International Transmission of Liquidity Shocks Between Parent Banks and Their Affiliates: The case of Polish banking sector

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Abstract

In this study we analyze how funding liquidity shocks affecting large international banks were transmitted to Polish subsidiaries and branches of these banks in recent years. We investigate differences in the effects of liquidity shocks on banks owned by both Polish and foreign institutions. All Polish banks reacted to liquidity shocks after Lehman Brothers failure; however, only Polish subsidiaries and branches of foreign parent banks adjusted their funding after liquidity shocks had taken place during the sovereign debt crisis of the Eurozone. Mortgage lending in foreign currencies was also affected by liquidity shocks during the crisis. Our results suggest that the intragroup links between banking institutions can serve both as an important channel for international transmission of liquidity shocks and as a stabilizing mechanism during liquidity crises.

Keywords: liquidity shocks, international transmission, parent banks, affiliate banks, Poland

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1. Introduction

In this study we investigate how funding problems within the banking sector can be transmitted across borders between parent banks and their affiliates. In contrast to earlier studies showing the perspectives of the home country where parent institutions are located and the spreading of shocks to their affiliates abroad, we provide evidence on the transmission of funding shocks from the foreign parent banks to their subsidiaries and branches located in one emerging market (i.e., we present the 'host country' perspective) (e.g., Cetorelli and Goldberg, 2012a and 2012b, and citations therein).

Specifically, we analyze how liquidity shocks in the balance sheets of foreign parent banks can affect their affiliate institutions located in Poland. We observe the way in which these shocks influence the supply of funding of parent banks to their Polish affiliates and how the lending activities of Polish banks are disturbed as a result. In addition, we examine how liquidity shocks in the Polish banking sector affect the balance sheets of local banks and verify whether these local banks are able to gain access to funding from their foreign parent institutions during turbulent periods. In fact, the two most harmful liquidity shocks in the Polish capital market in recent years were transmitted from more developed markets during the global financial crisis in 2008 and during the sovereign debt crisis in the Eurozone in 2011. It is interesting to analyze whether the high funding needs of affiliate banks in the flourishing market dominate over parent institution's reluctance to lend during liquidity squeezes.

Since the late 1990s Poland has been playing the role of a host country for multiple banks from a number of countries in Europe and from the US (e.g., Pawłowska, 2012, Kozak, 2013). The entire system contained about 70 banks (excluding relatively small cooperative banks). At the end of 2008, subsidiaries and (rather small) branches of foreign institutions constituted slightly more than 65% of all the banking assets in Poland. The parent financial institutions of Polish banks were located mostly in Western Europe (Austria, Belgium, Greece, Germany, France, Italy, Netherlands, Portugal, Spain) and in the United States (cf., Figure 4).

At the end of 2008 a crisis struck Poland in the form of a vast and sudden depreciation of the local currency (by more than 30% against euro). The foreign

exchange rate depreciation quickly increased the value of assets (e.g. foreign currency loans). Only a portion of a large portfolio of foreign currency loans was financed by liabilities in foreign currencies and the resulting open foreign exchange position on the balance sheets of Polish banks was hedged with foreign exchange derivatives (FX swaps and CIRS). After the depreciation of the local currency banks had to acquire more liquid assets to continue these hedging transactions, which indirectly increased their funding needs. Moreover, the interbank market froze and deposit transactions nearly vanished. This first wave of shocks caused temporary funding problems of Polish banks; however, the parent institutions in the US and in Europe suffered from funding problems even earlier. Nonetheless, the parent institutions were able to increase funding to several Polish subsidiaries and branches in such a way that Polish banks were able to continue lending to the nonfinancial sectors in Poland.

There are strong arguments in favor of the hypothesis that the problems of foreign parent institutions were effectively transmitted to the Polish banking sector during periods of financial crisis. In fact, some acquisitions of subsidiaries and branches in the Polish market were forced by financial turbulence in the parent banks. The examples of this are the Allied Irish Bank's forced selling transaction of the fourth largest bank in Poland in 2011, the Greek EFG Eurgasias Group selling the fifteenth largest bank in 2012, the Belgian KBC group selling the seventh largest bank in Poland in 2012, and the American International Group's trading of a smaller bank in 2010. Some institutions came through the structural changes (e.g., the small branch of Commerzbank in Poland was forced to become part of the local BRE Bank – a large Commerzbank subsidiary). Others such as Portuguese BCP Millennium, considered withdrawing from the Polish market altogether, but finally managed to keep their profitable Polish subsidiary. Another important fact is that several prominent parent banks with Polish affiliates received financial assistance from the governments in the countries where their headquarters were located (cf., National Bank of Poland, 2009, p. 77 for the list of supported parent entities of Polish banks).

