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Global banking and macroeconomic stability. Liquidity, control, and monitoring[☆]

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ABSTRACT

We study how the organizational structure of global banks shapes their impact on macroeconomic stability. We develop a two-country dynamic general equilibrium model in which global banks can either delegate loan monitoring to local affiliates or exert control over affiliates' monitoring activities, hiring loan officers centrally. Moreover, we allow global banks to transfer liquidity between parents and local affiliates through internal capital markets. We show that global banks with a centralized business model (with loan officers hired centrally by the parent and an intense use of internal capital markets) help mitigate the impact of financial shocks on the host economy. However, they may become a destabilizing factor following real shocks that hit the quality of firms' investments. The model predictions are consistent with bank-level evidence from a large set of countries that host global bank affiliates.

1. Introduction

The emergence of multinational banking conglomerates is one of the major developments in the international financial landscape in recent decades. In response, a growing literature has started to explore the macroeconomic implications of global banking (see, for example, Cetorelli and Goldberg, 2011, 2012a,b; Morelli et al., 2022, and references therein). Most of this literature, however, appears to neglect the internal decision processes that characterize complex financial institutions. Global banks routinely make choices regarding the allocation of funding as well as monitoring resources. These decisions not only have important implications for

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the lending behavior of these banks' headquarters but also of their local affiliates. Studying the allocation of liquidity and monitoring resources, on the one hand, and multinational banks' lending decisions, on the other hand, is therefore critical to better understand how multinational banks influence local macroeconomic stability. This has become even more important now that multinational bank affiliates hold dominant positions in many emerging markets and developing countries (Claessens and Van Horen, 2014; Claessens, 2017).

The aim of this paper is to understand how multinational banks influence the transmission and propagation of local shocks, with a focus on how the organizational structure and business model of global banks shape this relationship. To this end, we conduct both an empirical and a theoretical analysis. We first investigate empirically how the organizational structure of global banks shapes the response of their loan monitoring, liquidity allocation and, ultimately, their lending to aggregate shocks. We leverage rich bank-level data for a large set of countries from the Banking Environment and Performance Survey (BEPS), conducted by the European Bank for Construction and Development through face-to-face interviews with the "ultimate bank insiders", their CEOs. These unique data allow us to construct bank-level variables describing key aspects of global banks' business models and behavior, in particular whether and how these banks operate internal capital markets and the extent to which they actively shape the monitoring function of individual foreign affiliates. By combining this information with data on affiliate lending, we can verify whether the patterns predicted by our theoretical model, described below, are consistent with those detected in the data.

We document that a large fraction of global banks provide liquidity support to their foreign affiliates and actively engage in the loan monitoring efforts of these affiliates. We then show that, following major financial shocks (crises) in host countries, global banks tend to countercyclically increase their lending, and step up their liquidity and monitoring support of host-country affiliates. This countercyclical response is stronger when global banks feature a tighter, centralized control of affiliates' monitoring activities and a more centralized management of internal capital markets.

We next develop a two-country dynamic general equilibrium model in which multinational banks operate alongside local banks in the credit market of each country. There are two key components of banks in the model. First, banks perform active monitoring (due diligence) of loans by hiring loan officers. This loan monitoring activity enhances the pledgeability of their loans to bank financiers, enabling banks to relax their capital constraints, gather additional loanable funds, and extend more credit. Local (domestic) banks always rely on local loan officers for this monitoring activity. Global banks, by contrast, either rely on loan officers hired by local affiliates or instead use loan officers hired and controlled centrally by the bank's headquarters (possibly subject to some inefficiency due to the functional distance between conglomerates and host-country affiliates). Second, global banks transfer liquidity between parents and local affiliates through internal capital markets.

We allow multinational banks to either decentralize their monitoring and liquidity decisions or to operate a centralized model. Under a centralized monitoring model, global banks mostly hire loan officers at the parent level, financing their wage bill through dedicated "strings attached" transfers to affiliates. In contrast, under a decentralized monitoring model, global banks delegate the hiring of loan officers to host-country affiliates. Similarly, under a centralized liquidity model, global banks engage in reallocation of liquidity across their conglomerate through "no strings attached" liquidity transfers, while under a decentralized liquidity model, local affiliates can receive such transfers from parent banks only at a high cost.

We calibrate the model to the macro- and bank-level data used in our empirical analysis and then ask the following questions: how do global banks affect the transmission and propagation of financial and real shocks? And, especially, under what model of control, monitoring and liquidity allocation, do global banks play a more (de)stabilizing role for the macroeconomy? Is a centralized or a decentralized business model more conducive to macroeconomic stability? And how does the allocation of monitoring resources interact with the allocation of liquidity through internal capital markets, and hence influence the transmission of shocks?

We show that three main forces govern the behavior of global banks following host-country shocks. First, changes in investment returns, which directly drive responses of global bank lending. Second, the tightness of bank liquidity and capital constraints, which drives the allocation of global banks' monitoring resources and liquidity. Third, changes in loan portfolio quality, which most directly influence loan monitoring incentives.

Together, these forces ensure that following negative shocks originating in the financial sector that hit banks' net worth, global banks exert a stabilizing influence on host economies. They do so by supplanting the now scarcer loans of local banks: global banks boost their monitoring in the host country, transfer liquidity to host-country affiliates, and consequently expand their local lending in a countercyclical fashion. Crucially, the influence of global banks on macroeconomic stability is less benign after shocks that erode the quality of firms' investments and, through this, loan portfolio quality. Following capital quality shocks, in fact, the monitoring incentive and effort of global banks' affiliates declines, driving down their lending in the host economy in a procyclical fashion.

An important result is that centralization has an ambiguous effect on the (de)stabilizing role of global banks, with clearly distinct roles for liquidity and monitoring centralization. Monitoring centralization tends to amplify the response of global banks' monitoring following shocks. In contrast, liquidity centralization, while easing liquidity transfers within global bank conglomerates, tends to dilute the response of global banks' monitoring. That is, when global banks allocate substantial transfers to host-country affiliates through their internal capital markets, thus directly supporting affiliates' lending capacity, they also undermine the incentives to perform monitoring at these very same affiliates. In particular, the inflow of liquid funds from the conglomerates mitigates the tightening of the resource and capital constraints of affiliates following shocks. This dilutes the incentive to relax those constraints through the costly hiring of monitoring loan officers by the affiliates and by the conglomerates.

As a result of these mechanisms, when monitoring rises countercyclically—such as following shocks to banks' net worth—monitoring centralization will be more conducive to stabilization than liquidity centralization (though both have a stabilizing influence in the end). Indeed, in response to such shocks, monitoring intensity rises substantially more under monitoring centralization while its response is weakened under liquidity centralization. In contrast, when monitoring drops procyclically—such as following capital quality shocks—monitoring centralization exacerbates instability, while liquidity centralization instead exerts a mitigating influence. In this case, in fact, monitoring centralization exacerbates the reduction in monitoring incentives. Liquidity centralization, on the other hand, facilitates the repatriation of global banks' liquidity to parent countries, better sustaining monitoring incentives and the lending response of local affiliates. Overall, the relative benefits of monitoring and liquidity centralization are then reversed after capital quality shocks, relative to bank net worth shocks.

In further analysis, we investigate how the (de)stabilizing influence of global banks depends on salient organizational characteristics. The results reveal that, in the aftermath of bank net worth shocks, a more homogeneous distribution of monitoring skills between global bank parents and affiliates, and a lower balance sheet consolidation of global banks, reinforce the stabilizing influence of a centralized liquidity and monitoring business model of global banking. Finally, in supplementary work, we apply the model to the case of Hungary (a country with a large presence of multinational banks) and evaluate quantitatively the effect of regulations on foreign banks on business cycle dynamics. We find that this effect depends not only on the market share of global banks but also on their business model, i.e., their degree of monitoring and liquidity centralization.

Related literature. This paper relates to two main strands of the literature. First, our work speaks to a growing literature on the macroeconomic implications of multinational banking (Kollmann et al., 2011; Kalemli-Ozcan et al., 2013; Kollmann, 2013; Morelli et al., 2022; Fillat et al., 2023; Niepmann, 2023, 2015). These studies demonstrate how banking groups operating in multiple countries can propagate shocks across borders but can also allow for diversification in response to shocks. They also show that the balance between these effects of international banking integration can depend on the regulatory framework (e.g., the stringency of capital requirements) and the nature (financial or real) of aggregate shocks. A rich empirical literature also examines shock transmission through multinational banks (see, e.g., Cetorelli and Goldberg, 2011, 2012a; Chor and Manova, 2012; Popov and Udell, 2012; Schnabl, 2012; De Haas and Van Horen, 2013; Paravisini et al., 2015; Portes, 2021).

Our main contribution is to investigate how the organizational structure of global banks shapes the way they transmit and propagate shocks. In particular, we shed new light on the role of the allocation of monitoring resources within global banks and how this interacts with the functioning of internal capital markets in the propagation and transmission of shocks (Houston et al., 1997; Campello, 2002; De Haas and Van Lelyveld, 2010; Cetorelli and Goldberg, 2012b). Fillat et al. (2023) study multinational banks' choice of the branch-subsidiary structure and the influence of this structure on the impact of capital linkages across global banking conglomerates. Niepmann (2023) focuses on the role of the efficiency distribution of the banking sector in driving multinational banks' entry in host countries and their choice between cross-border lending and a direct presence in host countries. Bremus et al. (2018) and De Blas and Russ (2013) highlight the role of the size structure of the banking sector in the propagation of credit shocks to the aggregate economy.[1] Cao et al. (2021) study how the presence of multinational banks in a country can help explain the length of recessions and the trade-off between depth and duration of recessions. Apart from a different focus of their analysis, in Cao et al. (2021) global banks only manage liquidity within conglomerates while there is no role for monitoring, which is a core activity of banks (Diamond, 1984; Diamond and Rajan, 2001; Goodfriend and McCallum, 2007). We show that the way global banks organize their monitoring activity can play a fundamental role in the business cycle dynamics of host countries and interact in nuanced ways with the organization of internal capital markets. Our results indicate that after negative banking shocks the centralization of internal capital markets can weaken the resilience of global banks' monitoring and, hence, has ambiguous effects on the cyclical response of global banks' lending: it enhances the resilience of lending by facilitating affiliates' access to liquidity, but it can undermine such resilience by reducing monitoring efforts. On the other hand, the centralization of monitoring resources better enhances the resilience of global banks' lending following negative banking shocks, while potentially exacerbating the effects of negative capital quality shocks. Thus, our results imply that the monitoring channel in open economies can widen the asymmetry in the response of host countries to different types of aggregate shocks (financial or real). Accounting for this channel can then be important for informing the actions of policymakers and regulators aimed at strengthening macroeconomic stability.

