. Similarly, in Panel (b) of Figure 11, we plot the changes in the elasticities of nonbank loan supply as a function of the changes in the capital requirement index—the component of the bank regulation that is most relevant for nonbank lending. It shows that more stringent capital requirements are associated with less elastic loan supply in the nonbank network. Therefore, it is plausible that regulatory changes have contributed to less insurance provision in the global financial network.

Understanding the drivers of the changes in loan supply curves is crucial for policymakers when determining the optimal level of regulation, given their link to insurance in the global financial network. Although the results in this section cannot provide conclusive evidence on whether increases in regulatory strictness caused the decline in loan supply elasticities, we provide suggestive evidence that changes in regulation could explain the changes in loan supply curves on multiple dimensions in recent years. At the same time, more stringent regulation (at least by our measure) cannot fully explain the decline in insurance provision in the interbank network, which highlights the need for additional explanatory factors.

6 Conclusion

This paper provides a systematic analysis of international risk sharing and shock propagation through the global financial network over the past decade. We develop a structural model of the global financial network that incorporates both the global interbank network and the global bank-nonbank credit network as well as endogenous cross-border loan supply, loan demand, and lending prices. Using the model, we estimate time-varying supply and demand curves for cross-border interbank and nonbank lending. We uncover significant variations in the estimates of cross-border supply and demand elasticities across countries, which reveals significant heterogeneity in the willingness and capacity of global financial intermediaries to

provide intermediary services. We show that this heterogeneity governs the extent of risk sharing across countries: countries with lower supply elasticities receive less insurance in response to idiosyncratic shocks. We further show that the elasticities of cross-border loan supply have declined since the GFC, resulting in less insurance provision and greater shock amplification in both interbank and credit networks. We provide suggestive evidence that tightening of macroprudential policy instruments has contributed to the decline in insurance. Our results shed new light on the role of the global financial network in supporting risk sharing and shaping global systemic risk over time.

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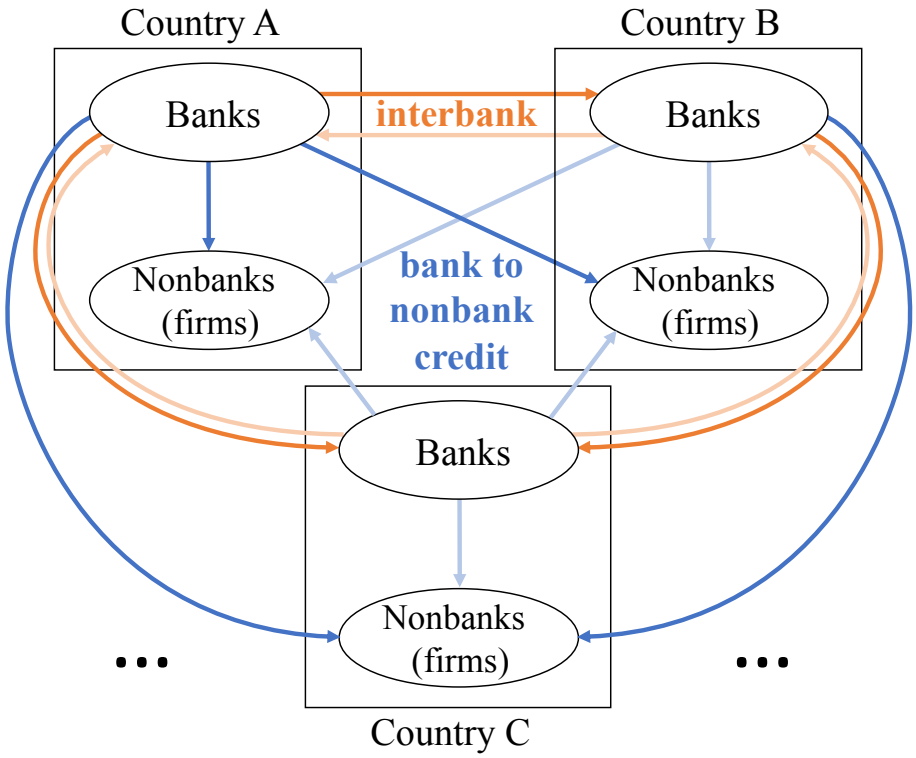
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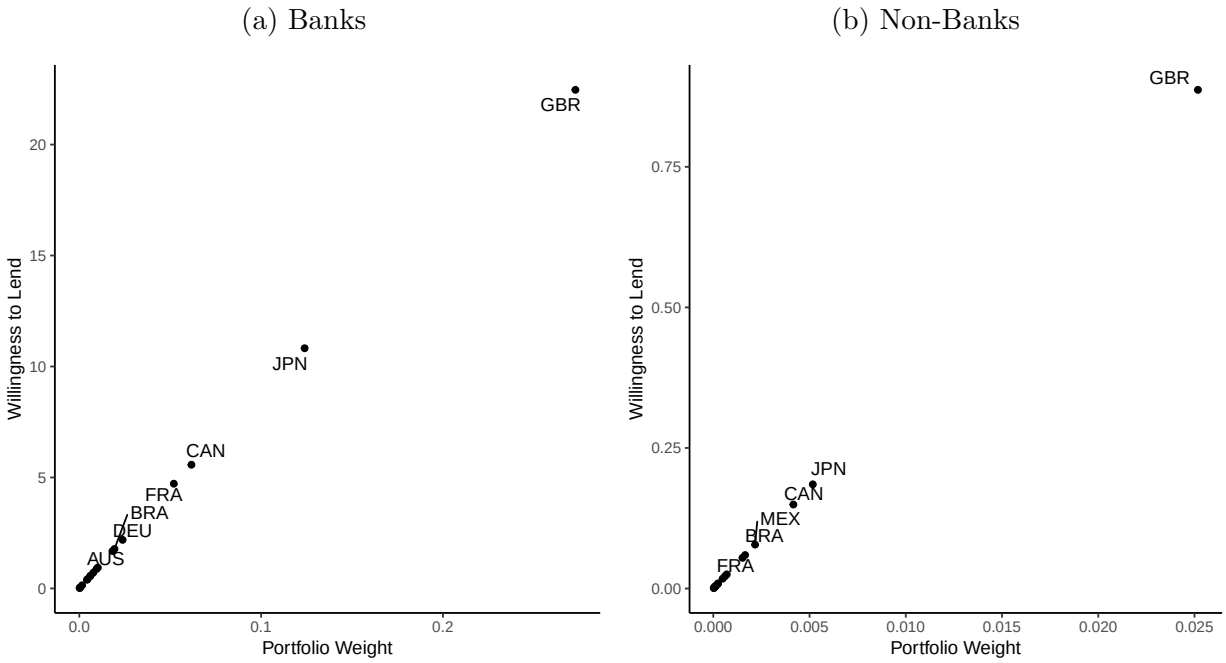
7 Figures and Tables

Figure 1: **Global Financial Network**



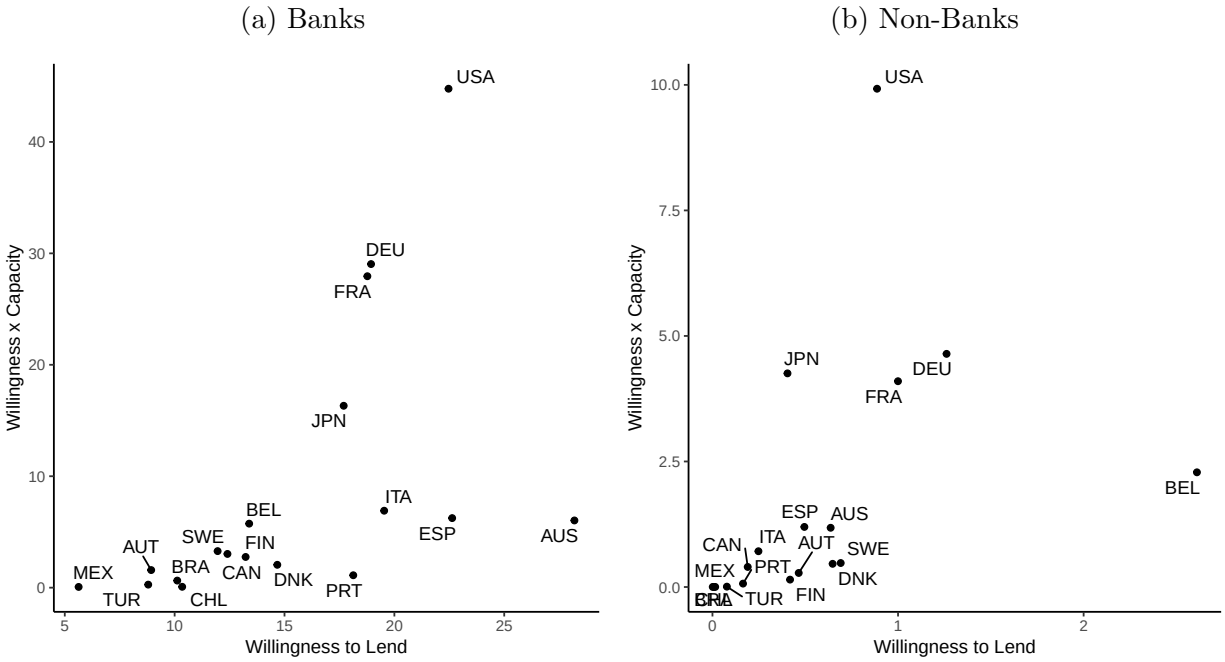
Notes: This plot provides a conceptual overview of the global financial network, which is comprised of the global interbank network and the global credit network.

Figure 2: Willingness of the U.S. Banking Sector to Extend Loans



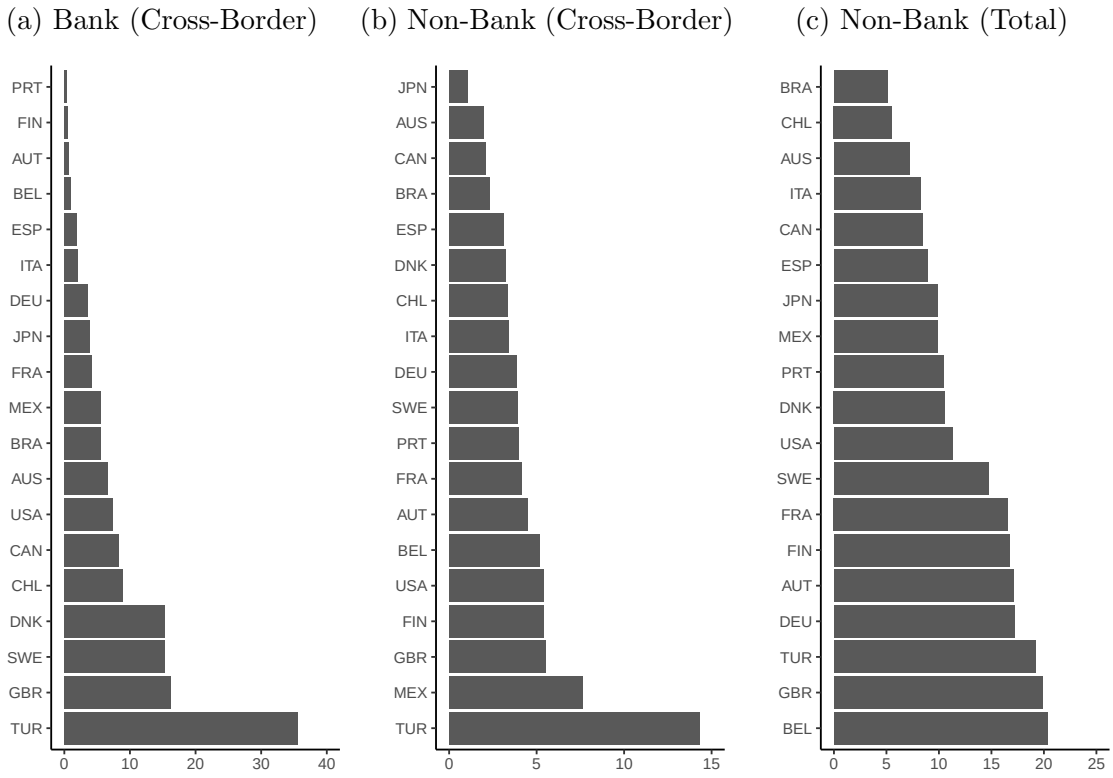
Notes: This exhibit plots the average willingness of the U.S. banking sector to lend to different borrower countries as a function of its average portfolio weights in that country in the bank (Panel a) and non-bank (Panel b) sectors. A lender country's willingness to lend to a borrower country in a sector is computed as the product of their bilateral supply elasticity and the weight of the borrower country in the lender's loan portfolio in that sector, as shown in equation (12). The bilateral elasticity is computed according to equation (A.2) in Appendix A. Averages are taken within country and over time.