Several theoretical and empirical studies examine the impact of liquidity shocks on bank lending (e.g., Diamond and Rajan, 2001, Khwaja and Mian, 2008,

Cornett, McNutt, Strahan and Tehranian, 2011). Funding constraints in banks usually force these banks to limit lending to other sectors of the economy. An important source of funding for banks in global banking groups is intra-group lending (e.g., by parent banks to affiliate banks). Liquidity shocks in banks may force these banks to reduce lending to other banks in the group (e.g., Cetorelli and Goldberg, 2011, Popov and Udell, 2012, Jeon, Olivero and Wu, 2013). This effect of liquidity shocks is of special interest because it generates the channel of transmission of liquidity shocks between financial institutions. Moreover, if the affected banks are located in different countries, the cross-border channel of financial contagion may be activated. Conversely, the intra-group funding may act as a stabilizing mechanism during liquidity crises, when liquidity constrained banks are able to obtain substitute funding from parent institutions (e.g., Dinger, 2009, Navaretti, Calzolari, Pozzolo, and Levi, 2010, de Haas and van Lelyveld, 2010).

Our empirical results confirm the significance of the intragroup links between banking institutions that serve as a channel for transmission of liquidity shocks on the one hand and as an effective measure to contain these shocks on the other. All Polish banks reacted to the liquidity shocks after the failure of Lehman Brothers; however, the impact of liquidity shocks on funding during the sovereign debt crisis in the Eurozone was visible only in the group of Polish subsidiaries and branches of foreign parent banks. The liquidity shocks also affected mortgage lending in foreign currencies by Polish banks during the crisis.

To our best knowledge this study is the first to investigate the transmission of large liquidity shocks in 2008-2009 and 2011-2012 from banks in multiple countries to the banking sector in one emerging market. Focusing on one emerging market facilitates controlling the policies and economic performance of banks located in a single country. Any demand shocks are also rather homogenous across banks present in a particular country and their effect can be extracted.

We believe that choosing the perspective of a host country like Poland is an interesting approach because it allows us to compare the behavior of local banks dependent on their foreign parent institutions with the behavior of locally owned banks in order to identify funding shocks. Moreover, we are able to exploit differences in the transmission of liquidity shocks originating in parent banks

located in countries with different risk profiles (i.e., Greece, Ireland, Italy, Portugal and Spain on the one hand and Germany and the US on the other).

The Polish market serves as an ideal natural laboratory for our exercise because it contains a significant banking sector with assets worth 85% of the country's GDP (e.g., Polish Financial Supervision Authority, 2013). Multiple subsidiaries and branches of foreign credit institutions as well as locally owned banks are present within this market. Equally important is the fact that the recent global financial crisis was truly exogenous to the Polish financial sector and the Polish economy remained relatively resilient to the macroeconomic shocks from abroad (e.g., Poland was the only European Union country to enjoy positive economic growth throughout the entire crisis period; domestic shocks played a rather minor role in the period under investigation). The absence of large domestic economic shocks should increase the estimation precision of the link between the funding problems of parent banks and their Polish affiliates.

Another advantage of analyzing the Polish market is the relatively simple and traditional business models of Polish banks. Polish banks concentrate their activities on lending to local companies and households (housing and consumer loans) and their lending to foreign nonfinancial sectors is marginal. The funding of Polish banks came mostly in the form of deposits from local nonfinancial sectors and from the resident and nonresident financial institutions, depending on the funding strategy of banks. Other sources of funding (e.g., issuance of bonds or stocks) were relatively less popular and sporadic. Before the crisis the banking sector was developing rapidly and the flourishing economy attracted new banks to the market. In particular, the market for FX housing loans was booming throughout the years 2005 – 2008. Some local banks were using funding in the form of loans and deposits from their parent institutions to increase their stake in the lending market (cf., Figure 2). About 90% of the liabilities to foreign financial sectors were comprised of funds borrowed from the parent institutions.

In the remainder of the paper we present our methodology to analyze the effects of international liquidity shocks in Section 2. Section 3 includes a brief description of the data used in our analysis and we present our empirical results in Section 4. The final section presents our conclusions.

2. Methodology

Our strategy to assess how liquidity shocks in parent banks influence the supply of funding by parent banks to their Polish affiliates and how these shocks affect the lending activities of Polish banks follows the approach described by Cornett, McNutt, Strahan and Tehranian (2011), and Buch and Goldberg (2013). We select the set of variables describing changes in funding from parent banks to Polish affiliates and changes in lending by Polish affiliate banks, respectively. These variables are used as dependent variables in econometric regression models and are explained by the vector of control variables observed at time $t-1$:[1]

$$\mathbf{x}_{i,t-1} = \left(\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \quad \frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \quad \frac{Capital_{i,t-1}}{Assets_{i,t-1}} \quad logAssets_{i,t-1} \quad \frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \quad \frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}\right)$$

measuring the Polish bank's committed credit lines, $Commit_{i,t-1}/(Commit_{i,t-1}+Assets_{i,t-1})$, share of illiquid assets, $IlliquidAssets_{i,t-1}/Assets_{i,t-1}$, capital adequacy, $Capital_{i,t-1}/Assets_{i,t-1}$, the value of the bank's logged assets, $logAssets_{i,t-1}$, core deposits from the nonfinancial sector as the share of total liabilities excluding liabilities from foreign financial institutions $Deposits_{i,t-1}/NonRelatedLiabilities_{i,t-1}$, and the share of liabilities from foreign financial institutions in the total value of liabilities, $NetDueTo_{i,t-1}/Liabilities_{i,t-1}$. In line with Cornett, McNutt, Strahan and Tehranian (2011), and Buch and Goldberg (2013), these control variables are expected to provide evidence of the most important factors affecting a bank's lending activities throughout the crisis.