Our second contribution is to the broad literature on information acquisition and monitoring inside banking organizations, with a focus on the case of internationally active banks. One set of studies investigates the effect of bank information acquisition and monitoring on borrowers' creditworthiness (Manove et al., 2001; Broecker, 1990). From a macroeconomic perspective, some contributions show that banks' incentive to monitor loan portfolios can get diluted during economic expansions (Dell'Ariccia and Marquez, 2006; Gorton and Ordoñez, 2020; Perri and Quadrini, 2018). Our specification broadly follows Goodfriend and McCallum (2007), who develop a dynamic general equilibrium economy in which banks employ labor to produce loans, thus affecting lending returns. It is also in line with the modeling in closed economies of Cao et al. (2022), where banks conduct due diligence of (potential) borrowers and, in doing so, loan officers preserve the viability of loan portfolios, raising their recovery value and pledgeability in markets for liquidity. In the spirit of Scharfstein and Stein (2000), we posit that within global banks contracting about local affiliates' loan monitoring is incomplete.

The paper is organized as follows. Section 2 introduces the inner workings of global banks and presents motivating empirical evidence. Section 3 lays out the model and solves for agents' decisions, after which we discuss the calibration and preview key mechanisms in Section 4. Section 5 presents simulation results and Section 6 concludes. Online Appendices contain more details about our data and model derivations as well as additional results.

[1] For a quantitative model stressing the role of the size structure of the banking sector, see also Corbae and D'Erasmo (2021). On the empirical side, Cerutti et al. (2007) and Buch et al. (2014) study global banks' choice of entry modes in host countries and the implications for the structure of banking conglomerates. More broadly, the empirical literature highlights that global banks can have complex organizational structures, which reflect their strategies in distributing and managing risks across divisions and subsidiaries. Correa and Goldberg (2022) demonstrate that global banks can maintain several non-bank affiliates structured across multiple ownership tiers. Cetorelli and Prazad (2024) show that bank holding companies with substantial nonbank operations can benefit from funding arrangements between banking and nonbank units. The complexity of global banks' organizational structures may also shape liquidity management, particularly during crises (Goldberg, 2023), and influence the transmission of macroprudential policies (Buch and Goldberg, 2017).

2. Empirical evidence

This section presents evidence on the lending, loan monitoring and liquidity allocation behavior of multinational banking groups using granular data from a large-scale survey of bank CEOs conducted by the European Bank for Reconstruction and Development (EBRD) and Tilburg University. Online Appendix B provides background information on the internal organization of liquidity and monitoring resources in multinational banking groups.

2.1. Data and measurement

The Banking Environment and Performance Survey (BEPS) covers banks across Central and Eastern Europe, Central Asia, Russia, Türkiye, and the Southeastern Mediterranean region (see also Appendix B). We draw information from two survey waves: the BEPS II (conducted in 2012 in 30 countries with reference to the 2005–2011 period) and the BEPS III (conducted in 2020 in 28 countries with reference to the 2012–2019 period). The surveyed banks represent more than 75 percent of all bank assets in the countries covered by BEPS. Crucially for our purposes, in case of multinational banks, the BEPS survey treats each subsidiary as an independent (foreign-owned) bank. In line with the literature, we consider a bank as foreign owned if at least 50% of its equity is owned by a foreign strategic investor (Claessens and Van Horen, 2014).

The countries in the sample have strongly bank-based financial systems. Using data from the World Bank Global Financial Development and World Bank Development Indicators Databases (World Bank, 2023), we computed measures of the relevance of banks relative to the equity market. The average ratio of bank credit to stock market capitalization equals 4.66, which is much higher than the average ratio (1.14) for OECD countries and the ratio for countries viewed as bank-based, such as Japan (1.32) and Germany (1.26). In addition, on average the share of fixed investment expenses covered by bank loans is roughly twice as large as the share of expenses covered by internal equity and shares issues. The limited role of non-bank funding for firms' financing is also confirmed by the very low reliance on international debt securities (long-term bonds and notes and money market instruments placed on international markets): this is on average just below 5% as a share of GDP, compared with much higher figures for many OECD countries, such as Spain (66%), Sweden (80%), or the United Kingdom (96%). Appendix Figure B1 illustrates the prominent role of the banking sector for a subset of 11 countries in Central and Eastern Europe and the Caucasus. Appendix B describes episodes of disruption of the banking sectors of the sample countries in recent decades.

We hand-match the BEPS survey data with Bureau Van Dijk's BankScope and Orbis databases for bank-level financials and with the Systemic Banking Crises Database II by Laeven and Valencia (2020) on major financial disruptions. In the end, our dataset contains foreign banks that were interviewed as part of the BEPS survey and that were matched with bank financials and systemic crisis data, thus creating a panel dataset for the years 2007–2017.

2.2. A first look at the data

Appendix Table B2 reports summary statistics for the sample of global bank subsidiaries (Appendix Table B1 contains variable definitions).[2] Average annual nominal credit growth is 14%, banks' average capital to asset ratio is 14%, and their net interest margin averages 4.5%. The median ratio between a bank's outstanding loans and its customer deposit base is 112%.

A crucial feature of the BEPS survey is that it provides us with information on the role played by parent banks as well as the degree of reliance of local affiliates on their parents in their lending, monitoring, and liquidity gathering decisions. We report summary statistics for variables that characterize the organizational structure and behavior of global banks along our two main dimensions of interest: the control of the subsidiary's monitoring activities (including the hiring and training of local loan officers) and the liquidity support provided by the parent to the subsidiary (capturing the presence and depth of internal capital markets). Consider first monitoring. About 86% of the subsidiaries declare that their parent bank sets targets for them in terms of credit growth, while in 41% of the cases the parent bank sets targets for the local market shares. Roughly 42% of the subsidiaries declare that the parent bank plays an important role in the credit assessment of borrowers. We observe wide variation in how intensely parent banks and their subsidiaries interact on a day-to-day basis, as measured by the average number of phone calls, conference calls, and video calls the subsidiary's CEO holds with the management or board of the parent bank on a monthly basis. The average number of such calls is 12 but varies between zero and 110. In more than 85% of all cases, the subsidiaries declare that the parent bank was also involved in the selection and training of local managers.

When considering internal capital markets, we see that 55% of all foreign bank subsidiaries are part of a global bank with a centralized treasury. About 73% of the CEOs mention that parent banks are a key source of funding in case of an unexpected funding shortfall. Moreover, 70% of the CEOs mention that their parent provides them with liquidity and/or capital "on a regular basis". We also find that 87% of the subsidiaries indicate that they have been supported by their parent bank via an internal credit line at least once during the past five years (for evidence on the financial support of parent banks to global bank subsidiaries see also Houston et al., 1997; Popov and Udell, 2012; Schnabl, 2012, and references therein).

[2] Information on financial variables refers to 208 subsidiaries. The parent banks of these subsidiaries are located in Austria (16%), Italy (13%), Greece (9%), France (9%), Germany (8%), Russia (8%), Türkiye (4%), the United States (3%) and several other countries. The set of banks to which summary statistics on the single variables refer and, hence, the sample size used in the various regressions, is dictated by data availability.

2.3. Global banks' response to shocks

The empirical models. Our dynamic general equilibrium model yields predictions on two fronts: (i) the response of global banks' lending, monitoring (loan officer employment and usage of other monitoring resources), and liquidity transfers following financial and real shocks; and (ii) how these responses depend on the degree of centralization of global banks (including the degree of control/intervention of global parents' headquarters into their affiliates' decisions).

To test these predictions, we estimate two sets of empirical models. The first model uses panel data at the bank-year level over the 2007–2017 period to study the lending behavior of global banks following shocks and how this behavior depends on the degree of centralization of global banks' liquidity and monitoring:

$$L_{jt} = \alpha_j + \alpha_t + \beta_1 Y_{it} + \beta_2 Y_{kt} + \gamma_1 (X_j \times Y_{it}) + \delta Z_{jt} + \eta L_{jt-1} + \epsilon_{jt}. \tag{1}$$

In estimating equation (1) we focus on major financial shocks (crises) and, in additional tests, extend the analysis to all recessionary shocks. L_{jt} denotes annual credit growth of global bank subsidiary j in year t; α_j and α_t are bank and time (year) fixed effects, respectively; Y_{it} and Y_{kt} are indicators for the occurrence of a financial crisis in the host country i and parent country k of the bank in t, respectively (Laeven and Valencia, 2020); X_j is a set of time-invariant, structural characteristics of the relationship of the affiliate with its parent, capturing the monitoring or liquidity centralization of the global bank; Z_{jt} is a set of time-varying controls for affiliate j, including its net interest margin, leverage, gross loans to total customer deposits ratio, and liquid assets to total assets ratio; L_{jt-1} is lagged credit growth; and ϵ_{jt} is the error term.

As described in Appendix B, the key indicators in X_j include two proxies for the degree of control exerted by the parent and, hence, its monitoring centralization: the intensity of the contacts between the global bank parent and the affiliate (the average number of monthly calls between the parent and the affiliate offices), and an indicator for whether the parent bank exerts an important role in the credit assessment of borrowers. They also include an indicator for the centralization of treasury and liquidity management in the global conglomerate.

We estimate Eq. (1) using a two-step difference Generalized Method of Moments (GMM) estimator. The lag of credit growth, the bank-level controls and the financial crisis dummies are treated as endogenous and instrumented with their lags. Standard errors are adjusted for Windmeijer's finite-sample correction for a two-step covariance matrix.

Next, in order to investigate the responsiveness of global banks' liquidity and monitoring to the incidence of aggregate financial shocks (crises) in the host country, we estimate the following cross-sectional empirical models:

$$Liq_j = \alpha' + \beta_1' Y_i + \beta_2' Y_k + \delta' Z_j' + \epsilon_j', \tag{2}$$

$$Mon_j = \alpha'' + \beta_1'' Y_i + \beta_2'' Y_k + \delta'' Z_j'' + \epsilon_j''. \tag{3}$$

We estimate equations (2)–(3) for the 2007–2017 period (see Appendix B for robustness using the 2007–2012 subperiod). Liq_j is a dummy that takes the value of one if the affiliate declares that it received liquidity support from the parent through a credit line or transfer during the period and Mon_j is a dummy that equals one if it declares that the parent intervened in training and selecting managers and loan officers during the period. Y_i and Y_k are, respectively, the indicators for the occurrence of any financial crisis in the host and parent country of the bank, averaged over the period (capturing the incidence of crises); Z_j' and Z_j'' are sets of controls for the bank (annual credit growth; equity to total assets; gross loans to total customer deposits; net interest margin), computed as period averages; and ϵ_j is the error term.