Figure 3: Banks' Willingness and Capacity to Extend Loans to the United Kingdom



Notes: This exhibit plots the average willingness and capacity (willingness to lend multiplied by total AUM of the lender) of different countries to lend to the United Kingdom's bank (Panel a) and nonbank (Panel b) sectors as a function of their average willingness to lend to the United Kingdom. See the notes from Figure 2 for details on calculating a country's willingness to lend.

Figure 4: Loan Supply Elasticities by Borrower Country

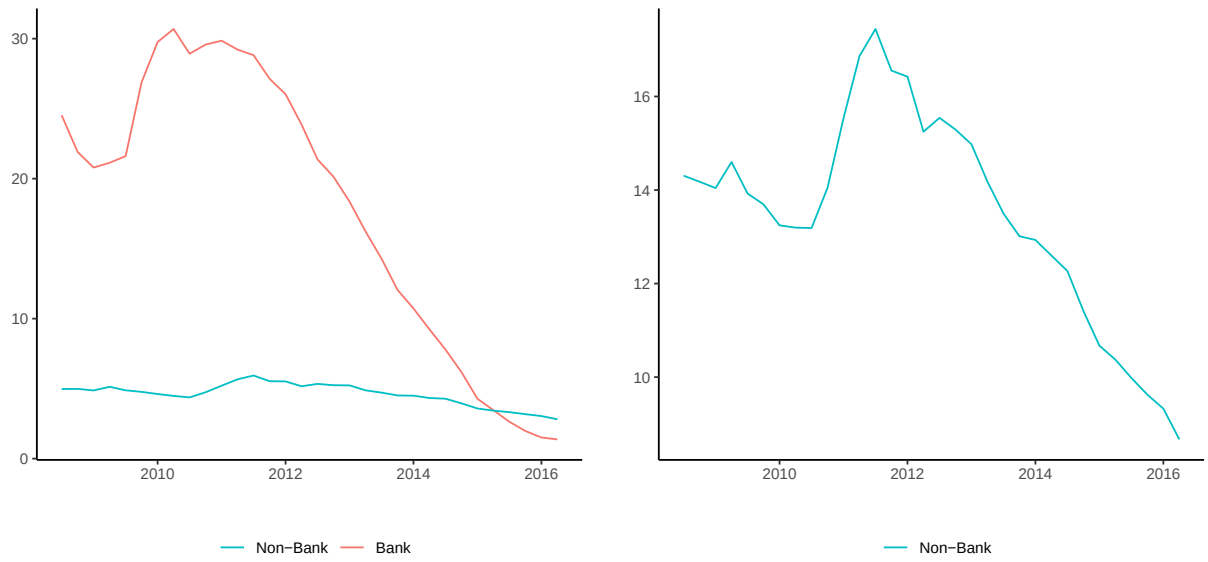


Notes: This exhibit presents the average cross-border loan supply elasticities for the bank sector (Panel a) and non-bank sector (Panel b) and the total (cross-border and local) lending elasticities for the non-bank sector (Panel c) of the borrower countries in the global financial network. The elasticities measure the percent change in the quantity of cross-border or total loans extended to a given sector in a given country in relation to a one percent increase in price. We compute the loan supply elasticity for each borrower country according to equation (12) using the full sample. Borrower countries are presented in ascending order from the least elastic lending supply to the most elastic.

Figure 5: Evolution of Global Banks' Loan Supply and Demand Curves

(a) Cross-Border Lending Elasticities

(b) Total Lending Elasticity for Non-banks

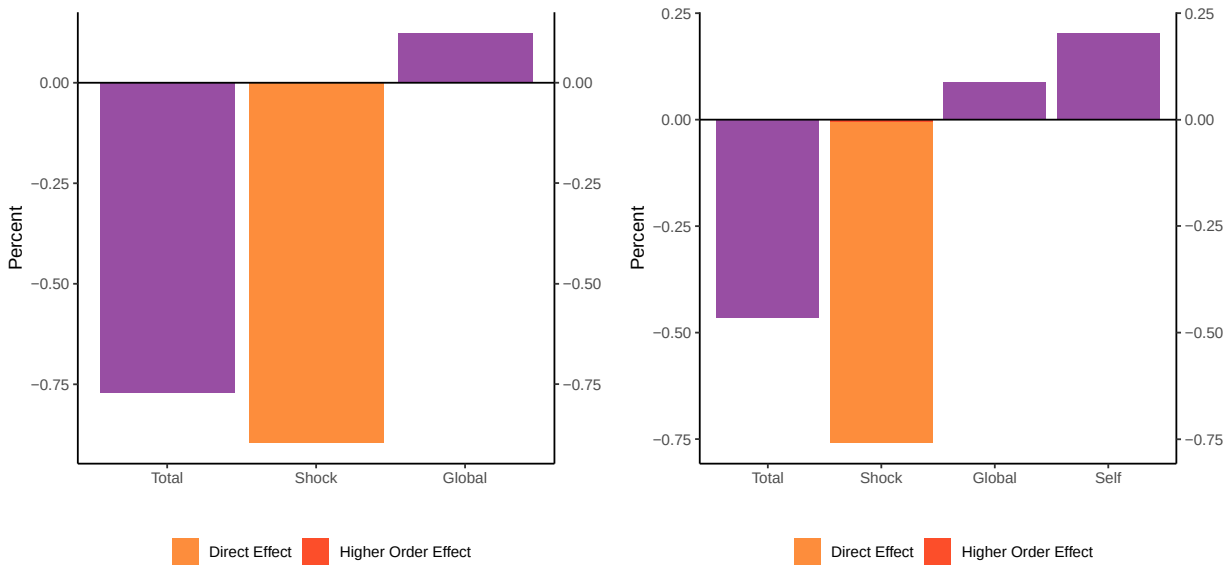


Notes: Panel (a) presents the average elasticities of cross-border interbank and nonbank loan supply and the average elasticities of cross-border interbank loan demand from 2005Q1 to 2019Q4. Panel (b) presents the average elasticities of total nonbank loan supply. The supply elasticities for each borrower country are computed based on a rolling regression using a 7-year subsample of the data, and are averaged across countries. See Figure 4 for more detailed descriptions of cross-border and total lending elasticities.

Figure 6: Effects of U.S. Funding Shock on Funding in the United States

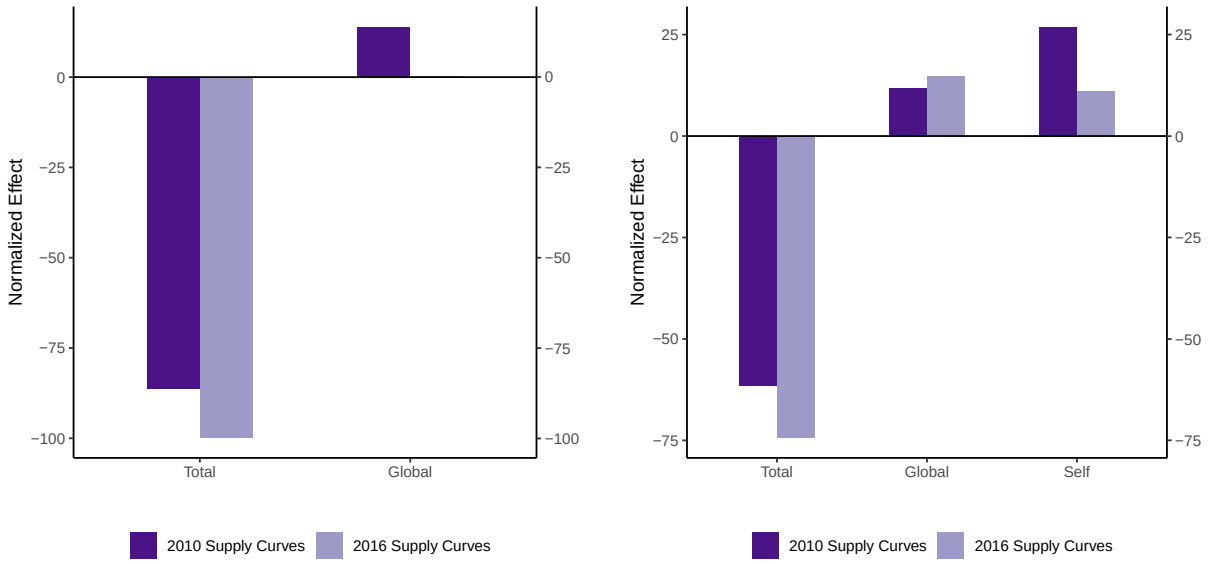
(a) Interbank Funding (2010Q4)

(b) Non-bank Funding (2010Q4)



(c) Interbank Funding (2010Q4 v 2016Q2)

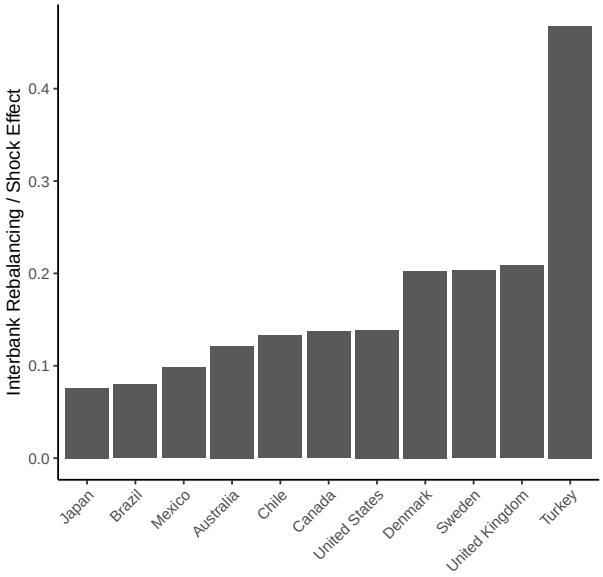
(d) Non-bank Funding (2010Q4 v 2016Q2)



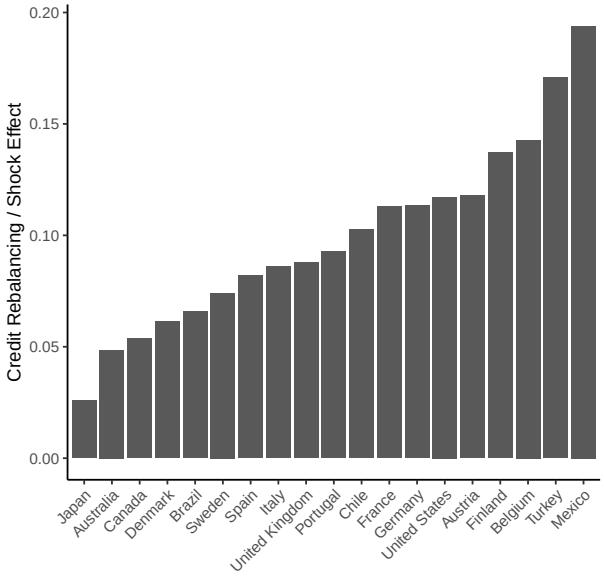
Notes: Panels (a) and (b) of this exhibit present the effect of a one percent decline in U.S. local funding on cross-border bank funding and total non-bank funding, respectively, in the United States in 2010Q4 based on the 2010Q4 supply and demand curves. The "shock" effect captures the change in lending that is directly attributable to the decline in U.S. local funding in a static network. "Global" interbank and credit rebalancing captures the change in lending resulting from endogenous reallocations of non-U.S. banks' loan portfolios to the corresponding sector. "Self" rebalancing captures endogenous reallocation of U.S. banks' loan portfolios to the nonbank sector. The shock effect and the rebalancing effect(s) sum up to the "total" effect. Panels (c) and (d) of the exhibit compare the effects of the one percent decline in U.S. local funding on cross-border bank funding and total non-bank funding, respectively, in the United States in 2010Q4 based on the 2010Q4 supply and demand curves (dark purple bars) to those based based on 2016Q2 supply and demand curves (light purple bars). In the bottom two panels, we normalize the total effect and the global and self-rebalancing effects by the shock effect in order to allow for comparison across time periods. We denote supply and demand curves based on the midpoint period of the 7-year subsample (e.g., the 2010Q4 supply curves denotes those estimated using the 2007Q1–2014Q2 subsample.)

