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Multinational Banks and the Drivers of Cross-Border Contagion

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Abstract

In this paper, we investigate the drivers of transmission of solvency and wholesale funding shocks to 84 OECD parent banks on the lending of 375 foreign subsidiaries. We find evidence for the transmission of both types of shocks. Parent undercapitalization affects the transmission of solvency shocks, while wholesale shocks transmit to subsidiaries of parents that rely primarily on wholesale funding. We further document that parent banks tend to guard investment markets at the expense of funding markets and to channel any excess liquidity to improve lending growth in lagging markets. These results have important theoretical and policy implications and add to our understanding of the transmission of solvency and wholesale shocks across borders.

1. Introduction

The ongoing global financial integration has warranted increasing regulatory attention regarding the effect of the operations of multinational banks on the supply of credit and economic growth worldwide, especially in times of distress. The analysis of the drivers of cross-border lending decisions of multinational banks under distress is of utmost importance for policy decision-making. However, there is still insufficient knowledge about the critical factors in the transmission of shocks internationally. In this context, of central importance are the issues of whether and how negative shocks to parent banks affect the lending behavior of foreign subsidiaries. This paper aims at answering these questions.

From a theoretical perspective, multinational banks rely on internal capital markets to shift risk from headquarters to subsidiaries, to reallocate revenues in either direction or across subsidiaries, and in general to allocate resources in an efficient manner, in order to optimally adjust to financial frictions in different markets (Cetorelli & Goldberg 2012*a*). Therefore, functioning internal capital markets are instrumental in a conglomerate's operational strategy. However, these markets can also facilitate the transmission of distress from parents to subsidiaries.

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The role of internal capital markets as a transmission channel of shocks has been well documented in the literature (see, e.g., Cetorelli & Goldberg 2012*a*,*b*). Authors usually focus on macroeconomic shocks (see, e.g., Buch et al. 2010) or global liquidity shocks (e.g., Ivashina & Scharfstein 2010) and the recent studies are mostly related to the global financial crisis. Cetorelli & Goldberg (2012*a*) find evidence of intra-bank funding flows between parents and their foreign affiliates in response to domestic shocks and show that this transmission channel is active not only during crises, but also during tranquil times. Furthermore, having global exposure seems to protect banks from unexpected changes in monetary policy.

In this paper, we analyze the transmission of shocks from 84 OECD parent banks to 375 subsidiaries around the world from 1997 to 2012. In contrast to previous studies that focus on global shocks, we concentrate on the effects of two types of adverse *idiosyncratic* shocks[1] on parent banks and how they are transmitted to foreign subsidiaries: Solvency and wholesale funding shocks. These shocks are defined as large and unexpected deviations in the capital of the parent bank (solvency shock) or in its wholesale funding (wholesale shock) from their respective targets.[2] We base this approach on the evidence from our talks to industry representatives that global banks address different type of shocks in a different manner, depending on their nature and the bank's business strategy.[3]

Our results suggest the following: One, it appears that a shock to the parent's bank equity, i.e. a solvency shock, is more strongly transmitted than a wholesale funding shock. An adverse shock to equity results in a reduction in lending of the foreign subsidiary of about 6-10 percentage points (depending on the specification), whereas a shock to wholesale funding only results in a reduction in lending of foreign subsidiaries of 2-5 percentage points, again depending on the specification. Moreover, the transmission of funding shocks is statistically insignificant in some specifications. The level of capitalization of parents plays a role in the transmission of solvency shocks, while wholesale shocks are transmitted primarily to foreign subsidiaries of parents that rely heavily on wholesale funding. The position of the subsidiary in the business strategy of the parent is also an important determinant of the transmission of shocks across borders: We find that parents extract funds from subsidiaries that are traditionally considered as funding sources within the conglomerate, while protecting subsidiaries that are an important source of investment revenue. The effects are stronger when we incorporate the within-parent variation by including parent fixed effects. This result generally suggests that the findings of Cetorelli & Goldberg (2012*b*) of a "locational pecking order" do not only apply to US banking conglomerates but is rather a global phenomenon.[4] When

[1] To disentangle the idiosyncratic component of the shocks, we control for the macroeconomic environment across all our main specifications.
[2] To identify the shocks, we follow the methodology of DeYoung et al. (2017) and Radev (2021). For more details, see Section 2.4.
[3] For the validity of our analysis, it does not matter whether the shock to the parent has a supply or demand side origin. The notion "lending supply shock" refers to the potential effect of a parent solvency or wholesale shock on the lending of its subsidiaries.
[4] Cetorelli & Goldberg (2012*b*) define *"organizational"* pecking order as a clear organizational preference of the headquarters in the global bank's management of the flows in the internal capital market and juxtapose it against *"locational"* pecking order, where there is no hierarchical preference favoring the headquarters' domestic business over its foreign subsidiaries' operations.

testing the symmetry of the shocks, we find that positive equity shocks to parents do not transform into a higher subsidiary lending growth, while positive wholesale shocks do, especially in foreign markets with slow past lending growth. Overall, our findings suggest that parents tend to guard investment markets at the expense of funding markets and to channel any excess liquidity to improve lending growth in lagging markets.

We perform a battery of additional robustness checks to verify the validity of our results. First, we confirm that the insignificant effect of wholesale shocks is not due to using up *subsidiary* liquidity buffers. Second, we include parent bank controls, which do not change our baseline findings. Third, we show that the results are not driven by the global financial crisis of 2008-2009. Fourth, we apply dynamic panel methods (Arellano & Bond 1991 and Arellano & Bover 1995), which also do not change our baseline findings. Fifth, we test different definitions of the shocks in terms of size and find no qualitative changes in our results. Sixth, we check whether the size of the non-traditional business of the parent, proxied by the ratio of non-interest operating income to total operating income, affects the transmission of shocks and find that not to be the case. Furthermore, since rolling over bad loans by subsidiary banks can artificially increase loan growth, we check whether evergreening affects the transmission of shocks, by regressing non-performing loans to total loans at the subsidiary level on solvency shocks up to the fourth lag. We cannot find evidence for this phenomenon in our foreign subsidiary sample. To alleviate concerns that our results are driven by larger subsidiaries only, we exclude subsidiaries with assets that are larger than 10% of the assets of the parent banks (about 10% of the subsidiary sample). The main results remain unchanged.

Our paper relates to a growing literature that focuses on the bank lending channel and the particular paths of transmission of lending supply shocks, and more specifically: Whether internal capital markets within multinational banks play a role in credit supply (Houston & James 1998; De Haas & van Lelyveld 2003, 2010; Holod & Peek 2010; Cetorelli & Goldberg 2012*a*,*b*; Radev 2021). De Haas & van Horen (2012) document that as a consequence of the subprime crisis, international banks had to write down assets, refinance in illiquid markets and suffered from a substantial decline in their market-to-book ratio. These negative solvency shocks were subsequently transmitted to foreign banks via a reduction in cross-border lending. Regarding the transmission of wholesale (liquidity) shocks, Schnabl (2012) finds that multinational banks transmit negative liquidity shocks across borders, which leads to a reduction in lending abroad. Correa et al. (2013) document that the U.S. branches of euro area banks received insufficient financing to fight their reduced funding opportunities after the outbreak of the euro area sovereign debt crisis, which then led to a reduction of the lending to U.S. firms. Comparing the effects between foreign and domestic subsidiaries, De Haan & van den End (2013) find that after a liquidity shock to their Dutch parent, foreign branches and subsidiaries reduce their lending by more than their domestic counterparts. Gambacorta & Mistrulli (2004) and Mora & Logan (2012) find that bank capital has a causal effect on the propagation of shocks to lending due to the existence of regulatory capital constraints. De Haan & van den End (2013) document that after a negative liquidity shock banks decrease their wholesale lending more intensively than their retail lending. The authors attribute this effect to the fact that wholesale loans have shorter maturity than retail loans and argue in favor of the requirement of the Basel Committee for an increase in liquidity buffers, especially for banks that rely heavily on wholesale funding.