Estimates. Table 1 displays the estimates of Eq. (1). We find consistent evidence that global banks expand their lending countercyclically during financial crisis episodes in the host country (see columns 1–2). We also find evidence that this countercyclical lending behavior is more pronounced when parents exert a more centralized control over their affiliates, as proxied by a higher frequency of contacts between affiliate and parent offices (columns 3–4) or by the intervention of parent offices in the credit assessment of borrowers (columns 5–6). The estimates further suggest that the centralization of liquidity (as proxied by the presence of a centralized treasury in the global banking conglomerate; columns 7–8) contributes to enhancing the countercyclical lending behavior of global banks. Appendix Table B3, Panel A, shows robustness to lagging the control variables of the global affiliate. Appendix Table B3, Panel B, further documents that the countercyclical lending behavior of global banks is specific to host-country financial crises, while we do not detect it for other types of recessionary episodes.

In Table 2, we show the estimates of Eqs. (2)–(3) for the response of global banks' liquidity and monitoring support to the incidence of crises in host countries. In columns 1–3, we obtain that global banks' parents are more likely to provide liquidity support to affiliates when the incidence of financial crises in the host country is higher. In columns 4–6, we find that when financial crises are more frequent in the host country, global banks are more likely to provide monitoring support, as captured by parents' training of loan officers at affiliates. As we will discuss below, these results are consistent with the predictions of our theoretical model.

3. The model

Motivated by the empirical evidence, we develop a dynamic general equilibrium model with two countries ("host" and "foreign"). In each country there are three sectors: households, firms (final good producers and capital producers), and banks (global and local banks). Households consume final goods and supply labor to firms and to banks operating in their country. They also hold deposits in banks operating in their country. Final producers use capital and labor in production, financing capital purchases with bank

Table 1
Global banks' lending, banks' organization, and crises.

	Annual Credit Growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any crisis host	58.885***	33.271**	8.738	10.348	10.180	−0.745	8.917	8.195
	(19.270)	(13.006)	(23.244)	(18.692)	(28.190)	(21.378)	(23.196)	(15.842)
# calls with parent × Any crisis host			3.765**	3.792***				
			(1.462)	(1.180)				
Credit risk assessment of clients × Any crisis host					83.190**	61.785**		
					(40.930)	(25.706)		
Liquidity centralization × Any crisis host							69.871**	45.428**
							(30.875)	(19.808)
Any crisis home	−79.012	0.673	−24.181	56.471	18.253	31.359	−11.594	10.815
	(67.209)	(63.855)	(58.929)	(56.961)	(40.054)	(29.415)	(47.373)	(37.690)
L.Annual credit growth	−0.031	−0.044	−0.025	0.142	−0.188	−0.108	−0.095	−0.064
	(0.270)	(0.271)	(0.172)	(0.143)	(0.203)	(0.174)	(0.235)	(0.211)
Equity/Total assets (%)	0.779	0.031	0.647	1.137	0.593	−0.856	0.943	−0.196
	(2.225)	(2.359)	(1.261)	(1.461)	(1.952)	(2.055)	(2.074)	(1.884)
Gross loans/Total customer deposits (%)		0.000		0.000		−0.001		0.000
		(0.001)		(0.000)		(0.001)		(0.000)
Net Interest Margin		0.281		−4.216		2.330		1.980
		(4.717)		(3.018)		(5.049)		(4.931)
Subsidiary FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1452	1433	836	833	1294	1275	1402	1383
Number of banks	205	201	109	109	183	179	199	195

Note: This table presents estimates for the effects of crises on global banks' lending in host countries. The estimator is a two-step difference GMM. The panel refers to the 2007–2017 period. For details on measurement see Section 2.3. For the definitions of all variables, see Appendix Table B1. Standard errors are adjusted for the Windmeijer's finite-sample correction for the two-step covariance matrix. ***, ** , *, + denote significance at the 1 percent, 5 percent, 10 and 15 percent level, respectively.

funding.[3] Banks monitor the loans they extend to firms, using labor (loan officers) as an input. The characterizing feature of our economy is the presence and organizational structure of global banks. Global banks manage liquidity and monitoring resources (loan officers) across their offices in the two countries.

We present agents' decisions focusing on the host country. The foreign country is symmetric, unless otherwise stated. Variables referring to the foreign country are denoted by an asterisk.

3.1. Households and firms

Households. For tractability, we posit a representative household in each country. We model households as in Gertler and Kiyotaki (2010) and Gertler and Karadi (2011). Within the household, a fraction $(1 - f)$ of household members consist of workers while a fraction f are bankers. Each banker manages a bank. Each worker can work in final good production or as a loan officer for bankers. There is perfect consumption insurance within the household. An exogenous turnover between bankers and workers makes bankers relatively impatient, creating an incentive for them to borrow from households through deposits and limiting their ability to save to overcome financial constraints. In every period, bankers exit with an i.i.d. probability $(1-\sigma)$, in which case they transfer retained earnings to the household. In turn, in each period a mass of $(1-\sigma)f$ workers randomly become bankers. Each new banker receives a transfer from the household, equal to a small, exogenous fraction ς of the total assets of exiting bankers.

Households choose consumption C_t, deposits D_t at local banks, deposits D_t^g at host-country affiliates of global banks, and their labor supply to final producers (H_t), to local banks (L_t), and to global bank affiliates (L_t^g). They maximize their expected lifetime utility

$$\max_{\{C_t, D_t, D_t^g, H_t, L_t, L_t^g\}_{t\geq 0}} E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, H_t, L_t, L_t^g)$$

$$\text{s.t.} \qquad C_t + D_t + D_t^g = R_{t-1}^D D_{t-1} + R_{t-1}^{D,g} D_{t-1}^g + W_t^H H_t + W_t^L L_t + W_t^{L,g} L_t^g + \Pi_t, \tag{4}$$

[3] We abstract from firms' direct financing through equity or bond markets. This is consistent with the highly bank-based nature of the countries in our empirical sample. We also note that for a large part of the corporate sector, the direct issuance of equity or bonds to international investors may constitute a very limited substitute for the credit of local banks and foreign banks' affiliates, especially in countries like those in our empirical sample.

Table 2
Parent banks' liquidity and monitoring support during crises.

	Liquidity Support			Monitoring Support		
	(1)	(2)	(3)	(4)	(5)	(6)
Any crisis host	0.553***	0.655***	0.520***	0.446+	0.674**	0.100
	(0.132)	(0.155)	(0.134)	(0.288)	(0.324)	(0.210)
SME lending	0.297*			0.225		
	(0.164)			(0.174)		
Relationship is important (SME)		0.249**			0.387*	
		(0.106)			(0.212)	
Liquidity centralization			0.128***			
			(0.044)			
# of calls with parent above 75th percentile						0.122***
						(0.041)
Any crisis home	−0.530	−0.366	−0.489	−1.911**	−1.566*	−1.862**
	(0.488)	(0.507)	(0.493)	(0.916)	(0.808)	(0.748)
Annual credit growth (winsorized; 0.01)	0.000	−0.000	−0.000	−0.001	−0.001	−0.002
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.001)
Equity/Total assets (%)	−0.005	−0.004	−0.002	0.001	0.004	−0.002
	(0.005)	(0.004)	(0.005)	(0.008)	(0.007)	(0.004)
Gross loans/Total customer deposits (%)	−0.000	−0.000	−0.000	−0.001	−0.001+	0.000*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Net Interest Margin	0.011	0.007	0.002	−0.009	−0.013	−0.000
	(0.009)	(0.009)	(0.009)	(0.014)	(0.014)	(0.012)
Constant	0.628***	0.683***	0.873***	1.009***	0.818***	1.108***
	(0.172)	(0.122)	(0.074)	(0.198)	(0.264)	(0.107)
R-squared	0.085	0.101	0.079	0.126	0.206	0.115
N	184	184	178	91	91	110

Note: This table presents estimates for the effects of the incidence of crises on global banks' liquidity and monitoring support of affiliates in host countries in columns (1) – (3) and (4) – (6), respectively. Estimates are from cross-sectional OLS regressions. The data is the collapsed panel which constitute averages of all variables between 2007 and 2017. For details on measurement see Section 2.3. For the definitions of all variables, see Appendix Table B1. Robust standard errors are in parenthesis. ***, ** , *, + denote significance at the 1 percent, 5 percent, 10 and 15 percent level, respectively.

where β is the discount factor, W_t^H is the wage rate in the goods sector, W_t^L ($W_t^{L,g}$) is the wage rate at local (global) banks, R_{t-1}^D ($R_{t-1}^{D,g}$) is the gross deposit rate on deposits held at local (global) banks, and Π_t are profits earned from owning firms and banks.

The optimizing conditions for households and firms are presented in Appendix A.

Final good producers. There is a unit continuum of final good producers that use physical capital and labor to produce final goods. Capital and labor are not mobile across countries. Similar to Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), to finance capital purchases, final good producers can issue state-contingent securities X_t, at a market price Q_t, and sell them to banks operating in the country (whether local banks or global banks' affiliates). Their constant-returns-to-scale technology reads

$$Y_t = A_t(\kappa_t K_{t-1})^{\alpha} H_t^{1-\alpha}, \tag{5}$$

where Y_t is output, K_t is capital, κ_t is an exogenous capital quality shock, and A_t is total factor productivity (TFP). Both TFP and the capital quality shock follow $AR(1)$ processes.

Letting δ be the depreciation rate and I_t denote investment, the law of motion of capital is

$$K_t = I_t + (1-\delta)\kappa_t K_{t-1}. \tag{6}$$

Capital producers. A capital producer can invest in I_t units of capital goods, which cost $\left[1 + F\left(\frac{I_t}{I_{t-1}}\right)\right] I_t$ units of consumption goods. $F(.)$ captures the adjustment cost in the capital producing technology, and satisfies $F(1) = F'(1) = 0$, and $F''(1) > 0$.

A capital producer chooses investment to maximize the expected present value of profits

$$\max_{\{I_t\}_{t\geq 0}} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left\{ Q_t I_t - \left[1 + F\left(\frac{I_t}{I_{t-1}}\right)\right] I_t \right\}, \tag{7}$$

where Q_t is the price of capital when sold to final good producers.