Figure 7: Heterogeneity in Global Insurance

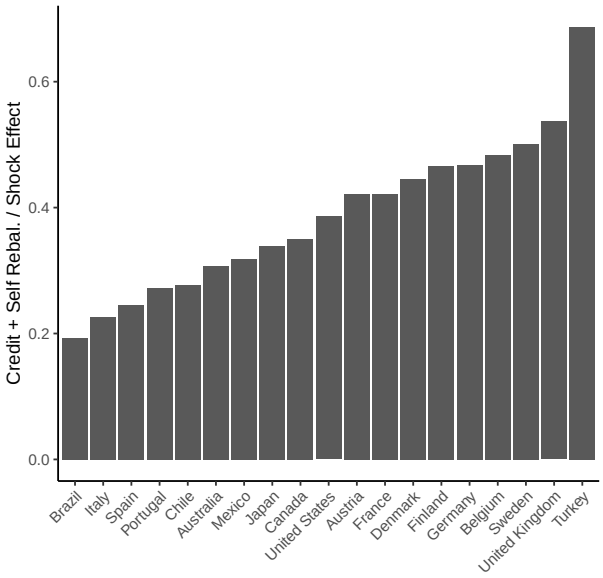
(a) Global Interbank Rebalancing



(b) Global Credit Rebalancing



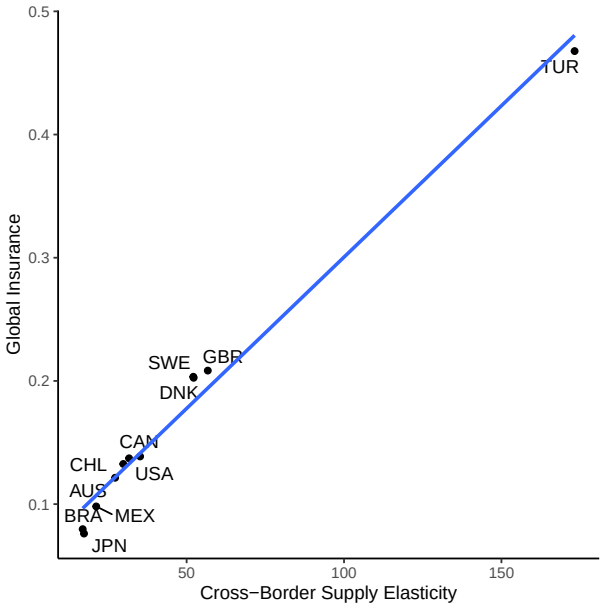
(c) Global Credit and Self Rebalancing



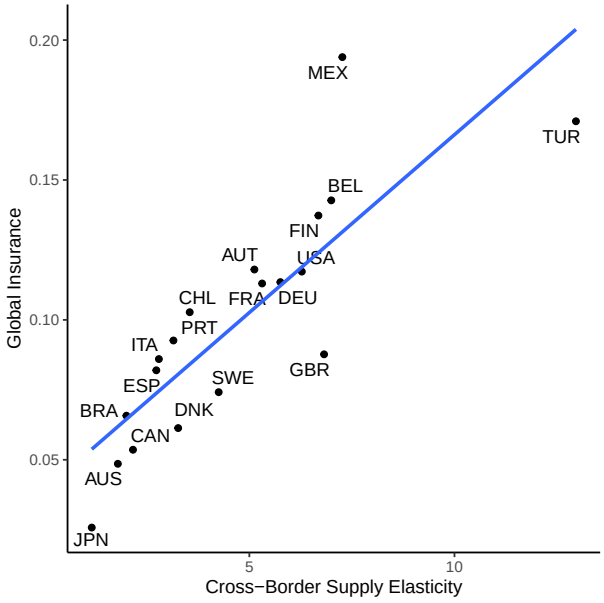
Notes: This exhibit presents the amount of insurance through global interbank rebalancing (Panel a), global credit rebalancing (Panel b) and total (global credit and self) rebalancing (Panel c) across borrower countries in response to a one percent local funding shock in each country. Tables 6 and 7 present the corresponding magnitudes. The estimates are based on the 2010Q4 supply and demand curves. See Figure 4 for additional details on the calculation of aggregate loan supply elasticities of each borrower country, and see Figure 6 for more detailed descriptions of the different margins of rebalancing.

Figure 8: Global Insurance and Elasticity of Loan Supply

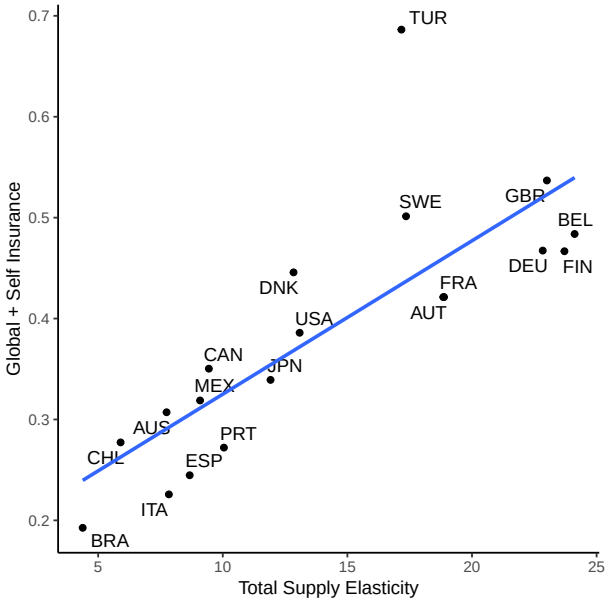
(a) Cross-border Funding (Banks)



(b) Cross-border Funding (Non-Banks)



(c) Total Funding (Non-Banks)

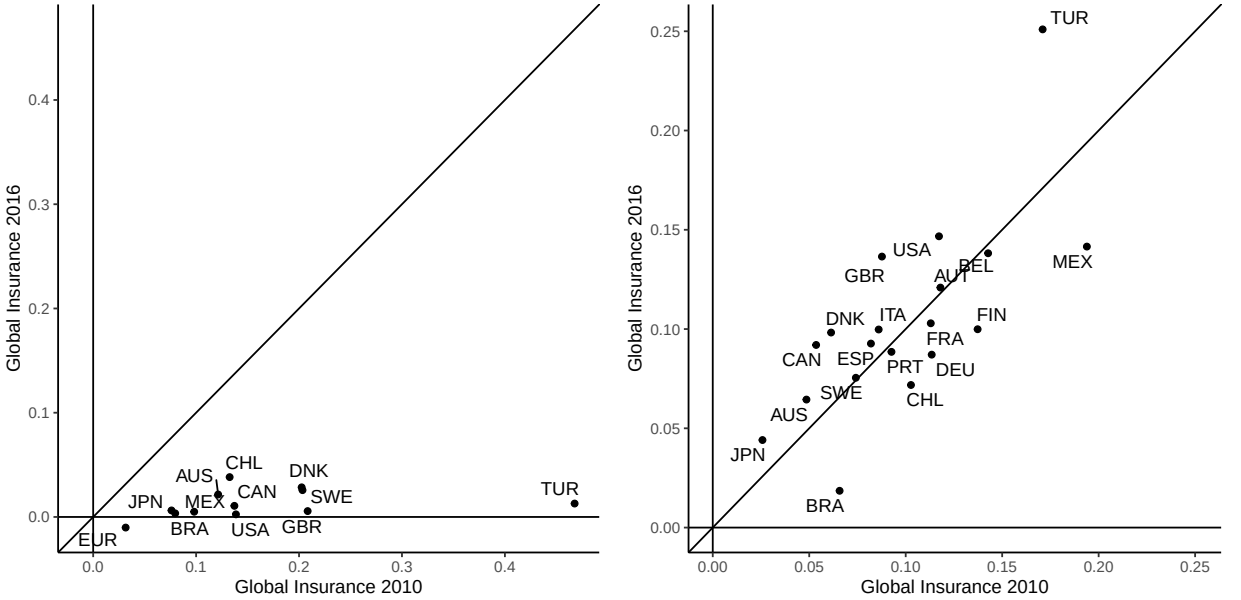


Notes: This exhibit presents the amount of insurance through global interbank rebalancing (Panel a), global credit rebalancing (Panel b) and total (global credit and self) rebalancing (Panel c) as a function of loan supply elasticities in response to a one percent local funding shock in each country. The estimates are based on the 2010Q4 supply and demand curves. See Figure 4 for additional details on the calculation of aggregate loan supply elasticities of each borrower country, and see Figure 6 for more detailed descriptions of the different margins of rebalancing. We include a fitted line in each panel.

Figure 9: Global Insurance through Rebalancing: 2010Q4 v 2016Q2

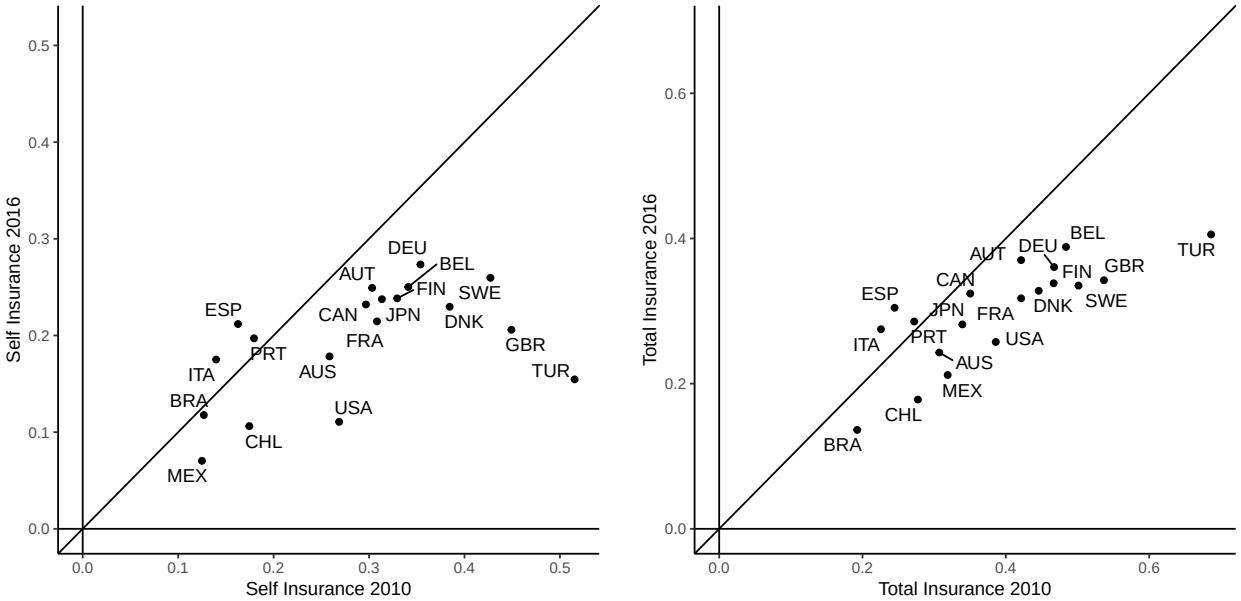
(a) Global Interbank Rebalancing

(b) Global Credit Rebalancing



(c) Self Rebalancing

(d) Total (Global and Self) Rebalancing

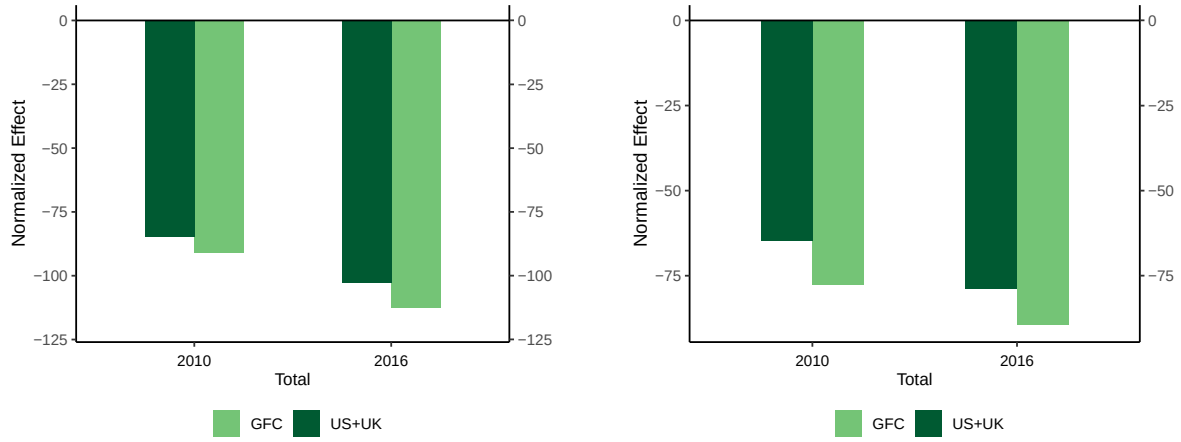


Notes: This exhibit presents the amount of insurance received by each country's bank and non-bank sector through global interbank rebalancing (Panel a), global credit rebalancing (Panel b), self-rebalancing (Panel c), and total (global credit and self) balancing (Panel d) in response to a one percent local funding shock based on the 2010Q4 supply and demand curves (x-axis) and the 2016Q2 supply and demand curves (y-axis). All margins of rebalancing are normalized by the shock effect. See Figure 6 for more detailed descriptions of the different margins of rebalancing. We include a 45-degree line in each panel.