The main explanatory variable is the measure of liquidity shock in the funding market, $LiquidityShock_{i,t}$. Our standard measure of liquidity shock in the parent bank is the LIBOR-OIS spread (as explained in Section 3; cf., Figure 1, Panel A). We use the geographical location of the parent bank to identify the funding market for parent banks. In the group of domestically owned banks, the WIBOR-OIS spread is the measure of liquidity shock instead.

[1] We used several different variables as dependent variables in our models, depending on the precise problem that we analyzed. We enumerated these variables in our empirical analysis in Section 4.

The econometric specification of our model includes the measure of liquidity shocks multiplied by the set of control variables, and it controls for possible cross-sectional (γ_i) and time fixed effects (δ_t):

$$y_{i,t} = \mathbf{X}_{i,t-1}\boldsymbol{\alpha} + \left(\mathbf{X}_{i,t-1} \cdot LiquidityShock_{i,t}\right)\boldsymbol{\beta} + \gamma_i + \delta_t + \varepsilon_{i,t}, \quad (1)$$

where $y_{i,t}$ is the dependent variable measuring changes in parent bank lending or funding of Polish banks, respectively. The column vectors $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ contain structural parameters and $\varepsilon_{i,t}$ is the independent error term. The parameters in vector $\boldsymbol{\alpha}$ can be interpreted as marginal effects of individual banks' characteristics on their funding or lending, respectively. In turn, the values of parameters in vector $\boldsymbol{\beta}$ statistically significantly differing from zero will be interpreted as evidence of liquidity shocks deeply affecting the funding and lending activities of affiliate banks during the financial crisis. We focus on analyzing the shock parameters $\boldsymbol{\beta}$ in our empirical investigation.

We also analyze the impact of liquidity shocks in the funding markets on the average funding and lending of Polish affiliate banks, applying some modification in the specification of the model. Here, we do not consider differences in liquidity shock effects between banks depending on bank characteristics, but instead we focus on changes in funding and lending of affiliate banks over time. Consequently, we estimate dynamic panel data regression models with cross-sectional fixed effects. These models explain changes in funding from foreign banks (predominantly from banks in the same banking group), changes in total lending, and changes in foreign exchange denominated housing loans supplied by Polish affiliate banks. Our measure of liquidity shocks, the LIBOR-OIS spread, enters the model as a separate explanatory variable:

$$y_{i,t} = y_{i,t-1} \cdot \rho + \boldsymbol{X}_{i,t-1}\boldsymbol{\alpha} + LiquidityShock_{i,t} \cdot \beta + \gamma_i + \varepsilon_{i,t}, \quad (2)$$

The control variables used in this model are analogous to those described above, but we use capital adequacy ratio instead of capital-asset ratio and the funding gap ratio (difference between loans and deposits divided by deposits) instead of deposits to better account for the factors influencing changes economic performance of Polish banks. The dependent variables are also adjusted against

foreign exchange rate changes to distinguish flows of funds and loans from changes in the volumes of funds caused by the floating exchange rate.

3. Data

We employ a panel dataset consisting of quarterly data from 86 individual commercial banking institutions in Poland. These institutions are either independent Polish banks or subsidiaries of Polish banks (12 banks), subsidiaries of foreign institutions (43 banks), or branches of foreign banking institutions (31 institutions).[2]

The data on the Polish banking institutions comes from the National Bank of Poland. All banks must submit monthly, quarterly and yearly financial reports to the National Bank of Poland, and these reports are available in both a consolidated and unconsolidated form. We have preferred to use individual (unconsolidated) banking statistics to account for financial exposures between banks of the same group[3]. We also used the Bankscope database[4] to collect valuable information about foreign parent institutions of the Polish affiliates. In this case, only consolidated data of sufficiently good quality are available; however, we use these data to proxy the economic situation of both the parent institutions and the entire banking groups.

Our sample begins at the fourth quarter of 2007 and ends in the second quarter of 2013. Beginning the sample as early as in 2007 enables us to investigate a short (one-year) period prior to the crisis since liquidity problems began to significantly affect the Polish banking sector relatively late (i.e., in the third quarter of 2008). Moreover, the quarterly data from the BankScope database are only available from the last quarter of 2007 for most of the banks. We interpolate some missing data for some banks in this database (there is no need to interpolate data from other sources).