3.2. Banks

There are two types of banks. The first is a local bank that gathers deposits from host-country households and acquires shares issued by host-country firms (and analogously for a local bank in the foreign country). A local bank is run by a banker in the same country where the bank resides. The second type of bank is global. This conglomerate consists of a parent bank (variables of which are denoted by superscript g^*) that gathers deposits from foreign households and acquires shares issued by foreign firms in the foreign country, and an affiliate (denoted by superscript g) that gathers deposits from host-country households and acquires shares issued by firms in the host country. A global bank is run by a pair of bankers from the foreign country household. When the bankers exit, both the parent and the affiliate terminate their business.

3.2.1. Liquidity and control in the banking sector

Similar to, for example, Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), bankers can engage in strategic default and renege on the repayment of their liabilities. When a banker defaults, the financiers can trigger liquidation and seize a fraction of the liquidation value of the banker's assets. Due to this risk of strategic default, the access to liquidity of all banks is subject to a collateral (capital) constraint: the value of their liabilities cannot exceed the pledgeable value of their assets. By hiring loan officers, banks perform monitoring (due diligence) of loans, raising their recovery value in case of default and, hence, their pledgeable value to financiers.[4]

A global bank can manage liquidity and monitoring resources (loan officers) within its conglomerate. It can transfer funds between the parent and the affiliate through internal capital markets (liquidity management). It can also engage in control over the hiring of loan officers in its parent and affiliate offices. In particular, loan officers employed in the affiliate office comprise those autonomously hired by the affiliate and those hired by the conglomerate.

Events in a period t unfold as follows. Aggregate shocks are realized. Then, production takes place. Thereafter, banks learn whether they exit and new banks enter. Finally, surviving banks gather deposits, receive transfers, hire loan officers, and purchase shares issued by firms.

3.2.2. Global banks: affiliates and parents

Global affiliates. The global bank affiliate chooses shares X_t^g to purchase in the host country, deposits D_t^g to gather from host-country households, and the number of loan officers L_t^a to hire, to maximize the expected discounted sum of the dividends distributed to the foreign household:

$$V_t^g \equiv \max_{\left\{X_{t+j}^g, D_{t+j}^g, L_{t+j}^a\right\}_{j\geq 0}} E_t \sum_{j=0}^{\infty} (1-\sigma)\sigma^j \Lambda_{t,t+j+1}^* N_{t+j+1}^g, \tag{8}$$

$$\text{s.t.} \quad Q_t X_t^g = N_t^g + D_t^g - W_t^{L,g} L_t^g + \mathcal{Z}_t^g, \qquad [\lambda_t^g] \tag{9}$$

$$R_t^D D_t^g + \theta R_t^D \mathcal{Z}_t^g \leq \xi \left[(1-\eta)\mathcal{P}^g(.) Q_t X_t^g + \eta \mathcal{P}^{g^*}(.) Q_t^* X_t^{g^*} \right], \qquad [\mu_t^g] \tag{10}$$

$$L_t^g = L_t^a + L_t^c, \tag{11}$$

where $\Lambda_{t,t+j+1}^*$ is the foreign country stochastic discount factor. $\mathcal{P}^g(.) = \mathcal{P}^g(Q_t X_t^g, L_t^a, L_t^c)$ is the pledgeable, recovery value of firm shares in case of strategic default of the global bank affiliate (and, similarly, $\mathcal{P}^{g^*}(.) = \mathcal{P}^{g^*}(Q_t^* X_t^{g^*}, L_t^{a*}, L_t^{c*})$ for the parent bank). $L_t^g = L_t^a + L_t^c$ is the total number of loan officers employed in monitoring (due diligence) by the affiliate, L_t^a denotes the number of loan officers autonomously hired by the affiliate, and L_t^c is the number of loan officers directly hired (or managed) by the global conglomerate. In (10), L_t^{a*} and L_t^{c*} denote the loan officers of the parent bank in the foreign country. The net worth is the gross payoff from assets net of borrowing costs:

$$N_t^g = \left[R_t^k + (1-\delta)\kappa_t Q_t\right] X_{t-1}^g - R_{t-1}^D D_{t-1}^g - \theta R_{t-1}^D \mathcal{Z}_{t-1}^g, \tag{12}$$

where R_t^k denotes the return to capital.

In the affiliate's resource constraint (9), $\mathcal{Z}_t^g$ is the total liquidity transfer from the conglomerate. This takes the form of a mix of an intra-group loan, possibly extended at a reduced interest rate, and an equity injection. The gross cost per unit of transfer is θR_t^D, where $(1-\theta) < 1$ governs the per-unit cost saving of the transfer relative to deposits gathered in the host country. λ_t^g denotes the Lagrange multiplier for the resource constraint. The affiliate takes as given the parent's portfolio choice. In addition, it takes as given the number of loan officers directly chosen by the conglomerate (L_t^c) and the intra-group transfer $\mathcal{Z}_t^g$ from the parent (or to the parent, if $\mathcal{Z}_t^g < 0$), which is determined at the conglomerate level.

Eq. (10) is the collateral constraint (with Lagrangian multiplier given by μ_t^g). This consolidates the assets of the affiliate and the parent bank. In particular, the right-hand side of (10) is the weighted sum of $\mathcal{P}^g(Q_t X_t^g, L_t^a, L_t^c) Q_t X_t^g$, the recovery value of the firm shares held by the affiliate, and $\mathcal{P}^{g^*}(Q_t^* X_t^{g^*}, L_t^{a*}, L_t^{c*}) Q_t^* X_t^{g^*}$, the recovery value of the firm shares held by the parent. The weight on the parent, η, determines the degree of consolidation. A value of $\eta = 0$ implies complete separation, whereas $\eta = 0.5$ implies full consolidation.

[4] By monitoring loans, banks preserve their viability and certify it to investors. For example, banks that default strategically need to identify buyers of project loans in the liquidation market. Loan monitoring and assessment enhances this ability, raising the recovery value of loans pledgeable to investors. There is extensive evidence on the effects of monitoring on banks' access to liquidity (see, e.g., King, 2008; BIS, 2015, and references therein). Note that, following Gertler and Karadi (2011), and as in a broad class of models (e.g., Kiyotaki and Moore, 1997), bankers' moral hazard is an off-equilibrium phenomenon. Thus, it causes the emergence of capital constraints but does not lead to realized losses in banks' balance sheets. Consistent with this, monitoring affects the tightness of capital constraints, impacting banks' lending capacity and, indirectly, banks' net worth.

The recoverable portion of the assets held by the affiliate bank depends on the monitoring performed by loan officers hired autonomously (L_t^a) and by loan officers managed by the conglomerate (L_t^c) according to the following due diligence function

$$\mathcal{P}^g(Q_t X_t^g, L_t^a, L_t^c) = \left(\frac{\mathcal{L}_t}{Q_t X_t^g}\right)^{1-\phi}. \tag{13}$$

Taking a leaf from a broad literature in labor, we posit a CES aggregator of loan officers ($\mathcal{L}_t$)

$$\mathcal{L}_t = \left[(1-\chi)\left(L_t^a\right)^{\frac{\tau-1}{\tau}} + \chi(L_t^c)^{\frac{\tau-1}{\tau}}\right]^{\frac{\tau}{\tau-1}}. \tag{14}$$

τ denotes the elasticity of substitution between loan officers controlled by the affiliate and loan officers controlled by the conglomerate, while χ governs the productivity weights on the two categories of loan officers.

Combining the FOCs for X_t^g, D_t^g, L_t^a with the corresponding envelope conditions, we obtain the optimizing conditions for the loans extended by the global bank affiliate in the host economy

$$[\partial X_t^g]: \quad -\lambda_t^g Q_t + \mu_t^g \xi(1-\eta)\phi\left[(1-\chi)\left(L_t^a\right)^{\frac{\tau-1}{\tau}} + \chi(L_t^c)^{\frac{\tau-1}{\tau}}\right]^{\frac{\tau(1-\phi)}{\tau-1}} (Q_t)^{\phi}(X_t^g)^{\phi-1}$$
$$+E_t\Lambda_{t,t+1}^*\left[R_{t+1}^k + (1-\delta)\kappa_{t+1}Q_{t+1}\right]\left(1-\sigma+\sigma\lambda_{t+1}^g\right) = 0, \tag{15}$$

for the deposits gathered in the host economy

$$[\partial D_t^g]: \quad \lambda_t^g - \mu_t^g R_t^D - E_t\Lambda_{t,t+1}^*\left(1-\sigma+\sigma\lambda_{t+1}^g\right)R_t^D = 0, \tag{16}$$

and for the loan officers hired in autonomy by the local affiliate

$$[\partial L_t^a]: \quad -\lambda_t^g W_t^{L,g} + \mu_t^g \xi(1-\eta)(1-\phi)\left[(1-\chi)\left(L_t^a\right)^{\frac{\tau-1}{\tau}} + \chi(L_t^c)^{\frac{\tau-1}{\tau}}\right]^{\frac{1-\tau\phi}{\tau-1}}$$
$$\times(1-\chi)\left(L_t^a\right)^{-\frac{1}{\tau}}(Q_t X_t^g)^{\phi} = 0. \tag{17}$$

Observe (15). Acquiring firm shares tightens the current resources constraint (λ_t^g) of the global affiliate, but relaxes its current capital constraint (μ_t^g) and future resource constraint (λ_{t+1}^g). The relaxation of the current capital constraint depends on the intensity of monitoring performed by loan officers employed at the affiliate. Consider next (17). From the perspective of the affiliate, hiring more loan officers tightens its current resource constraint (λ_t^g) but relaxes its capital constraint (μ_t^g). The latter effect depends on the productivity of loan officers hired by the affiliate $(1-\chi)$ and on the degree of consolidation between affiliate and parent $(1-\eta)$.

Global parents. The parent bank in the foreign country solves a problem similar to that of the affiliate, taking as given the transfer (intra-group loan or equity injection) $\mathcal{Z}_t^{g^*}$ and the level of monitoring $L_t^{g^*}$, which are decided at the conglomerate level. Given the similarity with the affiliate's problem, we present the parent's optimizing conditions in Appendix A.

3.2.3. Management of liquidity and monitoring in global bank conglomerates

Global banks can operate liquidity transfers between the parent and the affiliate through internal capital markets. These transfers are decided at the conglomerate level. In addition, global banks can also manage monitoring resources. In particular, they can exert partial control over the monitoring activities of their affiliates by being involved in the hiring of loan officers.