Figure 10: Insurance During the Global Financial Crisis (Shocked Countries)

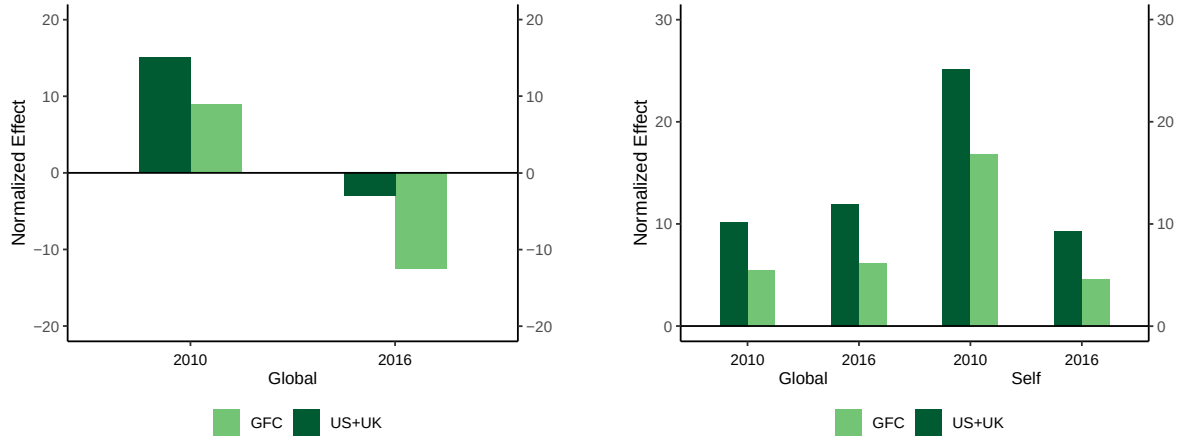
(a) Total Insurance (Bank)

(b) Total Insurance (Non-bank)



(c) Decomposition (Bank)

(d) Decomposition (Non-bank)

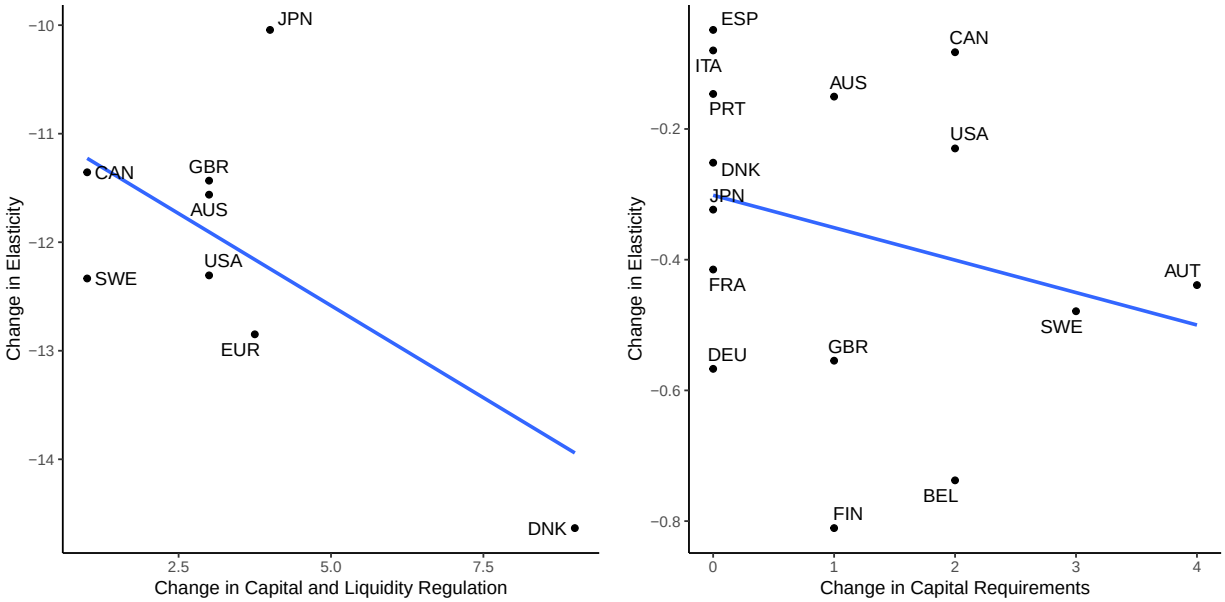


Notes: This exhibit presents insurance provision in response to a regional funding shock and a global funding shock. The regional funding shock is based on the observed decline in funding in the United States and United Kingdom during the Global Financial Crisis period. The global funding shock is based on the observed decline in funding in the United States, the United Kingdom, Japan, Germany, France, and Spain during the Global Financial Crisis period. We show insurance provision for the *shocked countries* based on the 2010Q4 and 2016Q2 supply and demand curves. In each panel, we normalize the total, global interbank rebalancing, global credit rebalancing, and self-rebalancing effects by the shock effect in order to allow for comparison across different supply and demand curves. See Figure 6 for additional details about the different margins of rebalancing.

Figure 11: Regulatory Stringency and Insurance Provision in the Global Financial Network

(a) Interbank Network

(b) Bank-Nonbank Credit Network



Notes: This exhibit presents the correlation between changes in the regulatory stringency measures after the Global Financial Crisis, and changes in loan supply elasticities between 2010 and 2016 in the interbank network (Panel a) and the bank-nonbank credit network (Panel b). In panel (a), the regulatory stringency measure is based on the stringency of the liquidity coverage ratio. The slope of the fitted line is -0.08 (s.e. = 0.04) with R-squared = 0.40. In panel (b), the regulatory stringency measure is based on the stringency of the capital ratio. The slope of the fitted line is -0.05 (s.e. = 0.05) with R-squared = 0.24. We restrict the sample to advanced economies. Data source: Integrated Macroprudential Policy (iMaPP) Database.

Table 1: Summary Statistics on Total Funding by Sector (Billions of USD)

	2007Q2–2014Q2						2012Q4–2019Q4					
	CB Bank		CB Non-banks		Total Non-banks		CB Bank		CB Non-banks		Total Non-banks	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Australia	112	38	85	23	1298	353	152	16	99	11	2051	247
Austria	156	34	59	6	532	65	89	31	76	7	546	39
Belgium	254	56	88	16	768	104	164	14	106	8	712	69
Brazil	42	20	60	29	595	449	76	8	92	14	1432	191
Canada	179	41	90	22	1814	274	230	24	145	24	2163	137
Chile	12	6	14	2	164	36	19	2	18	1	254	20
Denmark	154	32	56	19	634	97	140	24	70	8	713	40
Finland	89	37	37	5	296	37	141	17	49	5	329	17
France	955	175	371	56	3286	433	872	91	447	27	3739	241
Germany	811	121	391	83	4128	615	720	89	355	75	2807	1215
Italy	512	120	329	62	3143	384	296	51	249	60	3188	263
Japan	356	86	175	36	8736	1821	624	50	308	62	8701	1239
Mexico	10	6	57	12	330	38	21	1	79	4	416	26
Portugal	107	22	57	8	446	61	45	19	38	2	406	56
Spain	529	124	238	48	2773	365	240	75	190	16	2361	431
Sweden	147	24	74	9	635	79	182	14	80	5	766	38
Switzerland	397	97	120	24	772	141	325	22	127	6	1030	44
Turkey	28	10	49	11	147	34	58	8	62	5	211	14
United Kingdom	2478	389	746	123	5537	544	1735	367	1007	162	5659	328
United States	1088	224	1848	234	10771	901	1207	71	2186	236	13356	1581

Notes: This table reports the quarterly means and standard deviations of total cross-border lending to the bank sector (columns 2–3, columns 7–8) and non-bank sector (columns 4–5, columns 9–10), and of total (cross-border and domestic) funding to the non-bank sector (columns 6–7, columns 11–12) of the 19 countries in the global financial network over the sample period of 2007Q2–2014Q2 (left panel) and 2012Q4–2019Q4 (right panel).

Table 2: Within-sector Loan Supply Estimation (Full Sample)

	(1) Banks	(2) Non-banks
Log Price	-91.85	-35.04^{**}
	(66.06)	(14.65)
Exchange Rate	0.01	0.04
	(0.06)	(0.05)
Policy Rate Differential	9.33	3.14
	(10.60)	(2.87)
Log GDP (Lagged)	1.41^{***}	0.99^{***}
	(0.10)	(0.11)
Log GDP per capita (Lagged)	0.56^{*}	0.19
	(0.32)	(0.24)
Distance	-1.70^{***}	-1.31^{***}
	(0.20)	(0.17)
Trade Exposure	0.06	0.18^{*}
	(0.11)	(0.09)
Volatility	-0.39^{***}	-0.38^{***}
	(0.10)	(0.06)
Regulation (Borrower)	-0.38^{**}	-0.25^{***}
	(0.13)	(0.08)
Indicator: Own Country		3.42^{***}
		(0.89)
Obs.	18,435	18,601

Notes: This table presents the estimation results from equation (8) for the bank (column 1) and nonbank (column 2) sectors using the full sample period from 2005Q1 to 2019Q4. The estimation is based on an instrumental variable approach. All specifications include lender country, time, and borrower country MSCI market fixed effects. Standard errors (in parentheses) are clustered by lender and time period. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 3: Within-sector Loan Supply Estimation (2010Q4 and 2016Q2)

	2010Q2		2016Q2	
	(1) Banks	(2) Non-banks	(3) Banks	(4) Non-banks
Log Price	-367.09^{***}	-41.31^{***}	-20.62	-24.51
	(119.94)	(13.62)	(75.88)	(15.62)
Exchange Rate	-0.04	0.17^{***}	0.05	0.05
	(0.09)	(0.06)	(0.07)	(0.07)
Policy Rate Differential	51.90^{**}	13.07^{**}	-2.05	-0.68
	(18.73)	(6.03)	(11.69)	(1.77)
Log GDP (Lagged)	1.32^{***}	0.96^{***}	1.63^{***}	1.12^{***}
	(0.09)	(0.12)	(0.13)	(0.12)
Log GDP per capita (Lagged)	0.09	0.42^{*}	0.94^{**}	0.27
	(0.36)	(0.24)	(0.37)	(0.27)
Distance	-1.64^{***}	-1.28^{***}	-1.88^{***}	-1.43^{***}
	(0.20)	(0.17)	(0.23)	(0.21)
Trade Exposure	0.09	0.13	-0.02	0.17
	(0.10)	(0.09)	(0.12)	(0.10)
Volatility	-0.33^{***}	-0.37^{***}	-0.33^{**}	-0.36^{***}
	(0.10)	(0.05)	(0.13)	(0.09)
Regulation (Borrower)	-1.68^{***}	-0.77^{***}	-0.23^{*}	-0.21^{**}
	(0.37)	(0.18)	(0.12)	(0.09)
Indicator: Own Country		3.07^{***}		3.67^{***}
		(0.93)		(0.91)
Observations	8,993	9,138	9,163	9,237

Notes: This table presents the estimation results from equation (8) for the bank (columns 1 and 3) and nonbank (columns 2 and 4) sectors using 7-year subsamples with midpoints at 2010Q4 and 2016Q2. The estimation is based on an instrumental variable approach. All specifications include lender country, time, and borrower country MSCI market fixed effects. Standard errors (in parentheses) are clustered by lender and time period. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 4: Effects of U.S. Local Funding Shock on Cross-border Interbank Lending

	2010Q4		2016Q2	
	(1) Shock Amt (Mil.USD)	(2) Interbank Reb. (%)	(3) Shock Amt (Mil.USD)	(4) Interbank Reb. (%)
Australia	-501.1	-0.72	-798.2	-0.66
Brazil	-489.3	-0.43	-158.7	-0.41
Canada	-1,245.3	-0.34	-764.7	-0.43
Chile	-81.0	-0.60	-253.0	-0.40
Denmark	-26.0	-7.72	-153.8	-2.30
Euro-Area	-2,062.9	-2.06	-7697.8	-1.31
Japan	-2,708.5	-0.53	-5,918.3	-0.49
Mexico	-97.7	-0.55	-31.0	-0.51
Sweden	-125.2	-2.16	-804.9	-0.72
Turkey	-46.5	-1.33	-1.9	-3.50
United Kingdom	-4,338.2	-0.45	-5,575.3	-0.76
United States	-112,689.1	0.14	-112,689.1	0.00

Notes: This table presents the change in funding in each country's bank sector as a result of a one percent decline in U.S. local funding in 2010Q4 based on the 2010Q4 supply and demand curves (columns 1 and 2) and the 2016Q2 supply and demand curves (columns 3 and 4). The shock effect captures the change in cross-border funding directly attributable to the U.S. local funding shock in a static network. Global interbank rebalancing captures the endogenous reallocation of cross-border funding to each borrower country normalized by the magnitude of the shock effect.