In general, our study speaks to the two main views regarding the functioning of the internal capital markets of a global bank. One, cross-border inflows and withdrawals of funds due to shocks at the parent bank level may have a destabilizing effect in the foreign market (Pontines & Siregar 2012). There is some empirical evidence supporting this view (see, e.g., Reinhart & Rogoff 2009 and Forbes & Warnock 2012, who document broad patterns "capital bonanzas" and "sudden stops"). The most widely accepted explanation for this pattern is that global banking flows are not related to the conditions of the particular foreign market and are more driven by parents doing their liquidity management at the global level. This intuition is central in recent models for global banking (see, e.g., Bruno & Shin 2015 and Devereux & Yetman 2010). Since this view puts the interests of the headquarter above those of the foreign affiliate, Cetorelli & Goldberg (2012*b*) refer to the parent and its domestic operations as being on the top of an *organizational pecking order*. Alternatively, global banks may abide to a *locational pecking order*, where there is no clear organizational preference in the global bank's management of the flows in the internal capital market. Rather, a global bank hit by a shock decides whether to withdraw funds from a particular subsidiary depending on whether it views the host market as a source of funding or as an investment target (Cetorelli & Goldberg 2012*b*). It may also decide to shield strategically important subsidiaries entirely from shocks. Stein (1997) argues that internal capital markets alleviate cash constraints of units with better investment prospects and therefore allow for a more efficient capital allocation. A number of more recent empirical studies provide evidence that parents discriminate between subsidiaries, depending on the role of the latter in the parent business strategy. Cetorelli & Goldberg (2012*b*) argue that after a liquidity shock, U.S. parent banks tend to protect subsidiaries that provide stable investment revenue, while subsidiaries that are seen as a funding source (e.g. if the subsidiaries primarily focus on attracting external borrowing) substantially reduce their lending. Claessens & van Horen (2013) find the opposite effect: During the global financial crisis, foreign subsidiaries used to decrease their lending by less if they are funded locally.

To summarize, the contribution of our paper to the literature is along several lines. First, there are virtually no empirical studies investigating both solvency and wholesale shocks to parents simultaneously. Second, as most authors focus on shocks from or to U.S. banks, our work is among the rare instances of global bank-level studies (for other examples, see, for instance, Jeon et al. 2013, De Haas and Lelyveld 2010, and Ongena et al. 2013). Third, we confirm on a global scale that multinational banking conglomerates organize the flows in their internal capital markets by following a locational pecking order. Since Cetorelli & Goldberg (2012*b*) study only U.S. parent banks, and these prefer to enter foreign markets with branches, rather than with subsidiaries, our findings are much stronger and general due to the looser nature of the parent-subsidiary relationship, compared to the relationship between parents and branches. Fourth, we find that shock transmission is asymmetric, with positive solvency shocks not transmitting at all, while positive wholesale shocks being distributed by parents primarily to subsidiaries with lagging lending growth.

Fifth, in order to identify our shocks, we extend the methodology of DeYoung et al. (2017) for solvency-shock identification to applications for wholesale funding.

This remainder of this paper is organized as follows. Section 2 presents our major hypotheses, empirical baseline model and discusses the data. Section 3 reports the baseline empirical results and further findings and robustness checks. Section 4 concludes.

2. Empirical Model and Data

2.1 Theoretical Predictions

A number of theoretical studies suggest that solvency shocks to parent banks affect the lending of their subsidiaries, especially abroad. Bruno & Shin (2015) develop a model of the international banking system where global banks interact with local banks and show leverage to be a transmission channel of shocks through the banking sector capital flows. The authors show that their analysis applies irrespective of whether the local bank is separate from the global bank, or whether the local and global banks belong to the same banking organization. Devereux & Yetman (2010) develop a simple two-country model in which highly levered financial institutions hold interconnected portfolios and may be limited in their investment activity by capital constraints. The combination of portfolio interdependence and capital constraints leads a negative shock in the host country to affect the balance sheets of financial institutions in the home country and to precipitate an episode of global balance sheet contractions and disinvestment. Therefore, we formulate our first hypothesis as:

> Hypothesis 1. Shocks to the *solvency* of parents lead to a reduction in subsidiary lending.

Khwaja & Mian (2008) introduce a model for the transmission of liquidity shocks to the lending of domestic banks. We argue that through the internal capital markets within international conglomerates, these shocks can also transmit across borders. To test for this effect in our global sample, we introduce our second hypothesis:

> Hypothesis 2. Shocks to the *wholesale funding* of parents lead to a reduction in subsidiary lending.

With our next hypothesis, we try to capture the effect of parent capitalization on the transmission of solvency shocks across borders. The level of capital plays a role during crises because well-capitalized banks might be able to use their capital buffer or raise debt under more favorable terms due to lower agency costs (see, e.g., Kishan & Opiela 2000; Stein 1998; Holmstrom & Tirole 1997; Bernanke & Blinder 1988). However, Krause & Giasante (2012) use a network model to show that global minimum requirements are not effective in containing contagion and that they should be specifically tailor-made to fit each bank. To test these somewhat contradicting predictions, our third hypothesis reads:

Hypothesis 3. Subsidiaries of parents *with lower capital to asset ratio* are more affected by solvency shocks to parents.

Brunnermeier (2009) and Brunnermeier & Pedersen (2009) show that the lending channel can dry-up if banks that rely heavily on wholesale funding lose access to it and cannot roll-over their debt. Our next hypothesis, therefore, postulates:

Hypothesis 4. Subsidiaries of parents *that rely on wholesale funding* are more affected by wholesale funding shocks to parents.

With our next hypothesis, we provide a direct test of the "organizational vs locational pecking order" streams of literature, described by Cetorelli & Goldberg (2012*b*). Under the former theory, banks manage their liquidity on a global level and therefore a shock to a parent should be directly felt by its subsidiaries and be negatively correlated with lending (see, e.g., Bruno & Shin 2015 and Devereux & Yetman 2010). The latter theory postulates that the transmission may depend on the type of host market: Whether it is a funding or an investment source (Cetorelli & Goldberg 2012*b*). To analyze these contradicting theories, we formulate our fifth hypothesis as:

Hypothesis 5. The transmission of shocks depends on the *place of the subsidiary in the business strategy* of their parents: Whether it is a funding or an investment operation.

To summarize, we expect that: Negative (i) solvency and (ii) wholesale shocks to parents lead to a reduction in the lending of their subsidiaries. Furthermore, (iii) undercapitalized parent banks tend to transfer solvency shocks to their subsidiaries to a greater extent, compared to well-capitalized parents, while (iv) subsidiaries of parents that rely heavily on wholesale funding are more affected by wholesale shocks. Finally, we predict that the transmission of shocks is affected by (v) the importance of the subsidiary in the business strategy of the parent.

2.2 Empirical Model and Identification Strategy

2.2.1 General Model

In this paper, we investigate the transmission of idiosyncratic shocks to the solvency and wholesale funding status of a parent bank on the lending of its foreign subsidiaries.