To better understand the comparison of our economy with alternative economies later in the analysis, it is useful to think of intra-group transfers as comprising two components. One component has "no strings attached", that is, it does not entail any control of the conglomerate over the monitoring decisions of the affiliate or the parent. The second component, instead, has "strings attached", as it serves to finance the wage bill of loan officers hired by the banking conglomerate in the host country or the foreign country. Formally,

$$\mathcal{Z}_t^g = Z_t^g + W_t^{L,g} L_t^c, \tag{18}$$
$$\mathcal{Z}_t^{g*} = Z_t^{g*} + W_t^{L,g,*} L_t^{c*}, \tag{19}$$

where $\mathcal{Z}_t^g$ denotes the total intra-group transfer, Z_t^g is the "no strings attached" component of the transfer, and $W_t^L L_t^c$ is the wage bill of the host-country loan officers hired by the conglomerate (recall that the affiliate also hires L_t^a in autonomy).

The conglomerate thus decides the intra-group transfer (Z_t^g and $Z_t^{g^*}$), the affiliate's loan officers L_t^c to hire in the host country, and the parent's loan officers L_t^{c*} to hire in the foreign country solving the following optimization problem:

$$\max_{Z_t^g, Z_t^{g^*}, L_t^c, L_t^{c*}} \quad V_t^g + V_t^{g^*} \tag{20}$$

$$\text{s.t.} \quad \underbrace{(Z_t^g + W_t^{L,g} L_t^c)}_{\mathcal{Z}_t^g} + \underbrace{(Z_t^{g^*} + W_t^{L,g,*} L_t^{c*})}_{\mathcal{Z}_t^{g*}} + \frac{\psi_1}{2}\left(Z_t^{g^*} - \overline{Z}^{g^*}\right)^2 + \frac{\psi_2}{2}\left(W_t^{L,g} L_t^c - \overline{W}^{L,g}\overline{L}^c\right)^2 = 0. \tag{21}$$

Intra-group transfers between the parent and the affiliate incur quadratic implementation costs as in the resource constraint, where $\overline{Z}^{g^*}$ is the steady state value of the intra-group no strings attached transfers, and $\overline{W}^{L,g}\overline{L}^{c}$ is the steady state value of the strings attached transfers. The parameters ψ_1 and ψ_2 govern the size of the costs for making no strings attached transfers and strings attached transfers, as determined by the degree of centralization of liquidity and monitoring resources within the conglomerate, for instance. These costs capture resources that banks need to use to arrange, implement and supervise transfers across conglomerates, and echo the portfolio adjustment costs introduced by a large class of models in international finance.

The FOC for the no strings attached transfers equalizes their marginal values at the parent and the affiliate, adjusted for the implementation cost. For the affiliate,

$$\frac{\partial V_t^g}{\partial Z_t^g} = \lambda_t^g - \theta R_t^D \mu_t^g - \theta E_t \Lambda_{t,t+1}^* \left(1 - \sigma + \sigma \lambda_{t+1}^g\right) R_t^D. \tag{22}$$

The liquidity transfer relaxes the current resource constraint of the affiliate (λ_t^g), but it tightens its current capital constraint (μ_t^g) and future resource constraint (λ_{t+1}^g). For the parent,

$$\frac{\partial V_t^{g^*}}{\partial Z_t^{g^*}} = \lambda_t^{g^*} - \theta R_t^D \mu_t^{g^*} - \theta E_t \Lambda_{t,t+1}^* \left(1 - \sigma + \sigma \lambda_{t+1}^{g^*}\right) R_t^D. \tag{23}$$

Using (22) and (23), the conglomerate's optimal choice yields

$$\begin{aligned} &\left[\lambda_t^g - \theta R_t^D \mu_t^g - E_t \Lambda_{t,t+1}^* \left(1 - \sigma + \sigma \lambda_{t+1}^g\right) \theta R_t^D\right] \left[1 - \psi_1 \left(Z_t^{g^*} - \overline{Z}^{g^*}\right)\right] \\ &= \lambda_t^{g^*} - \theta R_t^D \mu_t^{g^*} - E_t \Lambda_{t,t+1}^* \left(1 - \sigma + \sigma \lambda_{t+1}^{g^*}\right) \theta R_t^D. \end{aligned} \tag{24}$$

When choosing no strings attached transfers, the conglomerate thus accounts for their impact on the resource and capital constraints of parent and affiliate, and for the implementation cost.

In turn, the first-order condition for the conglomerate's hiring of loan officers at the affiliate level (L_t^c) (and, hence, for the strings attached intra-group transfers) reads

$$\begin{aligned} [\partial L_t^c]: \quad & \xi(1-\phi)\left[\mu_t^g(1-\eta) + \mu_t^{g^*}\eta\right]\left[(1-\chi)\left(L_t^a\right)^{\frac{\tau-1}{\tau}} + \chi (L_t^c)^{\frac{\tau-1}{\tau}}\right]^{\frac{1-\tau\phi}{\tau-1}} \chi \left(L_t^c\right)^{-\frac{1}{\tau}} (Q_t X_t^g)^{\phi} \\ & -\theta \mu_t^g R_t^D W_t^{L,g} - E_t \Lambda_{t,t+1}^* \left(1 - \sigma + \sigma \lambda_{t+1}^g\right) \theta R_t^D W_t^{L,g} \\ & = W_t^{L,g}\left[1 + \psi_2 \left(W_t^{L,g} L_t^c - \overline{W}^{L,g}\overline{L}^c\right)\right]\left[\lambda_t^g - \theta R_t^D \mu_t^g - \theta E_t \Lambda_{t,t+1}^* \left(1 - \sigma + \sigma \lambda_{t+1}^g\right) R_t^D\right]. \end{aligned} \tag{25}$$

Hiring loan officers in the host economy relaxes both the affiliate's capital constraint (μ_t^g) and the parent's capital constraint ($\mu_t^{g^*}$), due to the consolidation of balance sheets across the conglomerate. However, it entails resource and implementation costs, as suggested by the right-hand-side of (25). We will come back to the interactions between liquidity management in internal capital markets and the control of monitoring resources by global banks.

3.2.4. Local banks

Local banks in the host country choose their deposit taking D_t from host-country households, purchases of shares X_t issued by host-country firms, and hiring of loan officers L_t, to maximize the expected discounted sum of dividends they distribute to the host-country household

$$V_t \equiv \max_{\{X_{t+j}, D_{t+j}, L_{t+j}\}_{j\geq 0}} \quad E_t \sum_{j=0}^{\infty} (1-\sigma)\sigma^j \Lambda_{t,t+j+1} N_{t+j+1}, \tag{26}$$

$$\text{s.t.} \quad Q_t X_t = N_t + D_t - W_t^L L_t, \qquad [\lambda_t] \tag{27}$$

$$R_t^D D_t \leq \xi^L \mathcal{P}(Q_t X_t, L_t) Q_t X_t, \qquad [\mu_t] \tag{28}$$

where $\mathcal{P}(\cdot) Q_t X_t$ is the pledgeable, recovery value of firm shares, with $\mathcal{P}(Q_t X_t, L_t) = \left(\frac{L_t}{Q_t X_t}\right)^{1-\phi}$. This is a function of the intensity of monitoring (due diligence) performed by the local bank, as determined by the number of loan officers L_t it employs. λ_t and μ_t denote the Lagrange multipliers for the resource constraint and the collateral constraint, respectively.

The local bank's net worth at time t is

$$N_t = \left[R_t^k + (1-\delta)\kappa_t Q_t\right] X_{t-1} - R_{t-1}^D D_{t-1} + nw_t, \tag{29}$$

where nw_t is an exogenous shock to the local bank's net worth following an $AR(1)$ process.

3.3. Market clearing

The market clearing conditions of the labor market and deposit market of the host economy are already embedded in the definition of the corresponding variables. In the loan market, the total firm shares held by local banks and global banks' affiliates must equal the total capital stock of firms, that is, $K_t = X_t + X_t^g$. Analogous conditions hold in the foreign economy. In equilibrium the global social resource constraint will also hold.

Table 3
Parameters.

Parameter	Description	Value
	Fixed Parameters	
Households		
β	Discount factor	0.99
h	Habits on consumption	0.50
φ	Inverse of Frisch elasticity in goods production	1.00
γ	Inverse of Frisch elasticity in due diligence	1.00
ν_H	Disutility of labor in goods production	1.00
ν_L	Disutility of labor in due diligence at local banks	0.50
$\nu_{L,g}$	Disutility of labor in due diligence at global banks	0.50
Firms		
α	Capital share	0.33
δ	Capital depreciation rate	0.025
$I(F''/F')$	Inverse elasticity of investment to capital price in SS	1.73
Banks		
σ	Survival rate of bankers	0.90
θ	Fraction of deposit interest rate paid on intra-group loans	0.60
η	Degree of balance sheet consolidation	0.10
	Fitted Parameters	
Banks		
ς	Proportional transfer to entering bankers	0.01
ξ^L	Pledgeability of bank loans (local)	2.85
ξ	Pledgeability of bank loans (global)	3.00
ϕ	Weight of loans in the recovery value of firm shares	0.70
χ	Productivity weight on locally-hired loan officers	0.50
τ	Elasticity of substitution between loan officers	0.50

4. Calibration and preview of mechanisms

This section provides details on the calibration and previews key mechanisms of the model.

4.1. Calibration

We solve the model numerically by linearly approximating it around the non-stochastic steady state. We posit symmetric countries and calibrate the model parameters to data moments from a broad set of economies in our sample. Parameters are shown in Table 3. In total there are 19 parameters to calibrate, seven referring to the household sector, three to the firm sector, and the remaining nine to the banking sector.

Parameters regarding the representative households and representative firms are set to standard values in the literature. For households, we posit a GHH utility function

$$U_t = \frac{\left(C_t - hC_{t-1} - \upsilon_H \frac{H_t^{1+\varphi}}{1+\varphi} - \upsilon_L \frac{L_t^{1+\gamma}}{1+\gamma} - \upsilon_{L,g} \frac{{L_t^g}^{1+\gamma}}{1+\gamma}\right)^{1-\sigma_c} - 1}{1-\sigma_c}, \tag{30}$$

where h denotes external consumption habits. φ and γ are the inverse of the Frisch elasticity for workers employed in final good production and as loan officers, respectively; υ_H and υ_L ($\upsilon_{L,g}$) govern the labor disutility in the final good sector and at local (global) banks, respectively. The household discount factor β is set to 0.99, and the Frisch elasticity of labor supply for producing final goods and for monitoring at both types of banks is set to 1. This choice is in line with the recommendation of Chetty et al. (2011) and is appropriate for our model since it does not distinguish between the intensive and extensive margins of employment. Households' habit in consumption h is set to 0.5, in line with a broad class of macroeconomic models. As for the final good producing firms, the effective share and depreciation rate of capital are set to the standard values of $\alpha = 0.33$ and $\delta = 0.025$, respectively. These imply a labor share of 67% and an annual capital depreciation rate of 10%. The inverse elasticity of investment to the price of capital in steady state is set to 1.73, in line with Gertler and Karadi (2011).