Table 5: Effects of U.S. Funding Shock on Cross-border and Local Non-Bank Lending

	2010Q4			2016Q2		
	(1) Shock Effect (Mil.USD)	(2) Credit Reb. (%)	(3) Self Reb. (%)	(4) Shock Effect (Mil.USD)	(5) Credit Reb. (%)	(6) Self Reb. (%)
Australia	-443.6	-0.21	-1.58	-649.7	-0.24	-0.70
Austria	-43.6	-1.97	-1.91	-41.4	-1.93	-0.82
Belgium	-60.9	-1.79	-3.94	-85.5	-1.53	-1.59
Brazil	-723.9	-0.23	-0.48	-194.8	-0.25	-0.42
Canada	-1452.5	-0.07	-1.09	-1285.4	-0.16	-0.46
Chile	-160.3	-0.18	-0.62	-284.5	-0.04	-0.28
Denmark	-21.0	-2.67	-13.93	-68.2	-1.34	-3.80
Finland	-84.4	-0.33	-1.74	-203.1	-0.11	-0.66
France	-671.9	-0.49	-2.79	-1465.7	-0.25	-1.19
Germany	-316.4	-1.13	-2.85	-614.0	-0.33	-1.64
Italy	-91.4	-2.89	-8.65	-125.8	-2.86	-4.79
Japan	-2504.3	-0.15	-1.83	-4716.7	-0.11	-0.66
Mexico	-334.4	-0.21	-0.30	-177.0	-0.32	-0.32
Portugal	-8.4	-4.01	-12.47	-10.9	-3.54	-6.34
Spain	-75.4	-2.42	-12.27	-120.0	-1.54	-5.97
Sweden	-122.0	-0.75	-1.83	-318.8	-0.17	-0.52
Turkey	-47.6	-0.34	-1.56	-8.3	-2.28	-0.40
U.K.	-4209.0	-0.08	-0.62	-6019.4	-0.11	-0.11
U.S.	-89935.6	0.12	0.27	-81206.4	0.15	0.11

Notes: This table presents the change in funding in each country's non-banking sector as a result of a one percent decline in U.S. local funding in 2010Q4 based on the 2010Q4 (columns 1–3) and 2016Q2 (columns 4–6) supply and demand curves. The shock effect captures the change in funding directly attributable to the U.S. local funding shock in a static network. Global credit rebalancing captures the endogenous reallocation of cross-border funding by non-U.S. banks normalized by the magnitude of the shock effect, and self-rebalancing captures the endogenous reallocation of funding by U.S. banks normalized by the magnitude of the shock effect.

Table 6: Global Interbank Rebalancing

	2010Q4		2016Q2	
Country	(1) Shock Effect (Mil.USD)	(2) Interbank Reb. (%)	(3) Shock Effect (Mil.USD)	(4) Interbank Reb. (%)
Australia	-20,953.0	0.12	-20,953.0	0.02
Brazil	-16,891.6	0.08	-16,891.6	0.00
Canada	-22,948.1	0.14	-22,948.1	0.01
Chile	-2,128.6	0.13	-2,128.6	0.04
Denmark	-8,396.7	0.20	-8,396.7	0.03
Euro-Area	-188,552.3	0.03	-188,552.3	-0.01
Japan	-114,285.4	0.08	-114,285.4	0.01
Mexico	-3,418.6	0.10	-3,418.6	0.00
Sweden	-10,424.0	0.20	-10,424.0	0.03
Turkey	-764.6	0.47	-764.6	0.01
United Kingdom	-82,697.1	0.21	-82,697.1	0.01
United States	-112,689.1	0.14	-112,689.1	0.00

Notes: This table presents the change in cross-border funding in each country's bank sector as a result of a one percent decline in *each country's* local funding in 2010Q4 based on the 2010Q4 and 2016Q2 supply and demand curves. See Table 4 for a description of each column.

Table 7: Global Credit and Self Rebalancing in the Non-bank Sector

	2010Q4			2016Q2		
	(1) Shock Effect (Mil.USD)	(2) Credit Reb. (%)	(3) Self Reb. (%)	(4) Shock Effect (Mil.USD)	(5) Credit Reb. (%)	(6) Self Reb. (%)
Australia	-17729.8	0.05	0.26	-15121.0	0.06	0.18
Austria	-4643.2	0.12	0.30	-3372.3	0.12	0.25
Belgium	-5542.9	0.14	0.34	-3999.4	0.14	0.25
Brazil	-16081.1	0.07	0.13	-13865.9	0.02	0.12
Canada	-18613.7	0.05	0.30	-12455.3	0.09	0.23
Chile	-2023.8	0.10	0.17	-1864.1	0.07	0.11
Denmark	-6174.4	0.06	0.38	-4556.4	0.10	0.23
Finland	-2289.1	0.14	0.33	-1700.5	0.10	0.24
France	-30714.5	0.11	0.31	-20196.1	0.10	0.21
Germany	-21664.3	0.11	0.35	-13425.8	0.09	0.27
Italy	-31038.8	0.09	0.14	-22657.8	0.10	0.18
Japan	-84408.3	0.03	0.31	-64180.1	0.04	0.24
Mexico	-3299.7	0.19	0.12	-3030.0	0.14	0.07
Portugal	-3890.9	0.09	0.18	-3072.1	0.09	0.20
Spain	-24646.3	0.08	0.16	-16132.0	0.09	0.21
Sweden	-6317.0	0.07	0.43	-4394.0	0.08	0.26
Turkey	-643.0	0.17	0.52	-381.1	0.25	0.15
U.K.	-42035.7	0.09	0.45	-25038.8	0.14	0.21
U.S.	-89935.6	0.12	0.27	-81206.4	0.15	0.11

Notes: This table presents the change in funding in each country's non-bank sector as a result of a one percent decline in *each country's* local funding in 2010Q4 based on the 2010Q4 and 2016Q2 supply and demand curves. See Table 5 for a description of each column.

Appendix
-For online publication only-

A Deriving Loan Supply Elasticities

In this section, we derive expressions for elasticities of lending supply with respect to price within each sector, including bilateral elasticities of loan supply for each given lender-borrower country pair and aggregate loan supply elasticity for each borrower country.

The log quantity of loans provided to sector ℓ of country m is given by

$$\hat{q}_{n,t}(m,\ell) = \log\left(A_{n,t}w_{n,t}(\ell)w_{n,t}(m|\ell)\right) - p_t(m,\ell). \tag{A.1}$$

Equation (A.1) shows that changes in the log price of loans affect the quantity of loans supplied through their influence on the across-sector weight $w_{n,t}(\ell)$, the within-sector weight $w_{n,t}(m|\ell)$, and the price of the loan itself $p_t(m,\ell)$.

To derive the elasticity of loan supply for a given lender n to borrower m in sector ℓ, we plug equations (1), (2) and (4) into equation (A.1) and differentiate with respect to $p_t(m,\ell)$:

$$-\frac{\partial \hat{q}_{n,t}(m,\ell)}{\partial p_t(m,\ell)} = 1 - \underbrace{(1-w_{n,t}(\ell))w_{n,t}(m|\ell)\beta_\ell\lambda_\ell}_{\frac{\partial \log(w_{n,t}(\ell))}{\partial p_t(m,\ell)}} - \underbrace{(1-w_{n,t}(m|\ell))\beta_\ell}_{\frac{\partial \log(w_{n,t}(m|\ell))}{\partial p_t(m,\ell)}}. \tag{A.2}$$

The aggregate log quantity of loans supplied to sector ℓ of country m is equal to

$$\hat{q}_t(m,\ell) = \log\left(\sum_n A_{n,t}w_{n,t}(\ell)w_{n,t}(m|\ell)\right) - p_t(m,\ell).$$

To derive the aggregate supply elasticity for lending to sector ℓ of country m, we take the derivative of the above expression with respect to $p_t(m,\ell)$:

$$-\frac{\partial \hat{q}_t(m,\ell)}{\partial p_t(m,\ell)} = \sum_n \left(\frac{A_{n,t}w_{n,t}(m,\ell)}{\sum_k A_{k,t}w_{k,t}(m,\ell)}\right)\left(-\frac{\partial \hat{q}_{n,t}(m,\ell)}{\partial p_t(m,\ell)}\right) \tag{A.3}$$

Equation (A.3) shows that the aggregate market supply elasticity for lending to sector ℓ of country m is a weighted sum of the supply elasticities of each individual lender country.

B Counterfactual Analysis: Spillover Effects from a U.S. Local Funding Shock

In this section, we study the spillover effects of a one percent U.S. local funding shock. We first focus on the effects on one specific destination country, Turkey, to highlight the mechanisms of propagation. We then discuss the effects across all destination countries. Finally, we study the evolution of the extent of shock propagation over time.

A specific case: Turkey. Panel (a) of Appendix Figure A.4 illustrates the effects of the shock on cross-border interbank lending to Turkey. As in Panel (a) from Figure 6, the shock effect here captures the immediate change in cross-border interbank lending to Turkey, holding all portfolio weights fixed, which encompasses the decline in lending from both the origin country, the United States (direct effect), and non-U.S. countries (indirect effect). While the U.S. funding shock induces a drop of $47 million in cross-border interbank lending to Turkish banks, interbank rebalancing amplifies the negative shock effect by more than 100 percent, exacerbating the direct spillover effects from the shock.

Panel (b) of Appendix Figure A.4 illustrates the effects of the funding shock on total funding to the nonbank sector in Turkey. In response to the shock, cross-border lending immediately declines by $48 million. Non-U.S. banks further reallocate funding away from Turkish nonbanks through global credit rebalancing, exacerbating the shock effect by an additional 34 percent. Global credit rebalancing serves as a mechanism of shock amplification in this case. Despite the negative shock effect and rebalancing effect, Turkish banks further lower funding to Turkish nonbanks through the self-rebalancing margin. Panel (b) of Figure A.5 in the Online Appendix shows that the decline in Turkish nonbank funding through self-rebalancing mostly results from the indirect effects of interbank rebalancing. Turkish banks lose funding through interbank rebalancing and therefore decrease their funding to the domestic nonbank sector. Turkish banks retrench to offset this loss in domestic nonbank funding but reverse the indirect interbank rebalancing effect only a little.

Generalization. Columns (1)–(2) of Table 4 present the effects of the U.S. funding shock on interbank funding across all destination countries based on the estimated 2010 supply and demand curves. Column (1) shows the amount of shock effect, revealing significant heterogeneity in immediate changes in cross-border interbank lending to each destination country. Bank sectors of the United Kingdom, Japan, and the euro area experience the greatest decline in cross-border interbank lending as a result of the U.S. funding shock, which is intuitive given U.S. banks provide a large amount of funding to them ex-ante. Column (2) of Table 4 shows the share of global interbank rebalancing relative to the shock effect across all destination countries. Note that in this and all subsequent tables, we adjust the sign of the ratio such as a positive number denotes mitigation of the shock effect, and a negative number denotes exacerbation of the shock effect. All countries witness an exacerbation of the shock effect, like Turkey, which shows that global interbank rebalancing generally serves a mechanism of shock amplification when bank sectors experience spillover effects from foreign funding shocks.

Columns (1)–(3) of Table 5 present the effects of the U.S. funding shock on nonbank

funding across all destination countries based on the estimated 2010 supply and demand curves. Column (1) shows the amount of shock effect, and columns (2) and (3) show the share of global credit rebalancing and self-rebalancing relative to the shock effect, respectively, across the destination countries. Nonbanks across most destination countries, like Turkey, experience an exacerbation of the shock effect as a result of global credit rebalancing. Therefore, global credit rebalancing serves as a mechanism of shock amplification for the nonbank sectors. The nonbank sectors of all countries also suffer substantial funding losses due to the indirect effects of interbank rebalancing.

On aggregate, we observe that emerging markets witness greater outflow of foreign capital in both the bank and nonbank sectors in response to the U.S. local funding shock, as shown in Appendix A.6. This observation is consistent with the established empirical fact on the fickleness of foreign capital for emerging markets in the literature (Forbes and Warnock 2021).

Variation in shock propagation to Turkey over time. Panels (c) and (d) of Appendix Figure A.4 compare the effects of the U.S. local funding shock on cross-border interbank lending and total nonbank funding, respectively, to Turkey based on the 2016 supply and demand curves with those based on the 2010 supply and demand curves. In terms of interbank lending, amplification through global interbank rebalancing grew over the sample period, resulting in a worsening of the spillover effect from the U.S. local funding shock on funding conditions for Turkish banks. Global insurance for Turkish banks declined from -133 percent of the shock effect based on the 2010 supply and demand curves to -350 percent based on the 2016 estimates.[1]

The Turkish nonbank sector also experiences a decline in insurance between 2010 and 2016 in response to the U.S. funding shock, driven by an even larger amplification of the initial shock effect though credit rebalancing. Given the negative shock effect and rebalancing effect, Turkish banks retrench from the global financial network through the self-rebalancing margin, as they invest more in domestic firms.[2]

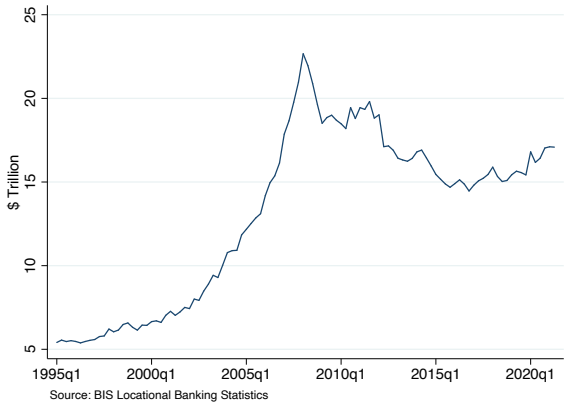
[1]Columns (3) and (4) of Table 4 present the share of global interbank rebalancing relative to the shock effect across all destination countries in response to the U.S. local funding shock. Many countries, like Turkey, experience an exacerbation of the amplification effect through interbank rebalancing, with some heterogeneity across countries.