There are two potentially turbulent episodes in our sample. The first was the global liquidity shock lasting in Poland from the third quarter of 2008 to the second quarter of 2010. This period also contain the so-called ‘deposit war’ event in the Polish market, which consisted of a strong increase in interest rates for deposits from nonfinancial sectors. During this period Polish banks were attempting to gain more

[2] The numbers of banks fluctuated in the sample due to acquisitions, liquidations, and new banks entering the market.

[3] Panel data set take into account mergers and acquisitions in the Polish banking sector.

[4] The BankScope database was created by Bureau van Dijk-Electronic Publishing. It contains information on balance sheets and income statements of commercial banks around the word. BankScope database provides information on individual countries on 90% of assets of domestic banking sectors in national currencies, EUR and the US dollar (e.g., Bhattacharya, 2003, p. 1–2).

funds from the nonfinancial sectors while the interbank market was frozen. The second turbulent episode was the period of the debt crisis in the Eurozone countries beginning in the third quarter of 2011 and ending in the second quarter of 2012.

We investigate the measure of liquidity shocks in the Polish banking sector and in the banking sectors of parent institutions proposed by Buch and Goldberg (2013). The spread between the (three-month) interbank interest rate (e.g., LIBOR rate) and the (three-month) overnight index swap rate is used to identify potential funding problems for all banks in the market. We investigate both spreads in the foreign interbank markets and in the local Polish market.[5]

[5] As an alternative measure of the funding shocks in the Polish market we also analyze excessive borrowing of banks from the Polish central bank (cf. lower panel of Figure 1). The Polish interbank market, very liquid before the crisis, dried up drastically throughout the crisis. Some Polish banks decided to draw extra funds from the National Bank of Poland via standard repurchase operations. We take the amount of funds lent to banks beyond the normal (long-run) level of borrowing as our measure of liquidity shocks in the local banking system. As an alternative measure of shocks on the markets where parent banks are present, we use the spreads of individual bank CDS contracts to measure the market assessment of the economic problems of parent banking institutions during the crisis. Another available instrument are the sovereign CDS spreads for countries where the parent institutions are located. The former CDS instruments should proxy potential funding problems of parent institutions since banks temporarily considered to be more risky may expect refusal of funding from market participants or may be forced to issue less debt. The sovereign CDS instruments may also indirectly proxy the funding problems of banks since the market assessment of individual banks depends on the quality of sovereign debt.

4. Empirical results

Liquidity shocks in the investigated sample came from two main sources. The first source was the early stage of the financial crisis in 2007 and a pervasive lack of trust amongst international banks after the failure of Lehman Brothers in September 2008. The second source was the debt crisis in the Eurozone countries throughout the years 2011-2012. Since each of the liquidity shocks hit a different group of countries most intensely (and thus a different group of parent banks in our analysis), we decided to investigate these shocks separately. Therefore, we split the full sample into two intervals: (1) the global crisis of 2008-2009 (the sample begins in 1Q 2008 and ends in 2Q 2010); and (2) the Eurozone crisis of 2011-2012 (the sample begins in 3Q 2010 and ends in 1Q 2013).[6]

We begin our investigation by analyzing how funding shocks in foreign parent banks are transmitted to their Polish affiliates. In our first approach we compare the effect of liquidity shocks in parent banks on the group of Polish banks owned by foreign investors with the effect of liquidity shocks on the group of locally owned banks. In order to compare these two effects we consider two regressions for each group of banks. These two regressions explain changes in net lending from foreign financial institutions to Polish banks, $\Delta(NetDueFrom - To)_{i,t}$, and changes in the amount of funding (in the form of loans and deposits) from foreign financial institutions to Polish banks, $\Delta(Funding)_{i,t}$, respectively, where i is the bank identifier and t is the time index.[7] The first group of banks includes foreign financial institutions that are normally parent institutions of the Polish banks (or banks in the same banking group owned by the parent institution). The second group of banks includes foreign financial institutions that can be any foreign banks with no ownership links to the local banks.

Table 1 presents the effects of liquidity shocks on the funding activities of two groups of banks in Poland, namely the group of subsidiaries and branches of foreign parent banks and the separate group of locally owned banks. If the liquidity

[6] We also investigated the full sample estimates of the liquidity shocks and the results were in line with the subsample results. These results are available upon request.

[7] All dependent variables are divided by the value of bank's assets at time $t-1$ to remain comparable in time and across banks in the sample. The variables are described in more detail in Appendix A.

crisis had a clear foreign origin and did not spread to banks in Poland through channels other than the channel of financial exposure, we could observe more apparent effects of liquidity shocks in the former group of banks and weaker effects in the latter group of banks. In fact, such a result can be observed in Table 1. In the first subsample and in the group of banks with foreign owners (cf., the first column in the upper panel of Table 1), the negative impact of the shock on funding from the foreign banks (routinely from their parent banks) was greater for banks with larger committed credit lines and a higher share of illiquid assets (mainly loans). Cornett et al. (2011) find a similar shock effect on parent bank's liquid assets. Allen et al. (2011) and Jeon et al. (2013) argue that banks in Central and Eastern European countries more dependent of parent funding had to adjust their internal funds for lending more than other banks during the crisis of 2008-2009. Moreover, banks with larger assets, higher capital ratios, and higher net liabilities to foreign banks increased their funding from abroad more than other banks did during the crisis. This suggests that parent banks provided greater support to those affiliate banks that relied more on parent funding and those with lesser capital constrains to increase lending. This result is in line with the hypothesis of a stabilizing role of multinational banks in emerging countries (e.g., Haas and Van Lelyveld, 2010; Naveretti et al., 2010; Hameter et al. 2012). Dinger (2009) and Navaretti et al. (2010) also find that the presence of global banks reduces the risk of aggregate liquidity shortages in emerging markets like Poland.