For the banking sector, we fix three parameters to values borrowed from the literature or calculated from external data: η, the parameter that governs the consolidation of global banks' balance sheets; θ, the weight of transfers in the bank capital constraint; and σ, the bankers' survival rate. Typically branches are consolidated and subsidiaries are not. We then set η to 0.1, reflecting the share of foreign bank assets accounted for by branches, as documented by Allen et al. (2013) for a large set of advanced and middle-income countries. θ is determined by market and regulatory requirements and by the composition of flows in internal capital markets. In line with other studies on such flows, Allen et al. (2013) report that in 2007–2009 for UniCredit and Citigroup, banks with large global networks of affiliates, the flows between foreign affiliates and parents consisted for 60% of intra-group loans and other non-equity flows. We set θ to 0.6. In line with Gertler and Karadi (2011), we set bankers' survival rate σ to 0.9.

We next calibrate six banking sector parameters to fit data moments: the proportional transfer to entering bankers ς; the pledgeability of local bank loans ξ^L; the productivity weight on locally-hired loan officers χ; the pledgeability of global bank loans ξ; the parameter ϕ in banks' due diligence function; and the elasticity of substitution between locally-hired loan officers and loan officers hired by conglomerates τ. To this end, we match six targets, predominantly based on the data in our sample. The global bank annual loan interest rate spread is set to 3%, in the ballpark of what is documented by studies on foreign bank lending. Global banks' leverage ratio is set to 7, as implied by our sample of global bank affiliates. The ratio of global banks' wage bill for loan officers over bank assets is set to 1.45%, in line with the annual expenses on salaries and employee benefits over assets of foreign banks observed in the balance sheet data of our sample (and consistent also with banks' reports for the euro area). We target a ratio of global bank loans over total loans close to 25%, which is around the average global banks' loan ratio observed in our sample. Accounting for this, and targeting a labor intensity (loan officers over assets) at local banks analogous to that at global affiliates, we set the monitoring (loan officers) at local banks over total monitoring $L/(L^g + L)$ to 0.7. Finally, our last target is the ratio of loan officers hired by conglomerates over loan officers hired by affiliates (L^c/L^a). In our data, approximately 85% of local affiliates declare an involvement of parents in the hiring and training of their loan officers. However, as noted, only the hiring of a fraction of loan officers at an affiliate will eventually be influenced directly by parent offices (see also De Haas and Naaborg, 2006, and the discussion in Appendix B). Our calibration implies that slightly more than 50% of loan officers at an affiliate is ultimately selected by parent offices.

In Appendix C, we examine the informativeness of the calibrated parameters and show that the results carry through when altering the parameters around the preferred values.

4.2. A preview of key mechanisms

We preview the key trade-offs that we expect to shape banks' response to aggregate shocks.

Monitoring. Consider first the monitoring decision (hiring of loan officers at the affiliate level) made by global banking conglomerates (25), reported again here for convenience

$$\begin{aligned}[\partial L_t^c]: \quad & \xi(1-\phi)\left[\mu_t^g(1-\eta)+\mu_t^{g^*}\eta\right]\left[(1-\chi)\left(L_t^a\right)^{\frac{\tau-1}{\tau}}+\chi(L_t^c)^{\frac{\tau-1}{\tau}}\right]^{\frac{1-\tau\phi}{\tau-1}}\chi\left(L_t^c\right)^{-\frac{1}{\tau}}(Q_tX_t^g)^{\phi} \\ & -\theta\mu_t^g R_t^D W_t^{L,g} - E_t\Lambda_{t,t+1}^*\left(1-\sigma+\sigma\lambda_{t+1}^g\right)\theta R_t^D W_t^{L,g} \\ & = W_t^{L,g}\left[1+\psi_2\left(W_t^{L,g}L_t^c-\overline{W}^{L,g}\overline{L}^c\right)\right]\left[\lambda_t^g-\theta R_t^D\mu_t^g-\theta E_t\Lambda_{t,t+1}^*\left(1-\sigma+\sigma\lambda_{t+1}^g\right)R_t^D\right]. \end{aligned} \tag{31}$$

The monitoring decision of global banking conglomerates is primarily driven by the tightness of the capital constraint in the host country and, through consolidation, in the foreign country, as captured by the Lagrange multipliers μ_t^g and $\mu_t^{g^*}$. Bank monitoring, in fact, enhances the pledgeability of banks' assets and allows to relax banks' capital constraint. Thus, the incentive to monitor is larger, the tighter the constraint. The monitoring decision is also governed by the value (quality) of bank loan portfolios, as captured by $Q_tX_t^g$. The larger this value, the higher the marginal productivity of bank monitoring and, hence, the incentive to monitor.

The monitoring decision of global conglomerates is also affected by their structural characteristics. Consider first the degree of centralization of monitoring resources, as captured inversely by the cost ψ_2 of making strings attached transfers for hiring monitoring loan officers in the host country. The higher such centralization (that is, the lower ψ_2 is), the stronger the incentive to monitor. The relative efficiency of conglomerate headquarters also shapes monitoring: the higher the value of χ, the larger the incentive of a conglomerate to hire loan officers at affiliate offices. Finally, consider balance sheet consolidation (η). When a conglomerate makes decisions about monitoring at the affiliate level, it takes into account the effect that loan officers have also on the pledgeability of loans for foreign lending, in the parent offices, while it takes correspondingly less into account the pledgeability of loans in the host country.

Liquidity. Internal capital markets allow global banks to make no strings attached transfers. The choice of such transfers is governed by Eq. (24), reported again here for convenience:

$$\begin{aligned} & \left[\lambda_t^g-\theta R_t^D\mu_t^g-E_t\Lambda_{t,t+1}^*\left(1-\sigma+\sigma\lambda_{t+1}^g\right)\theta R_t^D\right]\left[1-\psi_1\left(Z_t^{g^*}-\overline{Z}^{g^*}\right)\right] \\ & = \lambda_t^{g^*}-\theta R_t^D\mu_t^{g^*}-E_t\Lambda_{t,t+1}^*\left(1-\sigma+\sigma\lambda_{t+1}^{g^*}\right)\theta R_t^D. \end{aligned} \tag{32}$$

The use of internal capital markets is easier, the lower is the cost ψ_1. Transfers affect the availability of liquidity for affiliates. Crucially, they also have implications for monitoring: the provision of no strings attached liquidity (Z_t^g) can dilute the monitoring incentive of affiliates by making liquidity constraints less tight. Recall, from the FOC of loan officers L^c in (25), that the incentive to monitor is related to the tightness of the capital constraint, as captured by μ_t^g. To the extent that cheap intra-group transfers replace more costly retail deposits, the tightness of the capital constraint will be reduced too, diluting loan monitoring incentives.

5. Model analysis

We investigate the response of the economy to financial and real shocks. We consider shocks originating in the banking sector that erode banks' net worth (nw) and shocks that reduce the quality of firms' investments (capital quality) (κ). We compare our economy

Table 4
Effects of shocks on global banks' behavior (overview).

	Panel A: Bank net worth crunch				
	Loan monitoring	Transfers			Lending
		Strings attached	No strings attached	Total	
Overall effect	↑	↑	↑	↑	↑
Monitoring centralization	↑	↑	=	↑	↑
Liquidity centralization	↓	↓	↑	↑	↑
	Panel B: Capital quality drop				
	Loan monitoring	Transfers			Lending
		Strings attached	No strings attached	Total	
Overall effect	↑↓	↑↓	↑↓	↑↓	↓
Monitoring centralization	↓	↓	=	↓	↓
Liquidity centralization	↑	↑	↑	↑	↑

Note: This table provides an overview of the effects of negative shocks on global banks' behavior and of the influence of global banks' structure on such response. In the "overall effect" rows, "↑" indicates that the variable increases, "↓" indicates that the variable decreases, and "↑↓" indicates an ambiguous response (e.g., an increase on impact but then a decline below the steady state level). In the "monitoring centralization" and "liquidity centralization" rows, "↑" indicates that the variable increases more (or decreases less), "↓" indicates that the variable decreases more (or increases less), and "↑↓" indicates an ambiguous or negligible influence of centralization.

with two alternative economies. The first is a "decentralized monitoring" economy, in which global banks can implement no strings attached liquidity transfers, but cannot influence the hiring of loan officers by affiliates. Formally, in this comparison economy we posit an infinitely high cost ψ_2 for implementing strings attached transfers. The second comparison is a "decentralized liquidity" economy, in which global banks can influence the hiring of loan officers by affiliates and implement strings attached transfers to finance the associated wage bill, but cannot implement no strings attached transfers. In this second comparison economy, we posit an infinitely high cost ψ_1 for implementing no strings attached transfers. In the baseline economy, both ψ_1 and ψ_2 are set at a very small number, capturing a scenario with relatively centralized liquidity and monitoring ($\psi_1 = \psi_2 = 0.1$). In Appendix C, we also compare our economy with an economy where effectively all banks operate locally. Table 4 provides an overview of the results.

5.1. Bank net worth shocks

We first study the impact of shocks originating in the financial sector that erode banks' net worth. These can especially capture drops in banks' capitalization due to crises in asset markets in which banks have significant involvement, such as markets for sovereign debt and for real estate related securities. They can also capture drops in banks' capitalization due to the siphoning off of resources from local banks induced by political interference and bank managers' misbehavior. Thus, these shocks are the closest to the kind of financial shocks considered in the empirical analysis (and also described in Appendix B). As we illustrate below, the results suggest that the stabilizing or propagating effects of global banks are heavily influenced by the functioning of internal capital markets (liquidity centralization) and by the loan monitoring control exerted by parent offices vis-à-vis their affiliates (monitoring centralization).

Following a negative shock to the net worth of both local banks and global banks' affiliates, in spite of the reduction of their net worth, global banks expand countercyclically their lending to firms in the host economy, unlike local banks which instead contract their loans. This countercyclical lending behavior reflects the countercyclical behavior of global banks' loan monitoring intensity, financed by strings attached transfers from parent offices.