To test the hypotheses outlined above, we estimate variations of the following model:

$$
\begin{aligned}
\text{growth(Loans)}_{i,j,k,t} = {} & \alpha_0 + \alpha_1 \cdot \text{ SolvencyShock}_{\,j,t-1} \\
& +\alpha_2 \cdot \text{ WholesaleShock}_{\,j,t-1} \\
& +\alpha_3 \cdot \text{ Interactions}_{\,j,t-1} \\
& +\alpha_4 \cdot \text{ BankControls}_{\,i,j,k,t-1} \\
& +\alpha_5 \cdot \text{ MacroVariables}_{\,k,t} \\
& +\beta_t + \gamma_i + \epsilon_{i,j,k,t}
\end{aligned}
\tag{1}
$$

where $growth(Loans)_{i,j,k,t}$ is the loan growth of subsidiary i of parent j in host country k at time t; $SolvencyShock_{j,t-1}$ and $WholesaleShock_{j,t-1}$ are solvency and wholesale funding shocks on parent j at time $t-1$, respectively; $Interactions_{j,t-1}$ is a vector of interaction terms discussed later; $BankControls_{i,j,k,t}$ is a vector of individual bank-related indicators of subsidiary i of parent j in country k at time $t-1$; $MacroControls_{k,t}$ is a vector of macroeconomic variables, pertaining to host country k at time t; β_t is a time fixed effect for period t; γ_i is an entity fixed effect for subsidiary i.[5] We define the solvency and liquidity shocks, respectively, as a large and unexpected decline in the capital of the parent bank (solvency shock), or a sudden dry-up in its wholesale funding (liquidity shock). To identify the shocks, we follow the methodology of DeYoung et al. (2017). For more details, see Section 2.4.

The bank variables control for individual bank idiosyncratic characteristics, related to the size, sources of funding, performance and financial health of the subsidiary. The variables that we use are: *size*, defined as the logarithm of the subsidiary's total assets; *profitability*, proxied by the subsidiary's profit to total earning assets; *riskiness*, represented by the bank's loan loss provisions to total loans; *liquidity*, defined as liquid assets to total assets; *capitalization*, being the ratio of the bank's equity to total assets. The last variable, *internally generated funds*, defined by the ratio of net income at time t to total loans at time $t-1$, is an important indicator for the financial independence of the subsidiary from its parent, and is introduced by Jeon et al. (2013).[6] In our estimations, we lag the bank controls by one period. To control for the local demand for credit, we also introduce macroeconomic variables. These include *GDP growth*, *change in unemployment rate (Δ unemployment rate)* and annual inflation. Throughout the paper, we cluster the standard errors at the parent level.

2.2.2 Identification

Our main specification generally follows Peek & Rosengren (1997), as we regress loan growth on parent shocks, lagged subsidiary bank variables and host country macro characteristics. Since a drop in loan growth can be affected by a subsidiary's poor financial situation, which may coincide with a shock to the parent only by chance, by controlling for the situation at the subsidiary bank, we orthogonalize its loan growth with the shock to the parent. Since loan level is a result of the intersection of loan supply and demand, the macro variables help us to disentangle loan supply from loan demand. To further strengthen our empirical approach, we control for unobserved fixed effects in the host country. Loan growth rates can also be affected by a global shock that is unrelated to (or maybe even causes) the shock to the parent. We address this endogeneity concern in two ways. First, we include time fixed effects in our main workhorse model, and second, we provide a robustness check by additionally excluding the period of the global financial crisis (2008-2009) from our regression sample. Our results remain robust to these specification changes.

[5] Table 2 defines all variables and the sources of the data for the empirical analysis.
[6] In contrast to the remaining bank variables, which are stock variables, the internally generated funds is a flow variable.

Apart from controlling for observables at the subsidiary bank level, we control for unobservable bank characteristics by including bank fixed effects. The subsidiary bank fixed effects absorb host-country fixed effects and hence we simultaneously control for any time-invariant host country heterogeneity. Thus, in our analysis, we rely on within-subsidiary bank variation for identification. We relax this in our test of the locational pecking order (Cetorelli & Goldberg 2012*b*), by using parent fixed effects as an alternative specification. This allows us to employ for identification the within-parent variation, a la Khwaja & Mian (2008).

To further alleviate reverse causality concerns that parent shocks are for instance driven by shocks to big subsidiaries, we use data at unconsolidated level. Furthermore, most of our subsidiaries are small relative to the parent: More than 50% of the subsidiaries have assets that are less than 1% of the assets of the respective parent bank and more than 90% of the subsidiaries are at least 10 times smaller than their parents. In a robustness check, we exclude the biggest subsidiaries (with assets above 10% compared to parent assets) and find no significant difference in our results.

2.3 Data

2.3.1 Dataset Construction

In constructing our main dataset, we use annual bank-level data from Bureau van Dijk's Bankscope. As in most of the recent literature (see, e.g., Deléchat et al. 2012, Cornett et al. 2011 and Bonner et al. 2014), we concentrate on commercial banks to avoid bias due to the different business models of, for instance, investment banks. We start off with compiling a list of the biggest 500 commercial banks globally in terms of their total assets. Then, we search manually for the first-level subsidiaries of these banks.[7] We select global subsidiaries of OECD parents, where the ownership share of the parent is at least 50%, we have a first level (direct) subsidiary and the subsidiary is ranked by Bureau van Dijk in the top 10 000 in the world in terms of total assets. At this initial selection stage, we end up with 114 parents and 602 subsidiaries for the period 1997–2012. In the subsequent matching of the datasets of parents and subsidiaries, it turned out that in several cases, when data for the parent for a particular year were available, the data for the subsidiary were missing and vice versa. We also excluded all domestic subsidiaries from the analysis. Eventually, we ended up with 84 parents and 375 subsidiaries for the mentioned period. We used unconsolidated data for both parents and subsidiaries. The final dataset comprises 2791 subsidiary-year observations matched with 870 parent-year observations. Since Bankscope reports different units of measurement for each bank, the unit of measurement of the balance sheet data was uniformly transformed to millions. To guarantee the valid interpretation of the results, the data were further denominated from the original country-specific currency to U.S. Dollars.

[7] Although Bankscope provides a procedure for an automatic selection of the matching subsidiaries, it is not suitable for our analysis, since in the case of conglomerates (e.g. Mitsubishi), the conglomerate is listed as a global owner, and not the commercial bank that is in the top 500 list. In case the conglomerate has several independent commercial banks in the top 500 list, it is impossible to distinguish which subsidiary belongs to which commercial bank.

Table A1 in the Online Appendix provides a list of the parent commercial banks, as well as the respective number of their foreign subsidiaries, while Table A2 presents a lists of the subsidiary countries and the number of subsidiaries they host.[8] Overall, the parent banks represent 27 OECD countries, while the subsidiaries are located in 98 countries (OECD and non-OECD combined). Figures A1 to A3 in the Online Appendix depict the geographical distribution of the subsidiaries and the parents in our sample, respectively. The home countries with the highest number of parent banks are well-diversified across all 98 subsidiary host countries. France, Italy and Spain have the most foreign subsidiaries in our sample, with large representations in Luxembourg (the thick orange line coming out of Italy) and the US (the thick orange line from Spain). The biggest source of relationships is Europe, as European banking groups tend to enter foreign markets with subsidiaries. The biggest host countries in terms of links are the US, Luxembourg, China, Germany and Poland. Italy, Greece, Austria and the Netherlands have large investments in the banking sector of the CEE region and that could be an interesting venue for future research on the transmission of the latest crises in Western Europe to the Transition Economies.