At the same time, the impact of liquidity shock on funding from foreign financial institutions was greater for locally owned banks with relatively large committed credit lines and a low share of liquid assets than in other locally owned banks during the crisis (cf. the last two columns in the upper panel of Table 1). This suggests that the liquidity shock did not completely close access to foreign inter-bank markets for Polish banks independently of size and economic standing. However, it should be emphasized that in case of locally owned banks the share of funding from foreign financial institutions in total assets is relatively small in comparison to foreign owned banks. This difference increased as the result of the crisis (cf., Figure 3). Noncommercial institutions, such as the European Investment

Bank and the European Bank for Reconstruction and Development, granted a portion of this funding.

One reason that Polish banks were affected by the liquidity shock during the global crisis of 2008-2009 was the increase in risk aversion of international investors. This crisis did not require direct financial exposures to spread around the globe and to raise anxiety in banks. By contrast, during the Eurozone crisis the effects of liquidity shocks could be observed only in the group of foreign owned banks and were not apparent in the group of locally owned banks (cf., the lower panel of Table 1). In the group of subsidiaries and branches of foreign institutions, the liquidity shock caused smaller banks, banks with larger commitments and banks with lower capital ratios to receive more parent funding than other banks in this group. Outside of this group of banks no shock effects were statistically significant during the crisis of 2011-2012.

Our second approach to determine whether the global financial liquidity crisis had some influence on the Polish banks is based on a comparison of liquidity shock effects in parent banks on their lending to two separate sets of banks. The first set contains the (local and foreign) banks that do not belong to the analyzed banking group of the lender and the second set contains the Polish banks that do belong to the same banking group as the lender.

We constructed two regressions for each set of banks once again. The two dependent variables in the regressions for the first set of banks are defined as changes in lending by parent institution to all banks outside the banking group, $\Delta(LendingToBanks)_{i,t}$, and changes in lending to all banks outside the group less borrowing from these banks, $\Delta(NetLendingToBanks)_{i,t}$, respectively. The two dependent variables in the regressions for the second set of banks are the changes in the amount of funding to Polish banks from their foreign parent institutions, $\Delta(Funding)_{i,t}$, and changes in the net lending between foreign parent institutions and Polish banks, $\Delta(NetDueFrom-To)_{i,t}$, respectively.

The explanatory variables are the same as in our first approach with two exceptions. First, the explanatory variables are concerned with the economic standing of parent banks rather than the economic standing of their Polish

subsidiaries (i.e., the data come from the Bankscope database instead of the NBP database) (cf. Section 3). Second, our dataset concerning the parent banks does not contain information about the parent banks' commitments. Instead, we use the ratio of loans to assets as a proxy of the banks' exposure to nonfinancial sectors.[8] The specifications of this model are defined in (1) and the results are presented in Table 2.

In general, the net lending to banks outside of the group was significantly affected during turbulent periods. Larger banks and banks with more liquid assets lent more than other parent banks did during and just after the Lehman Brothers collapse. During the Eurozone crisis the shock effect was reversed; larger banks with more liquid assets lent less. Moreover, the negative impact of the shock on lending was relatively stronger in banks with more loans and less deposits. Interestingly, we were not able to irrevocably identify the factors that would cause foreign institutions to change their lending habits with Polish affiliate banks during liquidity shocks. Either the diversity of parent banks (e.g., in terms of their market location) does not allow us to identify the prevailing characteristics of parent institutions that would amplify the transmission of shocks to Polish affiliate banks or it is that the characteristics (e.g., the economic standing and demand) of Polish banks would better determine whether or not they receive funding from their parent institutions.

We have also estimated the effects of liquidity shocks within the Polish banking sector on the funding needs of local banks. This has allowed us to determine whether funding from parent institutions increased abnormally during these liquidity shocks. It is clear that liquidity shocks in global banks spilled over to the Polish banking sector in 2008; however, the subsequent problems in some Eurozone markets had a much weaker (and delayed) direct effect on the Polish inter-bank market (cf., both panels of Figure 1). Again, we found evidence that liquidity shocks forced a change in the funding behavior of foreign owned and locally owned banks only during the first phase of the crisis (i.e., in the years 2008-2009).[9]

[8] The BankScope database does not contain the values of credit lines granted by banks. Therefore, we used the loans to asset ratio, $Loans_{i,t-1}/Assets_{i,t-1}$, as a proxy of a bank's long-term exposure toward clients. When we give up this variable in our models the results are very similar.