[2]Columns (4)–(6) of Table 5 show the share of global credit rebalancing and self-rebalancing relative to the shock effect across all destination countries in response to the U.S. local funding shock. Most countries, like Turkey, experience a decline in insurance provision through these two margins of rebalancing, with some heterogeneity across countries.

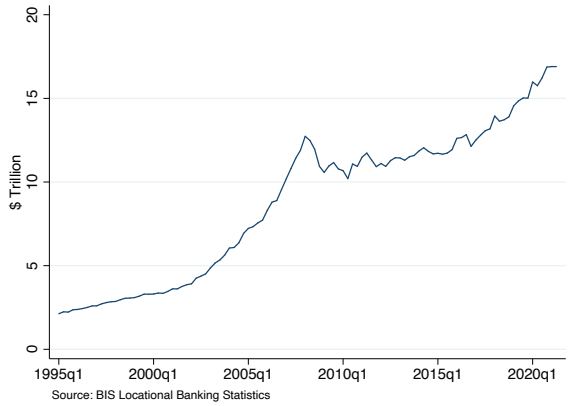
C Additional Figures and Tables

Figure A.1: **Capital Flows in the Global Financial Network**

(a) Cross-border Bank-to-bank Flows



(b) Cross-border Bank-to-nonbank Flows



Notes: This plot shows the aggregate cross-border bank-to-bank flows in the global interbank network (Panel a) and bank-to-nonbank flows in the global credit network (Panel b). Source: BIS Locational Banking Statistics.

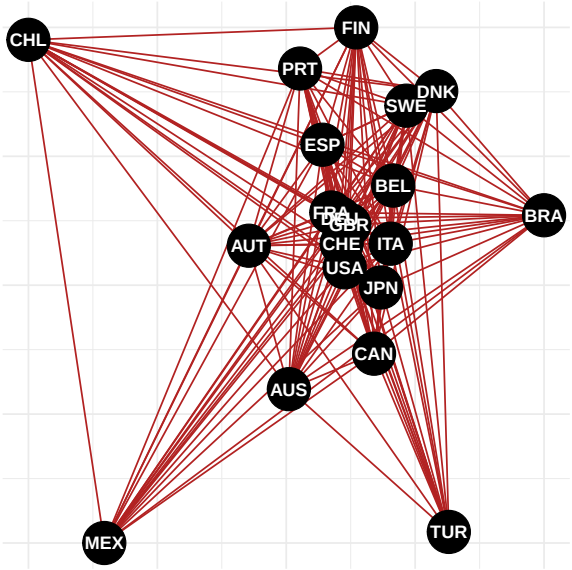
Table A.1: List of Countries

Financial Center:	*Advanced Economy:*	*Emerging Economy:*
United States	Australia	Brazil
United Kingdom	Austria	Chile
	Belgium	Mexico
	Canada	Turkey
	Denmark	
	Finland	
	France	
	Germany	
	Italy	
	Japan	
	Portugal	
	Spain	
	Sweden	

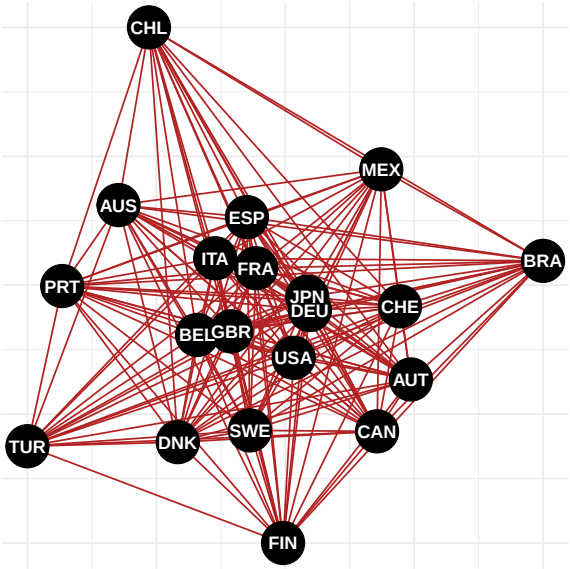
Notes: This table lists the countries in our sample, which is comprised of quarterly data from 2005Q1 to 2019Q4.

Figure A.2: **Global Financial Network**

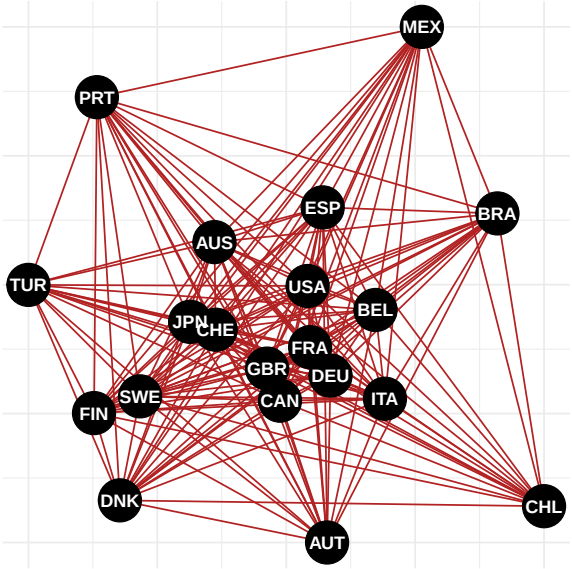
(a) Global Interbank Network, 2005Q1



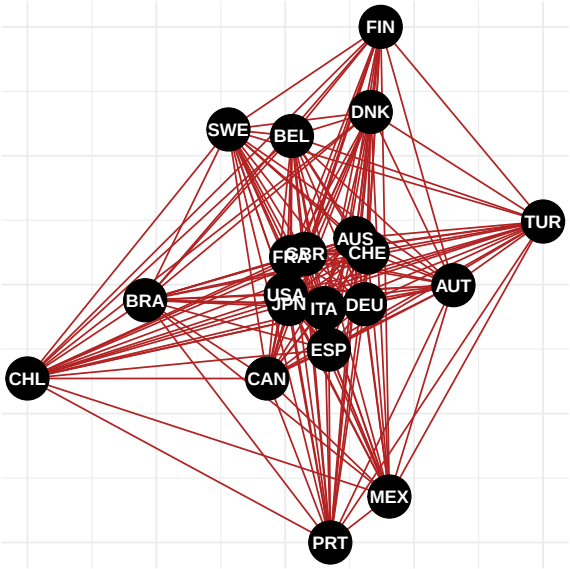
(b) Global Credit Network, 2005Q1



(c) Global Interbank Network, 2019Q4



(d) Global Credit Network, 2019Q4



Notes: This plot shows the global interbank network for 2005Q1 (Panel a) and 2019Q4 (Panel c) and the global credit network for 2005Q1 (Panel b) and 2019Q4 (Panel d) comprised of the 19 countries in our sample. Source: BIS Locational Banking Statistics.

Table A.2: Eigenvector Centrality

Global Interbank Network				Global Credit Network			
Country	2005Q1	Country	2019Q4	Country	2005Q1	Country	2019Q4
United Kingdom	1.000	United Kingdom	1.000	United States	1.000	United States	1.000
Germany	0.706	United States	0.741	United Kingdom	0.946	United Kingdom	0.917
United States	0.567	Germany	0.596	Japan	0.607	Japan	0.620
France	0.562	France	0.578	Germany	0.381	Germany	0.374
Switzerland	0.420	Japan	0.329	France	0.379	France	0.321
Japan	0.326	Italy	0.279	Belgium	0.177	Spain	0.143
Spain	0.213	Spain	0.275	Italy	0.174	Belgium	0.138
Italy	0.212	Switzerland	0.261	Spain	0.108	Italy	0.117
Belgium	0.197	Belgium	0.145	Switzerland	0.070	Canada	0.112
Canada	0.080	Canada	0.114	Canada	0.051	Switzerland	0.072
Austria	0.073	Australia	0.083	Sweden	0.045	Australia	0.071
Sweden	0.063	Austria	0.072	Australia	0.044	Sweden	0.040
Denmark	0.055	Sweden	0.058	Austria	0.033	Austria	0.038
Australia	0.051	Denmark	0.047	Denmark	0.026	Denmark	0.031
Portugal	0.044	Portugal	0.041	Portugal	0.025	Mexico	0.028
Finland	0.019	Finland	0.020	Mexico	0.021	Portugal	0.024
Brazil	0.012	Brazil	0.018	Turkey	0.012	Brazil	0.023
Turkey	0.009	Turkey	0.014	Brazil	0.012	Turkey	0.018
Mexico	0.003	Mexico	0.007	Finland	0.011	Finland	0.011
Chile	0.003	Chile	0.004	Chile	0.006	Chile	0.007

Notes: This table lists the eigenvector centrality of the sample countries in the global financial network in 2005Q1 and 2019Q4.

Table A.3: Description of Characteristic Variables

Characteristic	Code	Definition	Source
Bank Regulation	reg_d	Cumulative sum of macroprudential regulations.	IMF iMaPP
Distance	distw	Distance (km) between two countries, where distance is measured as the weighted arithmetic average of geodesic distances between the main population centers (cities) of each country. City populations are used as weights.	CEPII
Exchange Rate	fx_rate_od	Units of destination country's currency required to purchase one unit of origin country's currency.	Bloomberg
GDP	gdp_d	Nominal GDP (USD)	WDI
GDP Per Capita	gdpcap_d	Nominal GDP Per Capita (USD)	WDI
Interbank Rate	interbank_d	3-month interbank rate	Bloomberg
Lending Rate	lending_rate_d	Lending interest rate	See note
Dollar Rate Spread	sprd_d	Spread between local currency rate and U.S. dollar lending rate	FRB
Market Type	market_d	Emerging vs. Advanced Foreign Economy Dummy Variable.	
Policy Rate	policy_rate_d	Central bank policy rate	BIS
Trade Intensity	trade	Trade intensity between a country pair; measured as $Trade_{i,j} = \frac{Imports_{i,j} + Exports_{i,j}}{\sqrt{GDP_i \times GDP_j}}$.	IMF DOTS
Volatility	vol	Destination country stock market volatility.	Bloomberg

Note: This table presents the list of characteristics variables used in estimating loan supply and demand curves, as well as their definitions and data sources. The default source for commercial lending rates is the IMF's International Financial Statistics database. In cases of missing observations, we obtain data from Bloomberg, Danmarks Nationalbank, ECB Statistical Data Warehouse, Central Bank of Turkey, World Bank World Development Indicators, and Central Bank of Chile.