We notice that the final number of parents is significantly reduced, compared to our starting sample (500 vs. 84). There is a number of sample characteristics that drive this outcome: (1) Over 60 parent banks in the top 500 list do not have any subsidiaries; (2) Many banks either do not have foreign subsidiaries or these subsidiaries are not commercial banks;[9] (3) Many subsidiaries are too small to rank in the top 10 000 in the world. Given that the smallest bank in Top 500 has 1.5 Billion Dollar in unconsolidated assets and the average subsidiary is usually less than 1 percent of the size of the parent, searching beyond the Top 10 000 list would yield a number of insignificantly small banks even for emerging countries; (4) Many banks listed in Top 500 are subsidiaries of other banks in the list. For instance, UniCredit Bank Austria AG (number 63 in Top 500) is a subsidiary of UniCredit SpA (number 17 in Top 500) and Deutsche Postbank AG (number 66 in Top 500) is a subsidiary of Deutsche Bank AG (number 1 in Top 500); (5) Many banks, especially US banks, choose to enter foreign markets with branches and not with commercial bank subsidiaries. Thus, Citibank, with 121 overall subsidiaries recorded in Bankscope (bank and non-bank), ultimately has 10 foreign subsidiaries in Top 10 000 of commercial banks, and even more strikingly, JP Morgan, with 291 recorded subsidiaries, has no foreign commercial bank subsidiaries; (6) Many banks have only domestic subsidiaries, especially Japanese banks, which are tied to an industrial conglomerate. We intentionally exclude domestic subsidiaries to avoid simultaneity issues in our estimation.

[8] The full list of subsidiaries is available upon request.

[9] E.g., Deutsche Bank has over 5000 subsidiaries at the time of selection but only 18 fit our criteria for size, bank type and location abroad.

2.3.2 Descriptive Statistics

Table 1 presents the descriptive statistics of some of the main variables in our regression analysis.[10] In terms of loan growth, we notice that the average rate in the subsidiary sample is more than 4 percentage points higher than the average loan growth rate in the parent sample. However, the volatility in loan growth is twice higher in the former sample. Overall, subsidiaries are smaller than parents, but are more profitable, better capitalized and possess more liquid asset relative to total assets. Also, foreign subsidiaries allot more than 50% more funds than parents to provisions against bad loans. We notice a similar pattern when we consider internally generated funds: Foreign subsidiaries tend to generate twice higher net income to total loans than their parents. The full set of regression variables and their descriptions is provided in Table 2.

Table 1 Descriptive Statistics

Variable		*Parents*	*Subsidiaries*
Loan Growth Rate	Mean	14.33%	18.72%
	Standard Deviation	24.25%	44.99%
	Observations	870	2791
Size	Mean	11.77	7.70
	Standard Deviation	1.49	1.89
	Observations	870	2791
Profitability	Mean	0.91%	1.56%
	Standard Deviation	1.27%	2.51%
	Observations	860	2791
Riskiness	Mean	0.89%	1.31%
	Standard Deviation	1.11%	2.45%
	Observations	843	2791
Capitalization	Mean	6.36%	12.62%
	Standard Deviation	3.03%	9.74%
	Observations	870	2791
Liquidity	Mean	22.10%	27.86%
	Standard Deviation	12.96%	20.68%
	Observations	870	2791
Internally Generated Funds	Mean	1.80%	3.50%
	Standard Deviation	3.37%	7.51%
	Observations	860	2791

Notes: This table presents the descriptive statistics of the dependent variable and the bank control variables in our regression analysis. The sample comprises 375 foreign subsidiaries of 84 OECD parent banks in the period 1997-2012. Not all data for parents are available, therefore the number of observations for some of the variables below is lower than 870. These variables are not used in the regression analysis, as it is at the subsidiary level, and the averages are presented for the sake of approximate comparison only.

[10] Not all data for parents are available, therefore the number of observations for some of the variables is lower than 870. These variables are not used in the regression analysis, as it is at the subsidiary level, and the averages are presented for the sake of approximate comparison only.

Table 2 Regression Variables

Variable name	*Description*	*Data source*
Loan Growth Rate$_i$	Growth of total subsidiary loans	Bankscope
Size$_i$	Natural logarithm of total subsidiary assets	Bankscope
Profitability$_i$	Ratio of subsidiary profits to total earning assets	Bankscope
Riskiness$_i$	Ratio of subsidiary loan-loss provisions to total loans	Bankscope
Capitalization$_i$	Ratio of subsidiary equity to total assets	Bankscope
Liquidity$_i$	Ratio of subsidiary liquid assets (cash, trading securities and interbank lending of maturities less than three months) to total assets	Bankscope
Internally Generated Funds$_i$	Ratio of subsidiary net income at time t to total loans at time t-1	Bankscope
Parent Capitalization$_j$	Ratio of parent equity to total assets	Bankscope
Parent Wholesale Funding$_j$	Total parent liabilities minus equity and deposits	Bankscope
Parent Reliance on Wholesale Funding$_j$	Dummy variable that takes the value of 1 if the wholesale funding to total liabilities of the parent bank is above 90%, and 0 otherwise	Bankscope
Subsidiary Importance as a Funding Source	Ratio of total liabilities minus total customer deposits to total liabilities at the subsidiary level	Bankscope
Subsidiary Importance as an Investment Income Source	Ratio of net subsidiary loans to total subsidiary assets	Bankscope
Gross Domestic Product Growth$_k$	Annual GDP growth in subsidiary country	Datastream, World Bank's World Development Indicators
Inflation$_k$	Annual inflation in subsidiary country	Datastream, World Bank's World Development Indicators
Unemployment$_k$	End-of-year unemployment in subsidiary country	Datastream, World Bank's World Development Indicators

Notes: This table presents a description of the regression variables and data sources. All relevant balance sheet variables are converted to U.S. dollars for an easier interpretation of the results.

2.4 Estimation of Solvency and Wholesale Shocks

In estimating the solvency and wholesale funding shocks to parents, we adopt and extend the methodology by DeYoung et al. (2017). To this end, we use a partial capital adjustment model to estimate the banks' internal capital ratio targets in order to identify the parent solvency shocks. Following this model, every bank has a target capital ratio that is a function of observable characteristics:

$$K_{i,t}^{*} = \beta \cdot X_{i,t-1}, \tag{2}$$

with $K_{i,t}^{*}$ being the bank i's capital ratio in period t, while $X_{i,t-1}$ is a vector of observable determinants of the capital ratio, such as parent size, average return on assets, whether the bank is public and whether it is a global systemically important bank. β is a vector of coefficients.