[9] A more detailed description of these results is presented in Appendix B.

4.1. The funding problems of parent banks and the lending activity of Polish affiliates

We investigated the lending activities of Polish banks and have assessed how funding problems within parent banks can affect the lending practices of their Polish subsidiaries and branches. Therefore, we estimated regression models analogous to the one presented in formula (1). The control variables are the same as these in the vector $\mathbf{X}_{i,t-1}$ and they are determined with respect to the Polish banks (not the parent banks). The dependent variables include the total change in lending by Polish affiliate banks to all sectors in Poland $\Delta(Loans)_{i,t}$, the changes in liquid assets for Polish affiliates, $\Delta(LiquidAssets)_{i,t}$, as well as the changes in the FX housing loans to the household sector, $\Delta(FXHousingLoans)_{i,t}$. In line with Cornett et al. (2011), changes in liquid assets are used to measure how banks build up liquidity buffers to offset increased risk during a crisis.

One reason to include foreign currency denominated loans in the set of dependent variables is that FX housing loans were extremely popular in the period preceding the financial crisis due to significantly higher interest rates in the Polish market compared to the market rates for euro or Swiss frank. Interestingly, the total amount of lending in foreign currencies was strongly correlated with the amount of total funding raised by Polish banks from foreign financial institutions (i.e., typically from parent institutions) (cf., Figure 2).

Our empirical results show that liquidity shocks in parent banks affect the lending behavior of Polish affiliates during both phases of the financial crisis (cf., Table 3). Banks with a larger deposit base tended to lend more in this period. They required less liquidity during the liquidity shock. Larger Polish banks and those with lower liabilities to foreign banks preferred to increase their share of liquid assets and they were lending somewhat less (usually not statistically significantly) than the other banks during the liquidity shortage after the Lehman Brothers bankruptcy. Similarly, larger banks preferred to increase their liquid assets during the Eurozone crisis. However, those banks with higher exposure to nonfinancial sectors (i.e., in the form of loans and commitments) and lower capital ratios preferred to remain less

liquid during the liquidity shock of 2011. It is of interest to note that the estimations show some liquidity shock impact on the foreign exchange denominated housing loans, but only during the first phase of the crisis (cf. the last column of Table 3). The more negative impact of the shock was observable in banks with less liquid assets and with lower net liabilities to foreign banks during the first period. However, the size, capital adequacy, deposit base and prior credit commitments were not statistically significant factors to explain the shock effects on FX housing lending during both crisis periods.

Our dataset enables us to investigate the transmission of liquidity shocks from multiple banks and from several countries to Polish banks. Some of the foreign countries have been seriously hit by the recent financial crisis. We identified crisis countries as well as relatively calm countries during the sovereign debt crisis in the Eurozone in an additional exercise. We found no signs of change in the liquidity structure of assets or in the net borrowing from parents in the group of banks owned by parents located in crisis countries during the liquidity shock. In contrast, such changes were present in Polish banks owned by parents from relatively calm markets. Other differences in borrowing and lending by the two groups of banks were less evident.[10]

4.2. Aggregate effects of liquidity shocks

We present results on average (aggregate) effects of liquidity shocks in foreign markets on Polish affiliate banks in Table 4, applying model (2) described in Section 2. In this investigation we concentrate our attention on the estimates of the parameter of the variable $LiquidityShock$ in model (2).[11]

We observed statistically significant appreciation in funding during the liquidity shock in the model describing changes in funding from foreign banks to Polish banks around the Lehman Brothers collapse. This result is new and it is in clear contrast to other studies pointing to reduction of funding from liquidity-

[10] We describe these results in more detail in Appendix B.

[11] The average effects are also called aggregate effects hereafter to highlight the difference between the results comparing effects for groups of banks and the results obtained for a single (aggregate) group of Polish affiliates of foreign parent banks.

constrained banks to their affiliates (e.g., Cetorelli and Goldberg, 2011). In our opinion this outcome is the consequence of two effects. Firstly, the 2008-2009 liquidity shock hit several markets simultaneously and many Polish banks required more funding during the crisis, as explained earlier (demand side). Secondly, the profitable Polish banking sector played an important role in expansionary strategies of global banks during the early phase of the crisis. Therefore parent banks were willing to provide more liquidity to their Polish affiliates even when they were limiting credit expansion to other clients (supply side).

Nonetheless, the negative value of the parameter in the second model suggests that the boom in the housing market has been interrupted during the liquidity shock as banks, uncertain about future economic developments and surprised by the increased volatility of the local exchange rate, slowed down supplying the foreign exchange denominated loans. This result hints that the local effects related to economic uncertainty might have played a more important role than liquidity shocks in parent banks during the crisis. The funding channel has actually helped the Polish banks to continue their lending activity during the difficult times.