Table A.4: Within-sector Loan Supply Estimation (OLS, Full Sample)

	(1) Banks	(2) Non-banks
Log Price	-40.27^{**}	-13.80^{**}
	(11.93)	(4.19)
Exchange Rate	0.04	0.08
	(0.04)	(0.06)
Policy Rate Differential	1.54	0.04
	(1.75)	(1.69)
Log GDP (Lagged)	1.42^{***}	1.03^{***}
	(0.10)	(0.09)
Log GDP per capita (Lagged)	0.61	0.22
	(0.31)	(0.23)
Distance	-1.70^{***}	-1.18^{***}
	(0.20)	(0.17)
Trade Exposure	0.05	0.25^{*}
	(0.11)	(0.09)
Volatility	-0.37^{***}	-0.36^{***}
	(0.09)	(0.07)
Regulation (Borrower)	-0.32^{*}	-0.24^{**}
	(0.11)	(0.08)
Indicator: Own Country		4.54^{***}
		(0.46)
Obs.	18,435	18,601

Notes: This table presents the estimation results from equation (8) for the bank (column 1) and nonbank (column 2) sectors using the full sample period from 2005Q1 to 2019Q4 using OLS. The coefficients on *Log Price* should be biased upward. All specifications include lender country, time and borrower country MSCI market fixed effects. Standard errors (in parentheses) are clustered by lender and time period. $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table A.5: Loan Supply Estimation Within Sectors (OLS, Contaminated Regression)

	2010Q4		2016Q2	
	(1) Banks	(2) Nonbanks	(3) Banks	(4) Nonbanks
Log Price	-47.21^{*}	-13.49^{**}	-48.51^{**}	-15.21^{*}
	(18.65)	(3.45)	(16.27)	(6.56)
Exchange Rate	0.11^{*}	0.18^{*}	(16.27)	(6.56)
	(0.05)	(0.06)	0.04	0.07
Policy Rate Differential	4.22	6.76	(0.06)	(0.07)
	(2.81)	(3.64)	2.05	-1.14
Log GDP (Lagged)	1.32^{***}	0.98^{***}	1.62^{***}	1.14^{***}
	(0.09)	(0.10)	(0.13)	(0.09)
Log GDP per capita (Lagged)	0.51	0.38	0.92^{*}	0.28
	(0.32)	(0.24)	(0.35)	(0.26)
Distance	-1.63^{***}	-1.12^{***}	-1.89^{***}	-1.38^{***}
	(0.18)	(0.17)	(0.23)	(0.21)
Trade Exposure	0.05	0.23^{*}	-0.01	0.19
	(0.11)	(0.09)	(0.12)	(0.10)
Volatility	-0.31^{**}	-0.31^{***}	-0.35^{**}	-0.38^{***}
	(0.09)	(0.06)	(0.11)	(0.09)
Regulation (Borrower)	-1.03^{***}	-0.77^{***}	-0.26^{*}	-0.20^{*}
	(0.20)	(0.18)	(0.12)	(0.07)
Indicator: Own Country		4.54^{***}		4.14^{***}
		(0.46)		(0.55)
Obs.	8,993	9,138	9,163	9,237

Notes: This table presents the OLS estimation results from equation (8) for the bank (columns 1 and 3) and nonbank (columns 2 and 4) sectors using the 2010Q4 and 2016Q2 subsamples. All specifications include borrower country MSCI market fixed effects. Standard errors (in parentheses) are clustered by lender and time period. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Table A.6: Loan Supply Estimation Across Sectors

Variable	Symbol	(1) Full Sample	(2) 2010Q4	(3) 2016Q2
Log outside borrower weight:				
Banks	λ_1	0.70	0.73	0.68
		(1.49)	(1.73)	(1.08)
Non-banks	λ_2	0.68^{**}	0.73^{**}	0.62^{**}
		(0.32)	(0.37)	(0.27)
Sector fixed effects:				
Non-banks	α_2	0.25	0.05	0.55
		(1.06)	(1.21)	(0.77)
Obs.		1,102	551	551

Notes: This table presents the estimation results from equation (9) using the full sample (column 1) and the 2010Q4 (column 2) and 2016Q2 (column 3) 7-year subsamples. The estimation is based on an instrumental variable approach. Standard errors (in parentheses) are clustered by lender and time period. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Table A.7: Loan Demand Estimation

	Banks		Non-banks
	(1) 2010Q4	(2) 2016Q2	(3) Full Sample
Log Price	195.79^{***}	127.88^{***}	23.44^{*}
	(30.62)	(19.78)	(10.03)
Log GDP	0.39	0.44	1.20^{***}
	(0.33)	(0.26)	(0.12)
Obs.	513	513	2,146

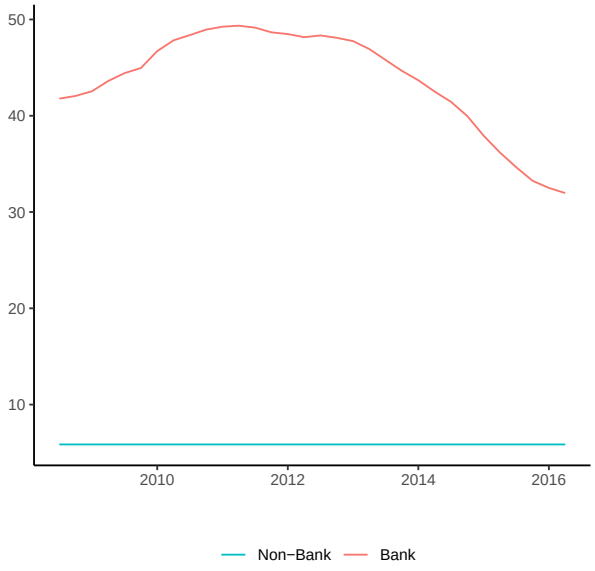
Notes: This table presents the estimation results from equation (10) for the bank (columns 1 and 2) and nonbank (column 3) sectors. Loan demand elasticities are estimated in 7-year rolling windows for the bank sector and are estimated using the full sample only for the non-bank sector. The estimation is based on an instrumental variable approach and includes time fixed effects. Standard errors are clustered by date. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Table A.8: Exchange Rate Estimation

Variable	Estimate
ΔIRD	-0.57
	(0.39)
Num. obs.	649

Notes: This table presents the estimation results from equation (7). ΔIRD for each country n is calculated by subtracting the U.S. interbank rate from country n's interbank rate and then taking differences over time. Estimation includes a time fixed effect. Standard errors are clustered by date. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Figure A.3: Demand Elasticity Estimates Over Time

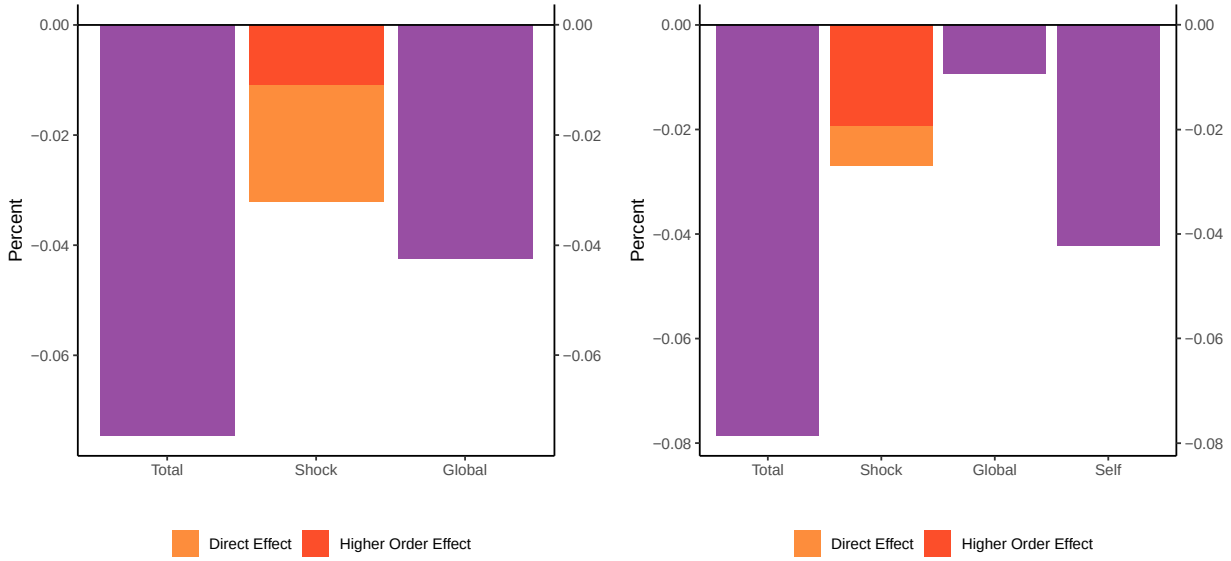


Notes: This figure shows the estimates of loan demand elasticities in the bank and non-bank sectors. The demand elasticities are a function of the coefficient on *Log Price* from equation (10). The coefficient on price for the banking sector is annualized by multiplying by 1/4. We estimate a time-invariant demand elasticity for the non-bank sector.

Figure A.4: Effects of U.S. Funding Shock on Funding in Turkey

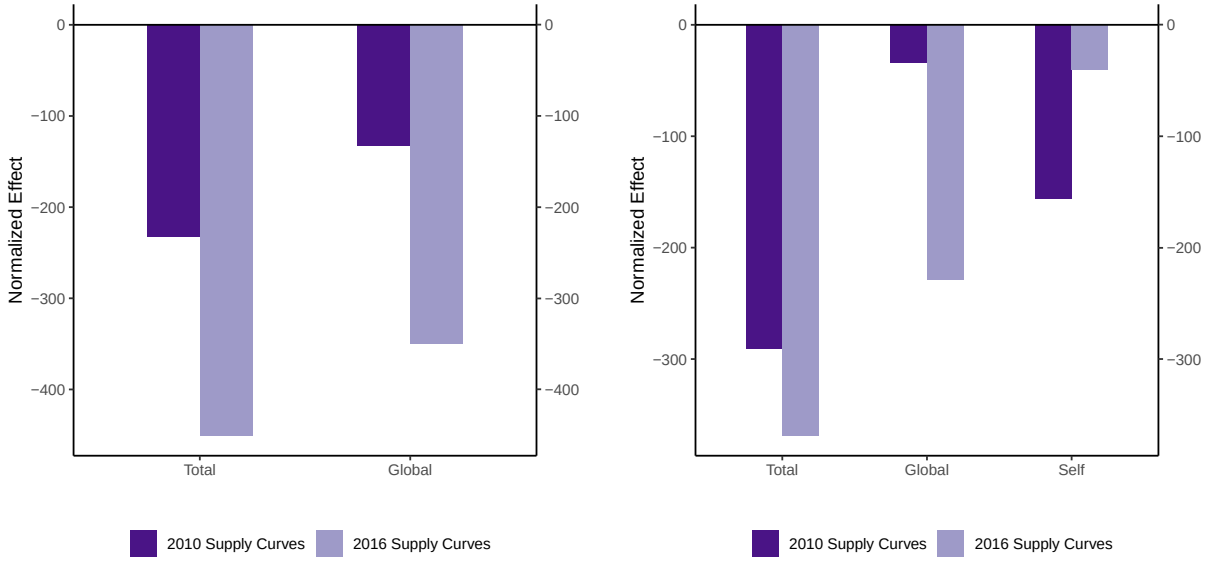
(a) Interbank Funding (2010Q4)

(b) Non-bank Funding (2010Q4)



(c) Interbank Funding (2010Q4 v 2016Q2)

(d) Non-bank Funding (2010Q4 v 2016Q2)

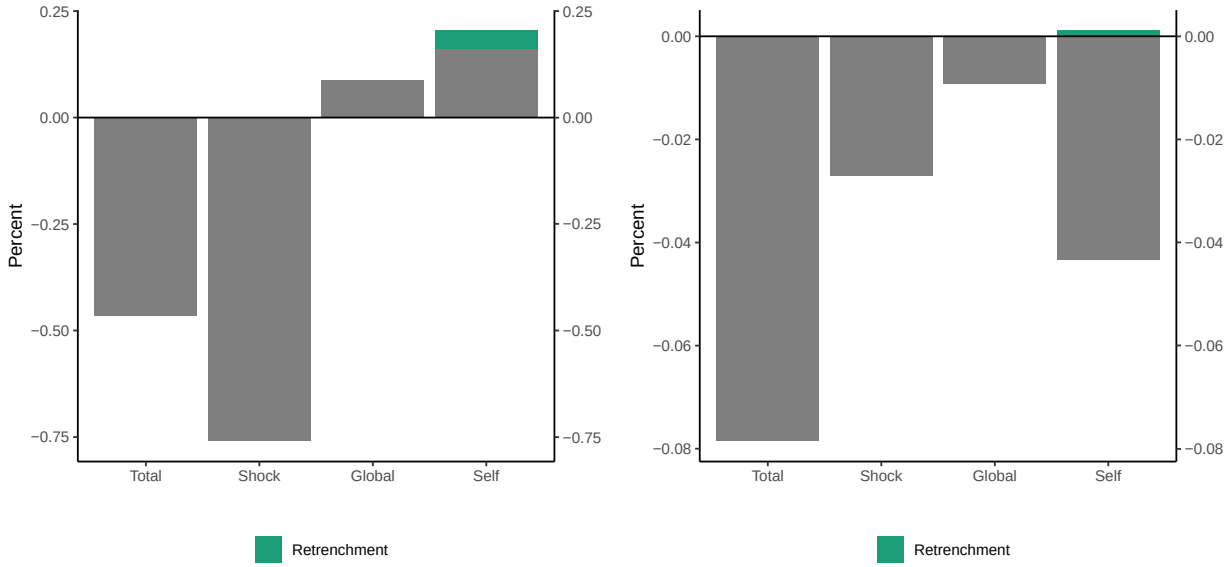


Notes: Panels (a) and (b) of this exhibit presents the effect of a one percent decline in U.S. local funding on cross-border bank funding and total non-bank funding, respectively, in Turkey in 2010Q4 based on the 2010Q4 supply and demand curves. The "shock" effect captures the change in lending that is directly attributable to the decline in U.S. local funding in a static network. "Global" interbank and credit rebalancing captures the change in lending resulting from reallocations of non-Turkish banks' loan portfolios to the corresponding sector. "Self" rebalancing captures the reallocation of Turkish banks' loan portfolios to the nonbank sector. The shock effect and the rebalancing effect(s) sum up to the "total" effect. Panels (c) and (d) of the exhibit compare the effects of the one percent decline in U.S. local funding on cross-border bank funding and total non-bank funding, respectively, in Turkey in 2010Q4 based on the 2010Q4 supply and demand curves (dark purple bars) with those based on 2016Q2 supply and demand curves (light purple bars). In the bottom two panels, we normalize the total, global, and self-rebalancing effects by the shock effect in order to allow for comparison across time periods. We denote supply and demand curves based on the midpoint period of the 7-year subsample (e.g., the 2010Q4 supply curves denote those estimated using the 2007Q1–2014Q2 subsample).