In extreme situations, banks may deviate from their target capital ratios, which results in costly capital adjustments. During this adjustment process, banks close a constant proportion λ of the gap between their actual capital K and K^* in each time period:

$$K_{i,t} - K_{i,t-1} = \lambda \cdot \left(K_{i,t}^{*} - K_{i,t-1}\right) + \epsilon_{i,t}, \tag{3}$$

where λ is the aforementioned adjustment speed. A value of $0 < \lambda < 1$ reflects the partial adjustment towards K^* between *t-1* and *t*. Substituting for the respective values in both equations and rearranging leads to:

$$K_{i,t} - K_{i,t-1} = \lambda \cdot \left(K_{i,t}^{*} - K_{i,t-1}\right) + \epsilon_{i,t}, \tag{4}$$

where λ is the aforementioned adjustment speed. A value of $0 < \lambda < 1$ reflects the partial adjustment towards K^* between *t-1* and *t*. Substituting for the respective values in both equations and rearranging leads to:

$$K_{i,t} = \lambda\beta \cdot X_{i,t-1} + (1-\lambda) \cdot K_{i,t-1} + \epsilon_{i,t}. \tag{5}$$

Recovering $\hat{\lambda}$ from $\left(\widehat{1-\lambda}\right)$ and subsequently $\hat{\beta}$ from $\left(\widehat{\lambda\beta}\right)$, we calculate the target ratio $K_{i,t}^{*}$ for bank i in period t. Since the equation contains a lagged dependent variable, DeYoung et al. (2017) suggest using the dynamic generalized method of moments by Blundell and Bond (1998).

To identify exogenous shocks, we follow DeYoung et al. (2017) and set a number of conditions, such as a decrease in the equity capital ratio $\left(\Delta K_{i,t-1}\right)$ of a bank that is already below its target capital ratio $GAPCAP_{i,t-2} = K_{i,t-2}^{*} - K_{i,t-2} > 0$ that leads to an *unexpected* even larger deviation from its internal target (assuming that the goal of the bank is to return to its target ratio as soon as possible – already in the subsequent period). We also require a drop in equity by at least 5%. As banks usually expect profits in the next year in their annual forecasts, a year-on-year drop in equity in the unconsolidated parent reports by 5% represents a substantial undershooting of these forecasts.

$$Solvency\ Shock = \begin{cases} 1,\ if \quad K_{\{i,t-2\}} < K_{\{i,t-2\}}^{*} \quad and \quad \Delta K_{\{i,t-1\}}^{*} < 0 \\ \quad and \quad \Delta\, GAPCAP_{\{i,t-1\}} > 0 \quad and \quad g_{\{equity,t-1\}} < -0.05 \\ 0,\ otherwise \end{cases} \tag{6}$$

We extend the methodology of DeYoung et al. (2017) to applications for wholesale funding by analogously assuming that the bank targets a specific wholesale funding to total liabilities ratio WF*. We substitute WF and WF* for K and K* in the procedure above and set the following conditions for wholesale funding shocks:

$$Wholesale\,Shock = \begin{cases} 1,\ if \quad \mathrm{WF}_{\{i,t-2\}} < \mathrm{WF}^{*}_{\{i,t-2\}} \quad and \quad \Delta\mathrm{WF}^{*}_{\{i,t-1\}} < 0 \\ \quad and \quad \Delta\, GAPWF_{\{i,t-1\}} > 0 \quad and \quad g_{\{\text{wholesale funding},t-1\}} < -0.05 \\ 0,\ otherwise \end{cases} \tag{7}$$

The results for the respective estimations are summarized in Table 3. Model (1) presents the estimated coefficients used to derive the solvency shocks, while Model (2) presents the coefficients used to identify the wholesale funding shocks. We observe a quicker adjustment to capital targets than for wholesale funding targets. We use the full data set of parent-year observations that we have at our disposal, which leads to a higher observation count than in Table 1.

Table 3 Partial Adjustment Model for Capital and Wholesale Funding

	(1)	*(2)*
Capitalization	0.6944***	
	(0.071)	
Wholesale Funding Ratio		0.7798***
		(0.035)
Size	0.0023***	0.0080***
	(0.001)	(0.002)
ROAA	-0.0013	0.0046*
	(0.001)	(0.003)
GSIB	-0.0120	-0.0023
	(0.008)	(0.012)
Public	-0.0021	0.0137
	(0.008)	(0.016)
Observations	1830	1830
λ	0.3056	0.2201
Average Targets	0.0733	0.4465

Notes: Parameters for a partial adjustment model estimated for an unbalanced panel for global parent banks between 1997 and 2002. Model (1) presents the estimated coefficients used to derive the solvency shocks, while Model (2) presents the coefficients used to identify the wholesale funding shocks. Statistical significance at the 1%, 5% and 10% levels is denoted by ***, **, and *, respectively.

Figures A4 and A5 present the number of the respective shocks for each year in our sample. Panel a) of Figure A4 (Figure A5) shows the solvency (wholesale funding) shocks per year in the *parent* sample. In total, there are 101 (174) solvency (wholesale funding) shocks in the parent dataset in the sample period. Panel b) presents the solvency (wholesale funding) shocks per year that are relevant for the sample of 375 subsidiaries after merging both datasets. Since a parent usually has more than one subsidiary, this results in a total of 323 (577) parent solvency (wholesale funding) shocks in our merged dataset. An important conclusion from observing the figures is that the shocks identified using our definitions are well-spread throughout the period and do no cluster exclusively around the global financial crisis of 2008-2009. In our robustness checks section, we show that our main results are not affected if we exclude these years.

The correlation between the solvency and wholesale shocks is 0.18 in the parent sample and 0.12 in the subsidiary sample, which means that the shocks are fairly uncorrelated, and banks are usually not hit by both shocks simultaneously. This could be seen in Figure A6, where we present the number of simultaneous solvency and wholesale shocks in our parent and subsidiary samples. Panel a) shows the simultaneous shocks per year in the parent sample. There are 40 simultaneous shocks in the parent dataset in the sample period. Panel b) presents the simultaneous shocks per year that are relevant for the sample of 375 subsidiaries after merging both datasets. In total, we have 110 simultaneous shocks in our subsidiary sample.

3. Results

In this section, we present the results from our empirical analysis. We study in detail the possible sources of the difference in transmission of shocks along several dimensions. First, we investigate whether the transmission depends on the specific characteristics of the parent bank – the level of its capitalization and its reliance on wholesale funding. Second, we analyze whether the transmission is affected by the position of the subsidiary in the business strategy of the parent: Whether the subsidiary is a source of depository funding or of investment income.

3.1 Capitalization, Reliance on Wholesale Funding and Shock Transmission

Model (1) of Table 4 presents the results of fixed effects estimation with both types of shocks and without interactions. The results show that solvency shocks to parents reduce subsidiary lending, while we cannot find strong evidence that wholesale shocks have a significant impact. These findings suggest that, overall, solvency shocks to parents are more important than wholesale shocks for the lending expansion of subsidiaries, which provides evidence for cross-border capital transfers after a solvency shock. This is in line with the previous literature (see, e.g., Krause & Giasante 2012 and Popov & Udell 2012), where subsidiaries are shown to react to solvency shocks to their parents by reducing their lending. However, we do not observe a negative impact of wholesale shocks one year after the shock. This differs from the findings documented in a number of studies (see, e.g., Ivashina & Scharfstein 2010 and Cetorelli & Goldberg 2012*b*). A possible explanation for this result is that wholesale shocks may transmit only to foreign subsidiaries of parents that may rely more on wholesale funding, which is a less stable strategy than funding primarily through deposits (see, e.g., Brunnermeier 2009 and Brunnermeier & Pedersen 2009). We find empirical support for that in this section.