Moreover, the aggregate lending of banks to all sectors seems not to be statistically significantly affected by the liquidity shock (although the respective parameter is negative), indicating that banks might have switched their lending priorities from the housing market to other markets, e.g., consumer loans or corporate loans. In the second phase of the crisis, the liquidity shock related to debt turbulences in the Eurozone did not impact the aggregate foreign funding of Polish banks statistically significantly. However, the banks dramatically reduced FX mortgage lending in the years 2011-2012 and the aggregate FX mortgage lending was negatively affected by the liquidity shock as well. Again, the total lending was not statistically significantly affected.

5. Conclusions

We find that liquidity shocks in international parent banks have been transmitted to Polish subsidiaries and branches of these banks during the global financial crisis in the years 2008 – 2012. The first phase of the crisis was related to the Lehman Brothers collapse and affected not only the funding of Polish subsidiaries and branches of foreign banks but also the funding of Polish locally owned banks. The affiliate banks, more dependent on funding from foreign banks, actually increased their funding from these banks during the liquidity shock. This result is confirmed by the estimates of the average impact of liquidity shocks.

The Eurozone crisis caused adjustments in the balance sheets of Polish affiliates of foreign parent banks. However, the locally owned banks show no sign of adjustment. This result is important and indicates that the international links between parent banks and their affiliates are an important channel of shock transmission. The impact of shocks on aggregate funding of the Polish banking sector is not statically significant during the Eurozone crisis.

It is interesting to note that we find evidence of liquidity shocks affecting FX mortgage lending in Poland, especially during the first phase of the crisis. The estimates of the aggregate impact of liquidity shocks reveal that funding problems of parent banks were also a statistically important factor explaining the slowing-down growth of FX housing loans in Poland during the sovereign debt crisis in the Eurozone. In general, our results pointed to differing effects of liquidity shocks in various groups of parent and affiliate banks and suggest that the geographical diversity of parent institutions and different characteristics of their Polish affiliates helped the local financial system to remain relatively vigorous throughout the global financial crisis.

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Table 1: The effects of liquidity shocks in parent institutions on their lending to Polish affiliates

	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$
Subsample: 1Q2008 – 2Q2010	subsidiaries and branches of foreign banks	subsidiaries and branches of foreign banks	banks with Polish owners	banks with Polish owners
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.942***	1.199***	-0.166	0.076
	(0.106)	(0.177)	(0.122)	(0.345)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.308*	-1.300***	0.165*	0.201
	(0.158)	(0.263)	(0.091)	(0.257)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.258***	-0.164**	0.013	0.039
	(0.050)	(0.083)	(0.048)	(0.137)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.211***	0.284***	0.077**	0.101
	(0.064)	(0.106)	(0.035)	(0.100)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	-0.186	0.427*	0.014	-0.152
	(0.130)	(0.218)	(0.085)	(0.241)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.319***	-0.008	-0.052	-0.251
	(0.090)	(0.151)	(0.089)	(0.253)
$logAssets_{i,t-1}$	0.156***	0.041	-0.002	0.015
	(0.028)	(0.047)	(0.022)	(0.062)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	0.011***	0.019***	0.003	0.014
	(0.003)	(0.005)	(0.004)	(0.011)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	0.067	-0.067	0.125	-0.027
	(0.056)	(0.093)	(0.097)	(0.276)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.040	-0.074	-0.036	-0.078
	(0.056)	(0.093)	(0.025)	(0.070)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.551***	0.413***	0.972***	0.363***
	(0.042)	(0.071)	(0.047)	(0.134)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.184***	-0.031	-0.012	-0.049
	(0.044)	(0.073)	(0.023)	(0.065)
N	345	345	114	114
within $-R^2$	0.753	0.426	0.925	0.437
Subsample: 3Q2010 – 1Q2013				
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.552***	0.313**	-0.048	-0.166
	(0.058)	(0.134)	(0.151)	(0.262)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.231*	0.463*	0.287	0.419
	(0.119)	(0.273)	(0.360)	(0.623)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.114***	0.010	0.067	0.092
	(0.031)	(0.071)	(0.074)	(0.128)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.030	-0.117	-0.226	-0.226
	(0.033)	(0.076)	(0.152)	(0.263)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	-0.040	-0.156	0.080	0.117
	(0.106)	(0.243)	(0.154)	(0.267)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.228**	0.076	0.104	0.142
	(0.103)	(0.236)	(0.196)	(0.340)
$logAssets_{i,t-1}$	0.087***	-0.075**	0.007	-0.032
	(0.016)	(0.036)	(0.018)	(0.031)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	-0.007**	-0.008	0.000	0.013
	(0.003)	(0.007)	(0.010)	(0.017)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	-0.124**	0.088	0.133	0.373
	(0.051)	(0.118)	(0.143)	(0.248)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.042	-0.041	0.012	0.065
	(0.041)	(0.093)	(0.047)	(0.081)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.835***	0.556***	1.132***	1.192***
	(0.027)	(0.063)	(0.111)	(0.193)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.020	-0.033	-0.039	0.011
	(0.031)	(0.072)	(0.093)	(0.162)
N	375	375	117	117
within $-R^2$	0.862	0.335	0.633	0.448

Note: The explanatory variables are concerned with the balance sheets of Polish banks in this table. The liquidity shocks are defined as LIBOR-OIS spreads (WIBOR-OIS spreads in case of Polish parent banks) and they are observed on the markets where the parent banks are present. The estimated parameters that are significant at the 10%, 5% and 1% levels are denoted with '*', '**', and '***', respectively. Standard errors of estimated parameters are presented in parentheses. Data for explained and explanatory variables are taken from the database of the National Bank of Poland.