Fig. 1 displays the impulse responses following a 1% negative shock to the net worth of local banks in the host country (solid black lines). For all shocks, we set the persistence to 0.7. In all figures, impulse responses are percentage deviations from the steady state; responses of no string attached transfers (Z^g) and total transfers ($\mathcal{Z}^g$) are scaled by steady-state deposits of the affiliates. Observe that, in spite of the shock hitting directly only local banks, net worth drops both at local banks and global banks' affiliates, as a result of the endogenous fall of investment returns and, hence, of asset prices (Q_t) in the host economy. This erodes the loan portfolio values of both types of banks, shrinking their net worth.[5] Following the shock, global banks' parent offices transfer liquidity to their affiliates in the host economy, both in the form of strings attached transfers ($W_t^{L,g} L_t^c$) and of no strings attached transfers

[5] The results are robust to allowing the shock to also influence directly the net worth of global affiliates. The specification of the shock can capture the significant heterogeneity between the sectorial exposures of local and global banks. Local banks tend to focus on non-tradeable industries (e.g., real estate). They also hold significant amounts of domestic sovereign debt. Using the IMF Sovereign Debt Investor Base, we obtained that for the median (average) country in our empirical sample for which data are available the share of sovereign debt held by domestic banks is three times (twice) larger than that of foreign banks, ranging from 1.4 times for Slovenia to more than 10 times for Estonia. And data from Altavilla et al. (2017) reveal that for several countries, domestic sovereign bonds account for roughly 10% of domestic banks' portfolio. These features can disproportionately expose local banks to shocks to non-tradeable industries and to sovereign bond values. In several countries, local banks also provide subsidized finance to government-controlled businesses and are subject to political interference. In Appendix B, we review several cases in which this exposed local banks to shocks, including the siphoning off of resources. In addition, as discussed in Appendix B, in the countries in our sample local banks are vulnerable to currency shocks, while global banks can frequently hedge against such shocks.

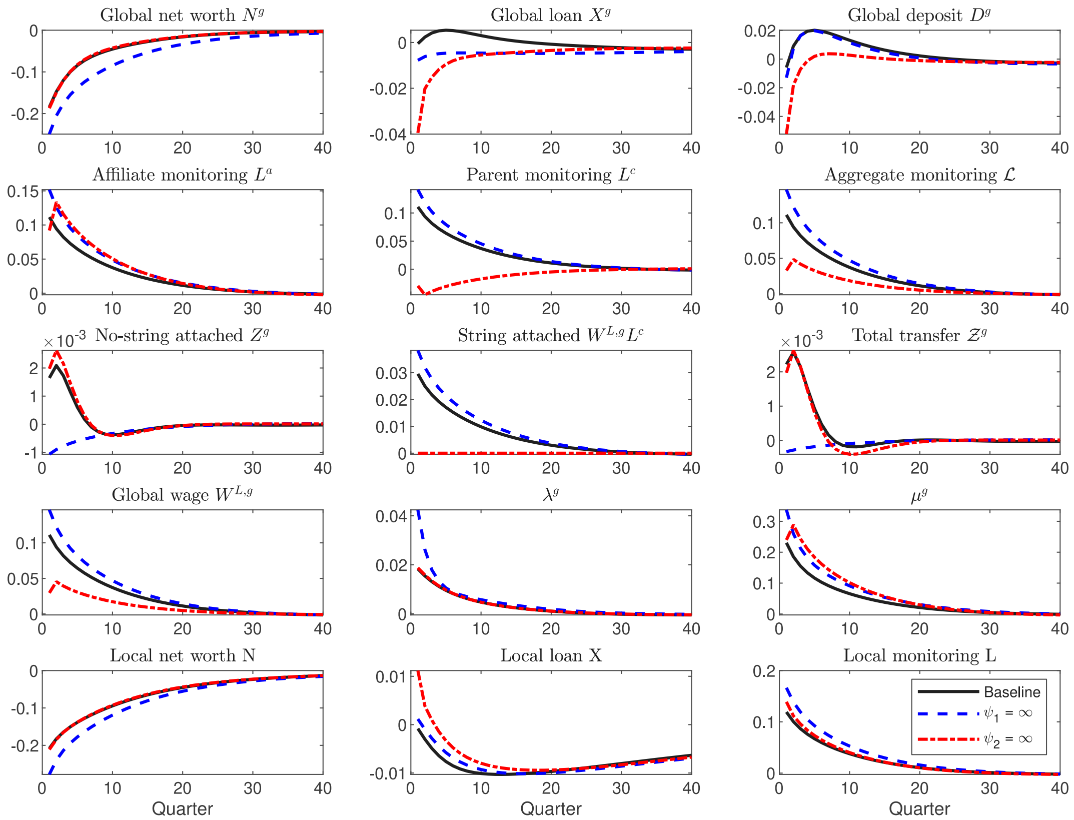

Fig. 1. Responses to negative net worth shock in host country: banking variables.

(Z_t^g). As suggested by the fourth row of Fig. 1, the increase in no strings attached transfers stems from the stronger tightening of liquidity constraints in the host economy, as captured by the larger increase of the Lagrangian multiplier associated with banks' resource constraint in the host country (λ_t^g), relative to the increase of the same multiplier in the foreign country (λ_t^{g*}). On the other hand, the increase of strings attached transfers reflects the rise of conglomerates' hiring of monitoring loan officers (L_t^c) at the affiliate level, which is primarily driven by the tightening of the capital constraint in the host economy (observe the increase of the Lagrangian multiplier μ_t^g).

Due also to the complementarity between loan officers hired by conglomerates and those hired by affiliates, the loan monitoring of global bank affiliates ($\mathcal{L}_t$) rises substantially in the host country overall, facilitated by the expansion of strings attached transfers. As a result of the boost to loan monitoring and of the inflow of transfers from parent offices, global bank affiliates can increase their loan supply in a countercyclical fashion. Conversely, while expanding somewhat their monitoring and deposit gathering, local banks shrink their credit supply.

In the aggregate, overall credit in the host economy shrinks, indicating that the countercyclical response of global banks' loans only partially offsets the credit crunch of local banks. Investment (I_t), capital accumulation (K_t), and production (Y_t) drop (Fig. 2). However, the countercyclical lending response of global banks helps to mitigate this contraction. We next investigate how the organizational structure of global banks shapes the above effects.

5.1.1. *Global banks' centralization*

To examine the implications of centralization, Fig. 1 compares the impulse responses following a negative bank net worth shock in our baseline economy and in the two alternative settings: an economy lacking liquidity centralization ($\psi_1 = \infty$, dashed blue lines) and an economy lacking monitoring centralization ($\psi_2 = \infty$, dashed-dotted red lines).

Monitoring centralization. Monitoring centralization triggers a stronger intervention of banking conglomerates, in terms of larger strings attached transfers and a more pronounced countercyclical response of monitoring by affiliates in the host country (compare the response of L^c in our baseline economy to the alternative economy with $\psi_2 = \infty$). As a result of the larger influx of strings attached liquidity, and of the sharper countercyclical boost to monitoring, the response of global bank loans is countercyclical in our baseline setting with monitoring centralization, while it is procyclical in the alternative setting with decentralized monitoring.

More specifically, as Fig. 1 shows, there are almost no differences in the net worth responses of local and global banks between the two settings. But in the baseline, the overall hiring of loan officers by global bank affiliates ($\mathcal{L}_t$) rises significantly more than

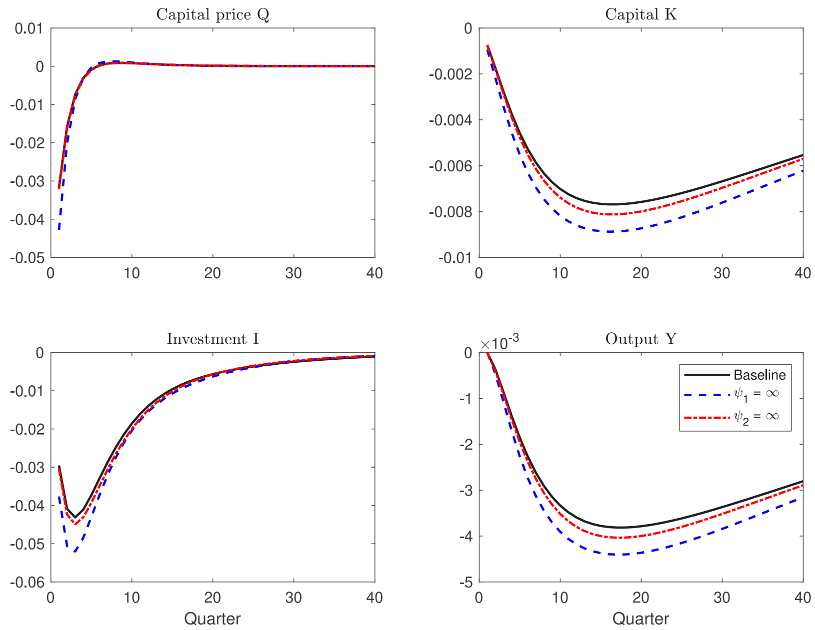

Fig. 2. Responses to negative net worth shock in host country: aggregate variables.

in the alternative setting (where, nonetheless, loan monitoring slightly rises, driven by affiliates' autonomous hiring decisions). The overall liquidity transfers ($\mathcal{Z}_t^g$) behave similarly in the two settings: indeed, in the alternative economy, global bank conglomerates reshuffle transfers from the strings attached type to the (much less costly) no strings attached type. As shown in the figure, global bank loans in the host economy increase countercyclically in our baseline setting, while, when $\psi_2 = \infty$, they instead drop. The much stronger loan monitoring response appears to be a key driver of the countercyclicality of global bank loans under monitoring centralization.

Liquidity centralization. Liquidity centralization has quite different consequences for the transmission of bank net worth shocks (compare the baseline economy with the $\psi_1 = \infty$ alternative setting in Fig. 1). Under liquidity centralization, we observe a larger inflow of no strings attached transfers (Z_t^g) than in the alternative setting but, remarkably, a less countercylical response of the hiring of loan monitoring officers by parent banks (L_t^c). Intuitively, the inflow of liquid funds from the conglomerates mitigates the tightening of the resource and capital constraints of affiliates, as revealed by the smaller increase of the multipliers λ_t^g and μ_t^g. This dilutes global banks' incentive to boost monitoring in the host economy. The overall influence of liquidity centralization on the behavior of global bank loans (X_t^g) is thus ambiguous a priori: there is a smaller increase in loan monitoring and hence in the pledgeability of affiliates' loan portfolio assets, but also more liquidity support. As shown in Fig. 1, on balance, liquidity centralization contributes to the countercylicality of global bank loans. Indeed, while increasing in our baseline economy, global bank loans decline in the setting with $\psi_1 = \infty$.