In Models (2) and (3), we analyze whether parent banks with low capitalization have a higher impact on the lending of their subsidiaries. For this purpose, we introduce the dummy variables “Below 4%” and “Below 5%” that take the value of 1 for parent banks with capital-to-total-assets ratios below 4 and 5 percent, respectively, and 0 otherwise.[11] In order to avoid simultaneity, we lag the new variables with one period. Although the results presented in Model (2) and (3) of Table 4 reveal no statistically significant additional effect of solvency shocks for undercapitalized parents, the cumulative effect with the coefficient of the standalone solvency shock dummy is highly significant. We also document a switch in sign between 4% and 5%, indicating that foreign subsidiaries of highly levered banks indeed reduce their lending after a solvency shock to the parent. Our findings support the results of Giannetti & Laeven (2012), who document a larger decrease in foreign loans for undercapitalized parents after a shock to a bank's net wealth.

We proceed with an examination of whether subsidiaries of parent banks that rely heavily on wholesale funding are more susceptible to shocks to their parents. We base this analysis on the conjecture that the higher the reliance on unstable non-deposit funding, the higher the likelihood that a parent bank could be hit by a funding shock. This could lead to abrupt and severe shortages of liquidity that the parent bank would need to compensate almost immediately and therefore such banks are theoretically more likely to transmit the shock to their subsidiaries (see, e.g., De Haas & van Lelyveld 2014 and Dagher & Kazimov 2015). To test these hypotheses, we introduce a new variable, "Reliance-on-Wholesale", that takes the value of 1 if the wholesale funding to total liabilities of the parent bank is 90%, and 0 otherwise.[12] The lagged variable and its interaction with the wholesale shock is included in the model now.

Model (4) in Table 4 presents the estimation results. We find that wholesale shocks do transmit across borders for parent banks that rely primarily on non-deposit funding (Models (4)): The coefficient of the interaction term is highly statistically and economically significant.[13] This supports the findings of Ivashina & Scharfstein (2010), Cornett et al. (2011), Dagher & Kazimov (2015) and De Haas & van Lelyveld (2014) that banks that rely on wholesale funding reduce their lending after an adverse shock by more, compared to banks that rely on retail deposits. And while these studies concentrate on the U.S. market, we find that heavy reliance on wholesale funding is a major channel for transmission of shocks *across borders*.

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[11] There is no single capital ratio applied by national regulators. The banks in countries that still follow the Basel II accord are required to maintain a Tier 1 ratio of capital to risk-weighted assets at a level no lower than 4%, while Basel III stipulates the minimum capital adequacy ratio to be at least 8%. Furthermore, the latter accord introduces different additional capital buffers. During the global financial crisis, it became evident that global banks take advantage of the definitions of the risk weights and are extremely overlevered despite officially fulfilling their capital adequacy requirements. For instance, Deutsche Bank and Société Générale were below 4% using our definition throughout our sample period, while at the same time fulfilling their capital adequacy requirement of 8%. We believe that our simple but conservative definition reflects better the capitalization of global banks.

[12] These values correspond approximately to the 97.5th percentiles of the wholesale funding-to-total-liabilities distribution.

[13] In an unreported robustness check, we set the threshold at the 95th percentile of the wholesale-funding-to-total-liabilities distribution. The results remain qualitatively unaffected. Moving the threshold closer to the median leads to a loss of significance of the coefficient of the interaction, which further strengthens the argument that the wholesale shocks in our sample transmit only for parents that rely extensively on wholesale funding.

Table 4 Shock Transmission Channels

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Solvency Shock $_{j,t-1}$	-0.0571** (0.026)	-0.0498* (0.029)	-0.0718*** (0.024)	-0.0570** (0.026)	-0.1773*** (0.059)	-0.1519*** (0.046)
Wholesale Shock $_{j,t-1}$	0.0226 (0.028)	0.0227 (0.027)	0.0229 (0.028)	0.0286 (0.028)	0.1052 (0.066)	0.1238* (0.065)
Below 4% $_{j,t-1}$		0.0221 (0.030)				
Below 4% $_{j,t-1}$ **Solvency Shock* $_{j,t-1}$		-0.0454 (0.047)				
Below 5% $_{j,t-1}$			0.0038 (0.024)			
Below 5% $_{j,t-1}$ **Solvency Shock* $_{j,t-1}$			0.0254 (0.050)			
Reliance-on-Wholesale $_{j,t-1}$				0.0238 (0.042)		
Reliance-on-Wholesale $_{j,t-1}$ **Wholesale Shock* $_{j,t-1}$				-0.3837*** (0.142)		
FundingMarket$_{i,j,k,t-1}$					0.1528 (0.097)	0.1095** (0.054)
InvestmentMarket $_{i,j,k,t-1}$					-0.0098*** (0.002)	-0.0014 (0.001)
FundingMarket$_{i,j,k,t-1}$ **SolvencyShock*$_{j,t-1}$					-0.1091 (0.067)	-0.1824*** (0.061)
FundingMarket$_{i,j,k,t-1}$ **WholesaleShock*$_{j,t-1}$					-0.0314 (0.078)	-0.0523 (0.074)
InvestmentMarket$_{i,j,k,t-1}$ **SolvencyShock*$_{j,t-1}$					0.0033*** (0.001)	0.0031*** (0.001)
InvestmentMarket$_{i,j,k,t-1}$ **WholesaleShock*$_{j,t-1}$					-0.0016 (0.001)	-0.0017 (0.001)
Subsidiary FE	Yes	Yes	Yes	Yes	Yes	No
Parent FE	No	No	No	No	No	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro Variables	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2791	2791	2791	2791	2775	2775
R-squared	0.233	0.235	0.235	0.236	0.265	0.227
Adjusted R-squared	0.226	0.227	0.227	0.228	0.256	0.194

Notes: This table reports the results from the estimation of Equation 1 with interactions at the subsidiary bank level. The sample for models (1)-(4) comprises 375 foreign subsidiaries of 84 OECD parent banks in the period 1997-2012. The sample for models (5) comprises 324 foreign subsidiaries of 75 OECD parent banks in the period 1997-2012. The dependent variable is the growth rate of subsidiary loans. "Solvency Shockj" and "Wholesale Shockj" are dummy variables that take the value of 1 if a parent bank j is hit by a solvency and wholesale shock, respectively, and 0 otherwise. "Below 5%j", "Reliance-on-Wholesalej" are at the parent j level. "Fundingi", "Investmenti" are at the subsidiary i level. The bank fixed effects are at the subsidiary level. The numbers in parentheses are standard errors. All standard errors are clustered at the parent level. Statistical significance at the 1%, 5% and 10% levels is denoted by ***, **, and *, respectively.

3.2 Subsidiary Importance and Shock Transmission

In this section, we analyze how the importance of the subsidiary within the multinational conglomerate affects the transmission of shocks. Cetorelli & Goldberg (2012*b*) find that after a negative liquidity shock, a parent's tendency to extract funds from their subsidiaries depends on their place in the parent's funding and investment strategy. The authors find evidence for what they call a "locational pecking order": Subsidiaries in locations that are an important source of investment revenue are protected during adverse liquidity shocks, while subsidiaries in markets that are used as a funding source appear to provide buffers to counter the shock at the parent level. As a measure of the importance of the subsidiary as a funding source, we use the ratio of total liabilities minus total customer deposits to total liabilities of the subsidiary. The measure of the importance of the subsidiary as an investment revenue source is the ratio of net loans to total assets of the subsidiary.[14] The higher the ratio of subsidiary loans to assets, the more the subsidiary is invested in a foreign market and the more the global bank relies on the profitability of these investments. The larger the ratio of total subsidiary liabilities net of deposits to total subsidiary liabilities, the more the parent uses the subsidiary to borrow from the local markets. We include the one-period lag of the variables and their interactions with both solvency and wholesale shocks.