Figure A.5: Effects of U.S. Funding Shock: Decomposing the Self-Rebalancing Effect

(a) U.S. Non-Bank Funding (2010Q4)

(b) Turkey Non-bank Funding (2010Q4)

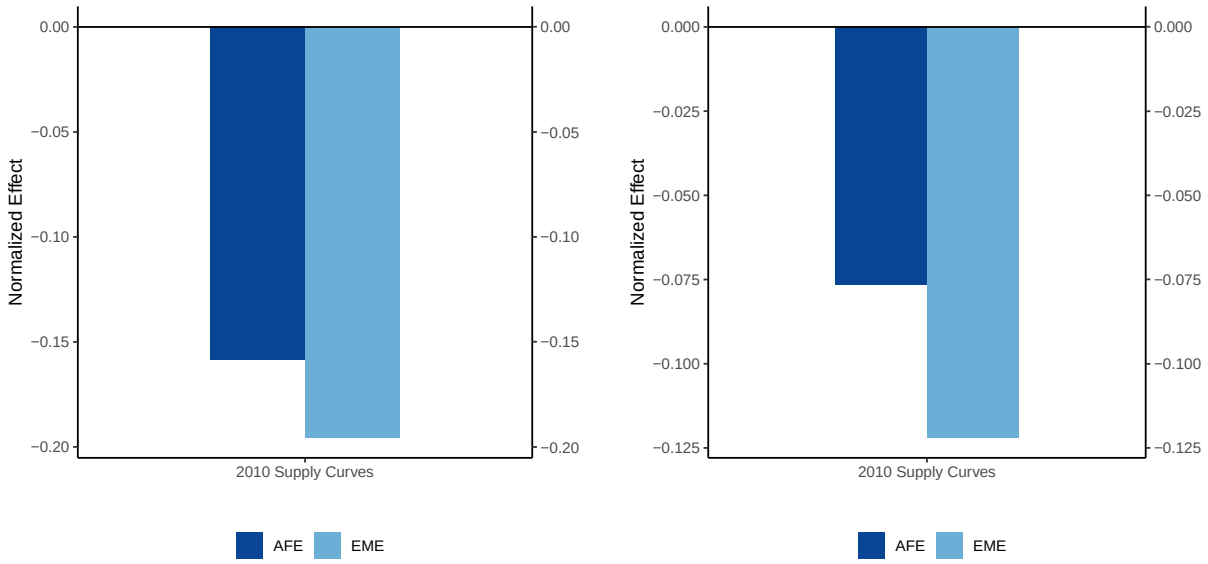


Notes: This exhibit decomposes the change in nonbank funding in the United States (Panel a) and Turkey (Panel b) due to the self-rebalancing effect in response a one percent U.S. local funding shock into an "indirect interbank rebalancing" component and a "retrenchment" component. The indirect interbank rebalancing component captures U.S. or Turkish banks' intermediation of foreign funding from global interbank rebalancing. The retrenchment component captures endogenous reallocation of funding by U.S. or Turkish banks.

Figure A.6: U.S. Local Funding Shock: Cross-border Funding Change in the Bank and Non-bank Sectors of Advanced Economies v Emerging Markets

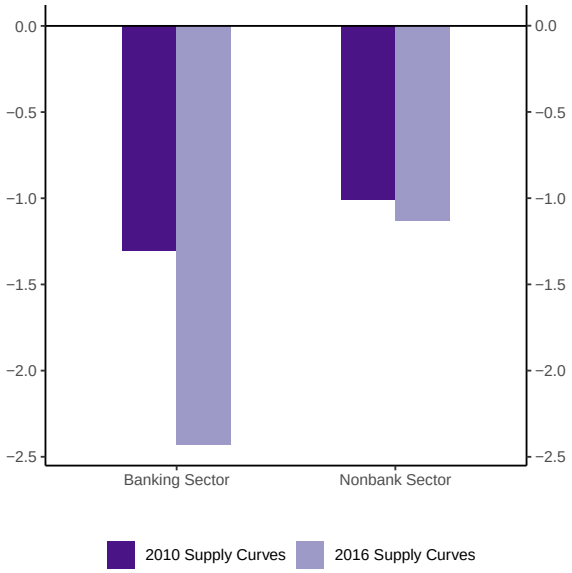
(a) Interbank Funding

(b) Non-bank Funding



Notes: This figure shows the change in cross-border funding in the bank and non-bank sectors of advanced (non-U.S.) foreign economies (AFE) and emerging market economies (EME) in response to a one percent U.S. local funding shock. The changes in funding are normalized by cross-border funding in each sector prior to the shock. Thus, the bars indicate the extent of funding outflows in response to the shock.

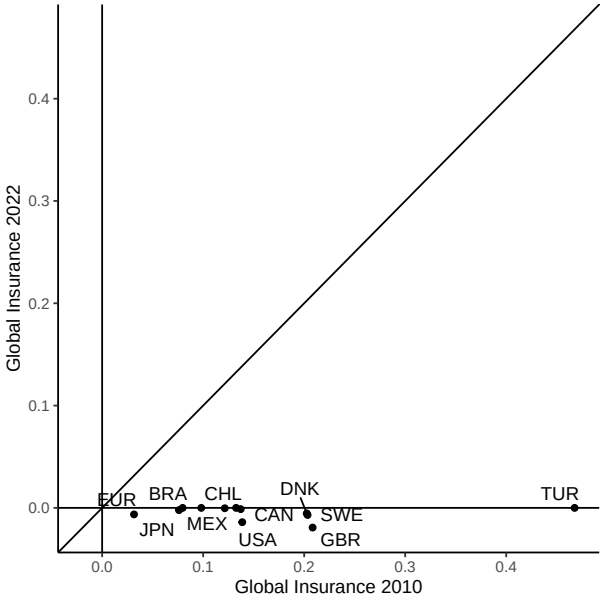
Figure A.7: U.S. Local Funding Shock: Aggregate Funding Change in the Bank and Non-bank Sectors



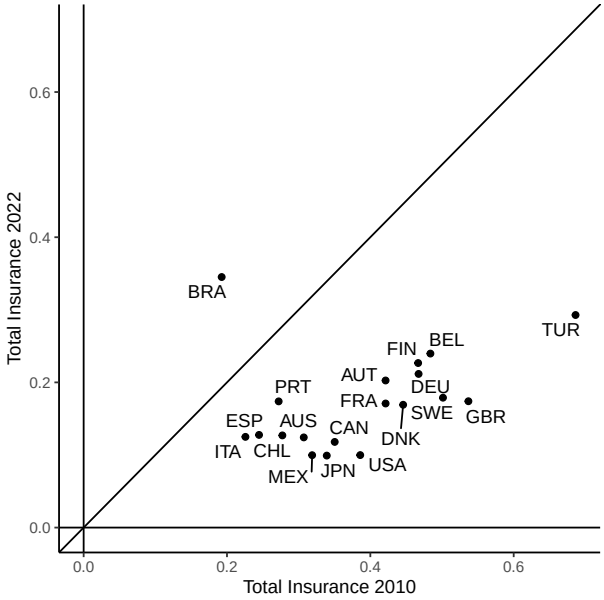
Notes: This figure shows the change in aggregate funding in the bank and non-bank sectors in response to a one percent U.S. domestic funding shock. The aggregate changes in funding are normalized by the shock effect in each respective sector. Thus, bars less than -1 indicate that the funding outflows are greater than the shock effect in magnitude, and bars greater than -1 indicate funding inflows at the sector level.

Figure A.8: Global Insurance through Rebalancing: 2010Q4 v Extrapolated 2022Q4

(a) Global Interbank Rebalancing



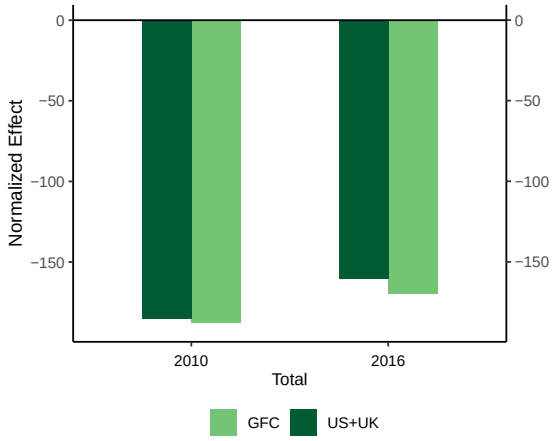
(b) Total (Global and Self) Rebalancing



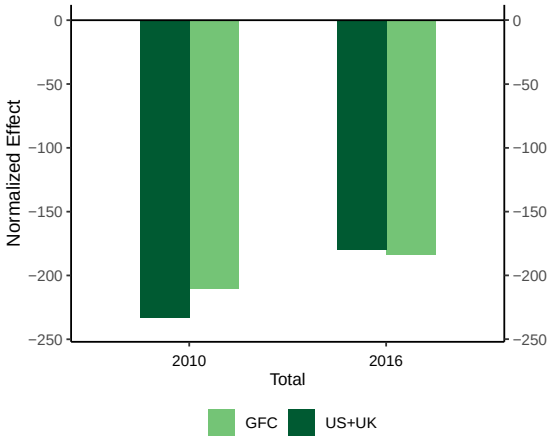
Notes: This exhibit presents the amounts of insurance received by each country's bank and non-bank sectors through global interbank rebalancing (Panel a) and total (global credit and self) balancing (Panel b) in response to a one percent local funding shock based on the 2010Q4 supply and demand curves (x-axis) and the extrapolated 2022Q4 supply and demand curves (y-axis). All margins of rebalancing are normalized by the shock effect. See Figure 6 for more detailed descriptions of different margins of rebalancing. Each plot includes a 45-degree line.

Figure A.9: Insurance During the Global Financial Crisis (Non-Shocked Countries)

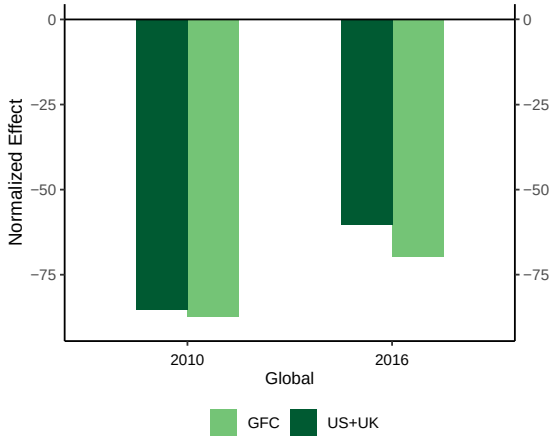
(a) Total Insurance (Bank)



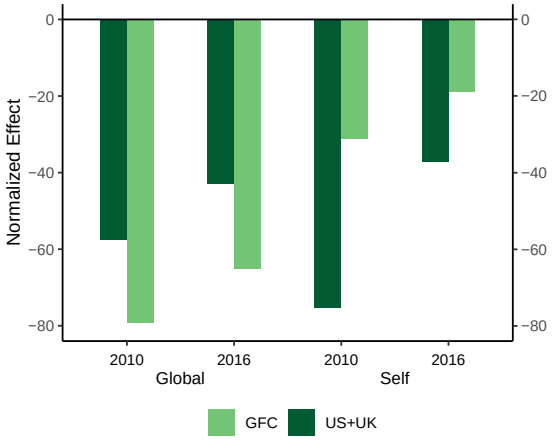
(b) Total Insurance (Non-bank)



(c) Decomposition (Bank)



(d) Decomposition (Non-bank)



Notes: This exhibit presents insurance provision in 2008Q2 in response to a regional funding shock and a global funding shock. The regional funding shock is based on the observed decline in funding in the U.S. and U.K. during the Global Financial Crisis period. The global funding shock is based on the observed decline in funding in the United States, the United Kingdom, Japan, Germany, France, and Spain during the Global Financial Crisis period. We show insurance provision for the *non-shocked countries* based on the 2010Q4 and 2016Q2 supply and demand curves. In each figure, we normalize total, global interbank rebalancing, global credit rebalancing, and self-rebalancing effects by the shock effect in order to allow for comparison across different supply and demand curves. See Figure 6 for additional details about each effect.