On the other hand, as revealed by the figure, the gap in global banks' loan response between the baseline economy and the economy with decentralized liquidity is smaller than the gap between the baseline and the decentralized monitoring economy. This points to a more pronounced influence of monitoring centralization on global bank loans' countercyclicality following bank net worth shocks relative to the influence of liquidity centralization.

Macroeconomic implications. The countercyclical lending of global banks can help supplant the drop in local bank lending. Fig. 2 shows that both in the case of liquidity and monitoring centralization, the host economy benefits in terms of stabilization of capital accumulation and output. In fact, under both types of global banks' centralization the host economy suffers a smaller drop in investment, capital, and output.

5.2. Capital quality shocks

The above analysis points to an overall stabilizing influence of global banks following shocks to the net worth of banks. This stabilizing influence is more pronounced when global banks centralize monitoring resources and, to a lesser extent, liquid resources.

The influence of global banks and of their organizational structure is more nuanced following negative capital quality shocks. Such shocks can capture deteriorations in the quality of firms' investments that result into deteriorations in the quality of loan portfolios (in the form of spikes in non-performing loans and loan defaults). Portfolio returns and portfolio quality effects play a large role in the transmission of such shocks. In the aftermath of negative capital quality shocks, the centralization of global banks'

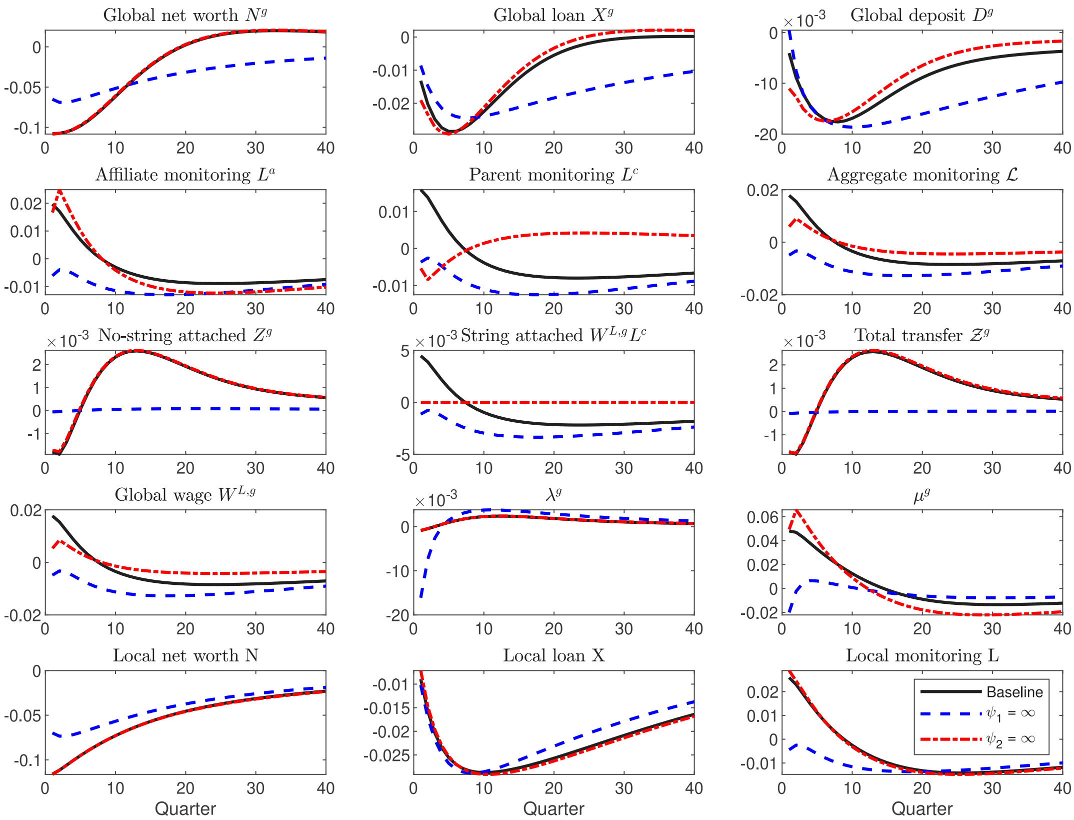

Fig. 3. Responses to negative capital quality shock in host country: banking variables.

monitoring is possibly less beneficial relative to the centralization of liquidity, and it can even become destabilizing. Intuitively, the deterioration in the quality of loan portfolios can depress global banks' incentive to monitor loans (recall the discussion in Section 4.2). This can be seen in Fig. 3, which displays the responses to a 1% negative capital quality shock. In our baseline economy, while increasing in the immediate aftermath of the shock, global banks' monitoring drops below the initial steady state level after a few periods. Accordingly, strings attached liquidity transfers become negative, driving down total transfers to affiliates. Global bank loans fall too in the host country, thus exhibiting a procyclical behavior, and they only recover once the effects of the shock fade away.

In this scenario global banks can take on a destabilizing role. This occurs especially when they deploy a centralized monitoring structure (in Fig. 3, compare the responses with those in the economy with $\psi_2 = \infty$). In fact, in the first few periods after the shock, the temporary increase in monitoring is stronger under monitoring centralization. Yet, in later periods, decentralization (i.e. the alternative economy) is associated with a lesser decline in monitoring. Intuitively, under monitoring centralization, global banks are more sensitive to the drop in investment and loan portfolio quality triggered by the shock. Their monitoring incentives therefore weaken more. This also implies that, while the decline in their lending is initially milder, the subsequent recovery is slower than in the economy with decentralized monitoring.

While monitoring centralization now exacerbates the destabilizing influence of global banks, liquidity centralization retains some stabilizing influence (in Fig. 3, compare the baseline economy with the alternative economy with $\psi_1 = \infty$). In fact, liquidity centralization of global banks is uniformly associated with a stronger response of their loan monitoring, a larger inflow of transfers and—except in the immediate aftermath of the shock—a countercyclical (rather than procyclical) response of global bank lending. Intuitively, as shown in the figure, when strings attached liquidity transfers are feasible, there is a larger repatriation of liquidity from global bank affiliates to parent offices. Thus, the bank resource and capital constraints in the host country become tighter, enhancing global banks' incentive to monitor. As a result, the economy with liquidity centralization exhibits a less procyclical response of global bank lending.

Overall, centralization has an ambiguous impact on the stability of global bank lending after capital quality shocks: it boosts stability in the case of liquidity centralization but undermines it in the case of monitoring centralization (see Table 4, Panel B, for a summary). Interestingly, these differential effects of monitoring and liquidity centralization contrast with those seen after bank net worth shocks, where monitoring centralization acted as a better stabilizer than liquidity centralization. Nonetheless, as revealed by Fig. 4, due to the contrasting forces at work, even in the case of liquidity centralization, the overall benefits for macroeconomic stabilization are clearly more modest than what we observed after shocks to banks' net worth.

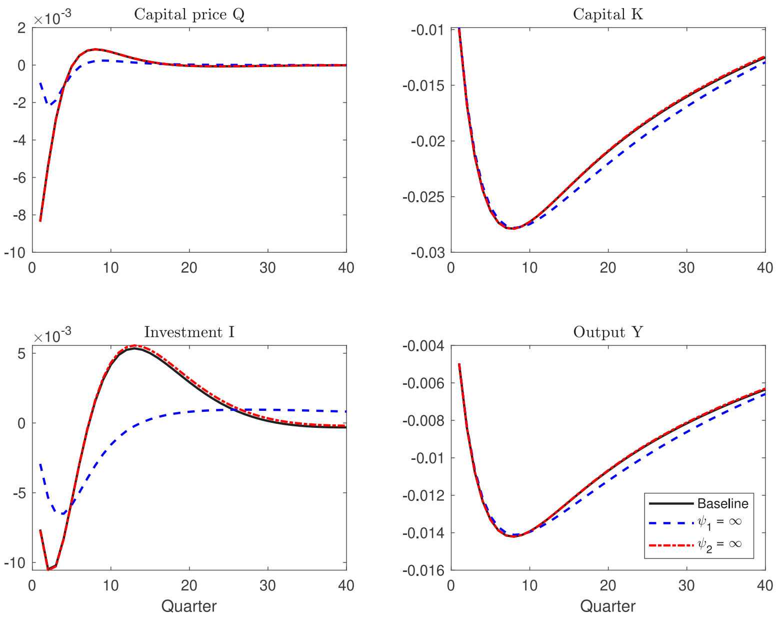

Fig. 4. Responses to negative capital quality shock in host country: aggregate variables.

5.3. *Extensions and further analysis*

In Online Appendix C, we extend the analysis in various dimensions. First, we show that the stabilizing effects of centralization are sharper when global banks feature a more homogeneous distribution of monitoring skills between parents and affiliates (as captured by χ) and a lower balance sheet consolidation (lower η). We also investigate the effects of TFP shocks. Finally, applying the model to the case of Hungary (a country with a large presence of multinational banks), we evaluate quantitatively the impact of regulations on foreign banks on business cycle dynamics. We find that this impact depends not only on the credit share of global banks but also on their business model, i.e., their degree of monitoring and liquidity centralization.

6. Conclusion

Global banks constitute complex financial institutions. We have studied the effects of global banking and global banks' organizational structure on macroeconomic stability. Motivated by evidence from a large set of multinational banks, we highlight two key dimensions of global banks' structure: their control of monitoring decisions across affiliates and their management of internal capital markets. The results reveal that more centralized global banks can mitigate the effects of negative financial (bank net worth) shocks by facilitating loan monitoring interventions and a larger infusion of liquidity by global parents. In contrast, global banks can be destabilizing following capital quality shocks that impair the quality of firm investments and loan portfolios, especially when global banks adopt a centralized business model of monitoring control. The analysis suggests, nonetheless, that following capital quality shocks the influence of liquidity and monitoring centralization on the (de)stabilizing behavior of global banks is significantly smaller than their stabilizing influence following bank net worth shocks.

The paper leaves questions open for future research. In the analysis, we have treated the structure of global banks as a given. However, the configuration of internal capital markets and the control of monitoring decisions likely interact with the network formation decisions of these banks. Exploring this interplay could yield important insights into the macroeconomic implications of global banking. We leave these and other related issues to future research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jinteco.2025.104077.

Data availability

ReplicationJIE_INEC-D-24-00345R1 (Original data) (Mendeley Data)

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