Model (5) in Table 4 presents the results from the regression with subsidiary fixed effects. We find evidence for a locational pecking order in the transmission of solvency shocks across borders: subsidiary banks used as a funding operation see an economically significant reduction in their lending after a solvency shock (with p-value at 10.5%, the coefficient is marginally statistically insignificant at the 10% level), while subsidiaries that provide higher investment revenue maintain a positive loan growth. In Model (6), we employ within-parent-bank variation by including fixed effects at the parent level. This set-up is in the spirit of Khwaja & Mian (2008) and allows us to compare the effect of parent shocks on the lending of subsidiaries within the same conglomerate. Using within-parent variation strengthens our results, both statistically and economically. If wholesale funding to total funding increases by one standard deviation (30 percentage points), a subsidiary in a funding market decreases its lending by more than 5.4 percentage points (up from a 3.27 percentage points reduction using within-variation only), while if the ratio of net loans to total assets increases by one standard deviation (20 percentage points), a subsidiary in an investment market sees an increase of their lending growth by almost 0.6 percentage

[14] We stay as close as possible to the definitions of the respective variables in Cetorelli & Goldberg (2012b), however, they have access to more granular data that also covers branches: They define $CoreFunding_{ijt}$ as $Local\ liabilities_{ijt}$ to $Total\ liabilities_{ijt}$ at the level of foreign affiliate i of parent j while $CoreInvestment_{ijt}$ is defined as total subsidiary claims to total parent claims. We do not have access to local liabilities for foreign affiliates in Bankscope and in our version, we define the respective measures as the ratio of total liabilities minus total customer deposits to total liabilities at the subsidiary level (FundingMarket) and ratio of net subsidiary loans to total subsidiary assets (InvestmentMarket). Cetorelli & Goldberg (2012b) define local liabilities as local borrowing and therefore we exclude deposits in our version. We also use only subsidiary data for total assets (and not total assets of the parent), because we use unconsolidated data.

points.[15] The positive coefficient of the interaction term for investment markets means that the higher the importance of a foreign market as an investment source, the lower the reduction in lending of subsidiaries operating there after a parent solvency shock. We use the continuous variable here and therefore the comparison is to the hypothetical case when subsidiaries do not lend at all. The average ratio is 53%, therefore, at the mean the total effect of the solvency shock is approximately zero.

These results complement the findings of Cetorelli & Goldberg (2012*b*), who conclude that strategic importance plays a major role in the intensity of the transmission of *liquidity* shocks across borders, based on data for U.S. banks and their foreign affiliates. We find that at the global level the effect is stronger if the source is a shock to the equity of the parent. Since Cetorelli & Goldberg (2012*b*) study only U.S. parent banks, and these prefer to enter foreign markets with branches and not subsidiaries, our findings are much stronger and general due to the looser nature of the parent-subsidiary relationship compared to the relationship between parents and branches.

3.3 Robustness and Further Findings

In this section, we perform a number of robustness checks and assess the reaction of subsidiary lending to positive shocks to parents.

In Table 5, we provide results for different estimation methods and samples. Since the reaction to parent wholesale shocks may be affected or captured by subsidiary liquidity, in Model (1) we drop that variable from our baseline model. The intuition remains unchanged: On average, parent wholesale shocks do not affect subsidiary lending in following years. In Model (2), we add parent controls to the sample in addition to the parent shock variables and do not find quantitatively and qualitatively different results to our baseline outcomes. Our results may also be affected by the subprime crisis period of 2008-09 and therefore, as a robustness check, we exclude this period in Model (3). This as well has practically no effect on our baseline results. In Model (4), we use within-parent variation for identification, in the spirit of Khwaja and Mian (2008) and the results remain unchanged. In Model (5), we follow De Haas & van Lelyveld (2010) and apply dynamic panel estimation within a GMM framework (Arellano & Bond 1991 and Arellano and Bover 1995). The main results are confirmed.

Since an increase in deposits may substitute a drop in wholesale funding, the reason why we do not observe an effect due to the latter might be simply because of a change in the funding source. The average bank in our sample splits its funding equally between deposits and wholesale funding and therefore, in Model (1) in Table 6, we redefine the wholesale shock dummy by setting it to zero when a wholesale funding shock occurs at the same time as an increase of deposits by at least 5%. This does not change the coefficients and their statistical significance substantially. A reduction in parent equity may be accompanied by a reduction in parent assets (e.g., through selling or outsourcing of parts of the headquarters' operations), and hence a drop in equity may not reflect a decline in the parent's solvency position. Therefore,

[15] Normally, we would expect the ratio of net loans to total assets to be below 1. However, the ratio ranges from -.13 to 99.43 in our sample, hence the value of the original ratio is multiplied by 100 in Bankscope, which also affects the interpretation of the economic effects.

in Model (2) we reduce the sample to cases where we have observed only a positive change in total parent assets in the previous period. The baseline results are qualitatively unchanged.

We may also be interested in whether the transmission of shocks is symmetric: Whether positive solvency or wholesale shocks *increase* the lending of foreign subsidiaries. Models (3) and (4) in Table 6 present the results from these estimations, by setting both shocks at their 90^{th} (Model (3)) and 95^{th} (Model (4)) distribution percentiles, respectively. Interestingly, we find that positive solvency shocks do not have a significant effect on subsidiary lending, while positive wholesale shocks generally increase lending. In unreported regressions, we find that the increase of lending is mainly for subsidiaries with slow past lending growth. These findings suggest that parent banks channel any excess liquidity to increase their presence in markets where their lending has been lagging.

Table 5 Robustness Checks: Estimation Models and Samples

	No Liquidity	***Parent Controls***	***No 2008-2009***	***Parent FE***	***GMM Estimation***
	(1)	***(2)***	***(3)***	***(4)***	***(5)***
Solvency Shock $_{j,t-1}$	-0.0630**	-0.0539**	-0.0712**	-0.0668***	-0.0554***
	(0.026)	(0.027)	(0.032)	(0.025)	(0.021)
Wholesale Shock $_{j,t-1}$	0.0252	0.0219	0.0401	0.0227	0.0189
	(0.027)	(0.024)	(0.030)	(0.027)	(0.024)
Lending Growth $_{i,t-1}$					0.1235***
					(0.025)
Subsidiary Fixed Effects	Yes	No	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Parent Fixed Effects	No	No	No	Yes	No
Macro Controls	Yes	Yes	Yes	Yes	Yes
Subsidiary Controls	Yes	Yes	Yes	Yes	Yes
Parent Controls	No	Yes	No	No	No
Observations	2791	2791	2235	2791	2762
R-squared	0.203	0.237	0.194	0.221	
Adjusted R-squared	0.196	0.228	0.186	0.189	
No. Instruments					311
AB AR(1) (p-value)					0.000
AB AR(2) (p-value)					0.567
Hansen J (p-value)					0.986

Notes: This table reports the results at the subsidiary bank level of positive and negative solvency and wholesale shocks. Model (1) exclude subsidiary liquidity from the bank controls. Model (2) adds parent controls to the baseline regression. Model (3) excludes the global financial crisis of 2008-2009 from the sample period. Model (4) uses within-parent variation. Model (5) presents GMM estimation of our baseline regression. The full sample comprises 375 foreign subsidiaries of 84 OECD parent banks in the period 1997-2012. The dependent variable is the growth rate of subsidiary loans. The bank controls include: Size, Profitability, Riskiness, Capitalization„ Liquidity and Internally Generated Funds and are at the subsidiary i level. They are lagged with one period. The "Macro Controls" vector of variables contain Gross Domestic Product growth, inflation and unemployment in the host country k of the respective subsidiary. All variables are defined in Table 2 and in the main text. The numbers in parentheses are standard errors. All standard errors are clustered at the parent level. Statistical significance at the 1%, 5% and 10% levels is denoted by ***, **, and *, respectively.

Table 6 Robustness Checks: Different Shock Definitions

	5%-Increase in Deposits	*Positive Change in Assets*	*Positive Shocks (90%-Tail)*	*Positive Shocks (95%-Tail)*
	(1)	*(2)*	*(3)*	*(4)*
Solvency Shockj,t−1	-0.0571** (0.028)	-0.0737* (0.041)		
Wholesale Shock$_j$,t−1	0.0226 (0.421)	0.0242 (0.038)		
Positive Solvency Shockj,t−1 (90%-Tail)			-0.0382 (0.027)	
Positive Wholesale Shockj,t−1 (90%-Tail)			0.0523** (0.026)	
Positive Solvency Shockj,t−1 (95%-Tail)				-0.0281 (0.052)
Positive Wholesale Shockj,t−1 (95%-Tail)				0.0790 (0.056)
Bank Controls	Yes	Yes	Yes	Yes
Subsidiary FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Observations	2791	2116	2791	2791
R-squared	0.235	0.214	0.235	0.234
Adjusted R-squared	0.228	0.205	0.228	0.227

Notes: This table reports the results at the subsidiary bank level of positive and negative solvency and wholesale shocks. Model (1) is our baseline regression. Model (2) constrains the sample to cases with positive change in parent assets. Model (3) sets the solvency and wholesale shocks at the 90-% tail (right tail) of equity and wholesale funding, respectively. Model (4) sets the solvency and wholesale shocks at the 95-% tail (right tail) of equity and wholesale funding, respectively. The full sample comprises 375 foreign subsidiaries of 84 OECD parent banks in the period 1997-2012. The dependent variable is the growth rate of subsidiary loans. The bank controls include: Size, Profitability, Riskiness, Capitalization,, Liquidity and Internally Generated Funds and are at the subsidiary i level. They are lagged with one period. The "Macro Controls" vector of variables contain Gross Domestic Product growth, inflation and unemployment in the host country k of the respective subsidiary. All variables are defined in Table 2 and in the main text. The bank fixed effects are at the subsidiary level. The numbers in parentheses are standard errors. All standard errors are clustered at the parent level. Statistical significance at the 1%, 5% and 10% levels is denoted by ***, **, and *, respectively.

In unreported regressions, we perform a number of additional robustness checks to verify the validity of our results.[16] First, we vary the severity of the shock by redefining our shock criteria in Section 2.4 to shocks above 10% and 15%. The intuition remains the same and follows monotonic path – the larger the solvency shock to parents, the higher the reduction in subsidiary lending. We do not find significant effect on subsidiary lending for larger parent wholesale shocks. Second, we check whether the size of the non-traditional business of the parent, proxied by the ratio of non-interest operating income to total operating income, affects the transmission of shocks and find that not to be the case. Third, since rolling over bad loans by subsidiary banks can artificially increase loan growth, we check whether evergreening affects the transmission of shocks, by regressing non-performing loans to total loans at the subsidiary level to solvency shocks up to the fourth lag. We

[16] The results are available upon request.

cannot find evidence for this phenomenon in our foreign subsidiary sample. Furthermore, to alleviate concerns that our results are driven by larger subsidiaries only (which may even lead to concerns about reverse causality), we exclude subsidiaries with assets that are 10% of the assets of the parent banks (about 10% of the subsidiary sample). The main results remain unchanged.

4. Conclusions

The internal capital markets within international banking conglomerates lead to a reduction of information asymmetries and provide a liquidity source in cases when outside funding is scarce or unavailable. They, however, could also be channels for transmission of adverse shocks. In this paper, we analyze the drivers of the transmission of negative shocks from parent banks to their foreign subsidiaries.

In our analysis, we recognize that not only the negative shocks are important as such, but also is their type, because banks use different approaches to address different types of shocks. We use this observation to analyze whether solvency and wholesale shocks to parent banks are systematically related to a reduction in subsidiary lending. Our findings suggest that solvency shocks to parents generally have larger effect on subsidiary lending than wholesale shocks. Transmission of wholesale shock does occur and affects primarily foreign subsidiaries of parent banks that rely heavily on wholesale funding.

Further, the transmission of shocks depends on the relative importance of the subsidiary within the parent business strategy: Subsidiaries that are traditionally used as a funding source by the parent tend to be affected by solvency shocks, while subsidiaries that provide investment income appear to be protected by the parent. Cetorelli & Goldberg (2012*b*) find this effect for U.S. banks hit by liquidity shocks and call it a "locational pecking order". We find evidence for this phenomenon on a global scale.

Despite covering a sample period that predates the most recent banking regulation initiatives, the results in the current paper have important theoretical and policy implications and add to our understanding of the transmission of solvency and wholesale shocks across borders. To this end, we would like to touch upon three of the recent regulatory initiatives: Ring-fencing and the tightening of capital and liquidity regulation.

First, we are not convinced that ring-fencing will completely prevent contagion between countries through the internal capital markets of global banks. Ring-fencing has many applications and initially was related to separating retail from investment banking. In our context, we focus on the retail banking portion of the business of global banks, since we have only subsidiaries that are commercial banks. The applications of ring-fencing have recently been extended to international operations of global banks. However, our observations are that the goal is not to prevent contagion *per se*, but to protect the home country retail business of global banks. In that sense, the contagion addressed by ring-fencing regulation is not in the direction that we look at in the current paper. The threat from the latter is still present and not adequately addressed by global regulation.

Second, while capital requirements have been tightened recently, especially for the global systemically important banks in our sample, these buffers may still be insufficient in case of a large solvency shock to parents. There still exist ample opportunities that allow a transfer of capital in the direction of the headquarters. For instance, foreign subsidiaries continue to be overcapitalized, especially in the CEE region, and have sufficient reserves for dividend payouts to their parents, which is a regular practice during global crises, such as the crisis in 2008-2009, the sovereign debt crisis or the current COVID-19 pandemic. This practice reduces the balance sheet of foreign subsidiaries and may slow down or halt their lending. Even after three decades of improving the Basel Accords, regulators still had to impose *ad hoc* moratoriums on dividend payouts to prevent contagion during the global pandemic of 2020-2021.

Regarding the recent tightening of liquidity regulation under Basel III, we do believe that it is an important addition to the comprehensive reforms after the global financial crisis. We find that subsidiaries of parent banks that rely primarily on wholesale funding tend to reduce their lending relatively more than subsidiaries of parents that fund themselves primarily through deposits. Therefore, the introduction of targeted measures encouraging more stable funding sources, such as the Net Stable Funding Ratio, are crucial for the stability of the global banking system. Whether an improvement of this metric across the board will prevent cross-boarder transmission of shocks is an empirical question that is an interesting subject for future research. We believe that our setup is suitable to evaluate that particular policy.

Overall, ring-fencing and higher capital and liquidity requirements may increase parent capital and decrease risk-taking incentives *ex ante*, but we are not convinced that these rules are time-consistent. Parent banks still have numerous channels to export solvency and wholesale shocks abroad (intentionally or not) and contagion through internal capital markets is still an extremely important issue that host country regulators should be conscious about.

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