Table 2: The effects of liquidity shocks in parent institutions on their lending to Polish affiliates, Data for explanatory variables from the Bankscope database.

	$\frac{\Delta(LendingToBanks)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetLendingToBanks)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$
Subsample: 1Q2008 – 2Q2010	foreign parent banks	foreign parent banks	all Polish banks	all Polish banks
$\frac{Loans_{i,t-1}}{Assets_{i,t-1}}$	-0.074	0.174	1.014	0.223
	(0.104)	(0.122)	(0.917)	(0.646)
$\frac{Loans_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.022	0.082	0.079	-0.138
	(0.062)	(0.073)	(0.620)	(0.436)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.234***	0.229***	-0.592	0.206
	(0.060)	(0.071)	(0.561)	(0.395)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.076	-0.197**	0.231	0.041
	(0.072)	(0.085)	(0.700)	(0.493)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	0.325	-0.041	6.926	6.910**
	(0.585)	(0.687)	(4.483)	(3.156)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.086	0.261	-0.079	0.476
	(0.293)	(0.345)	(2.930)	(2.063)
$logAssets_{i,t-1}$	-0.039	0.061	0.650**	0.369*
	(0.032)	(0.037)	(0.286)	(0.202)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	0.003	0.006**	-0.013	-0.002
	(0.002)	(0.002)	(0.019)	(0.013)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	-0.036	-0.090	-0.171	0.046
	(0.055)	(0.065)	(0.489)	(0.345)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.038	-0.064	0.129	-0.058
	(0.050)	(0.059)	(0.436)	(0.307)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	-0.133*	0.663***	0.123	0.018
	(0.070)	(0.082)	(0.632)	(0.445)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.003	0.022	-0.142	0.176
	(0.050)	(0.059)	(0.513)	(0.362)
N	495	495	463	463
within $-R^2$	0.098	0.244	0.045	0.051
	$\frac{\Delta(LendingToBanks)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetLendingToBanks)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$
Subsample: 3Q2010 – 1Q2013				
$\frac{Loans_{i,t-1}}{Assets_{i,t-1}}$	0.151**	0.131	1.345*	-0.403
	(0.071)	(0.096)	(0.704)	(0.391)
$\frac{Loans_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.147***	-0.191**	-0.207	-0.126
	(0.055)	(0.074)	(0.552)	(0.307)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	-0.112***	-0.124**	0.606	0.206
	(0.041)	(0.055)	(0.412)	(0.229)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.177**	0.194**	0.538	0.217
	(0.071)	(0.095)	(0.695)	(0.386)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	-0.321	-0.747**	0.876	1.308
	(0.282)	(0.377)	(2.827)	(1.569)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.265	-0.146	-0.363	0.340
	(0.244)	(0.326)	(2.822)	(1.566)
$logAssets_{i,t-1}$	-0.038*	-0.006	0.165	-0.053
	(0.022)	(0.029)	(0.208)	(0.116)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	-0.004**	-0.004*	0.006	-0.019**
	(0.002)	(0.002)	(0.017)	(0.010)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	-0.189***	-0.196***	0.532	0.197
	(0.037)	(0.050)	(0.385)	(0.213)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.079*	0.113**	-0.424	0.095
	(0.042)	(0.056)	(0.393)	(0.218)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.043	0.580***	-0.862*	0.035
	(0.053)	(0.071)	(0.498)	(0.277)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.043	-0.097*	0.219	-0.049
	(0.042)	(0.056)	(0.427)	(0.237)
N	653	652	564	564
within $-R^2$	0.239	0.336	0.055	0.047

Note: The explanatory variables are concerned with balance sheets of parent institutions in this table. The liquidity shocks are defined as LIBOR-OIS spreads and they are observed on the markets where the parent banks are present. The estimated parameters that are significant at the 10%, 5% and 1% levels are denoted with '*', '**', and '***', respectively. Standard errors of estimated parameters are presented in parentheses. Data for explanatory variables are taken from the Bankscope database.

Table 3: The effects of liquidity shocks in parent institutions on lending activity of Polish banks during the two phases of the global financial crisis

	$\frac{\Delta(Loans)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(Credit)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(LiquidAssets)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(FXHousingLoans)_{i,t}}{Assets_{i,t-1}}$
Subsample: 1Q2008 – 2Q2010	all banks	all banks	all banks	all banks
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.271	0.462***	1.541***	0.005
	(0.239)	(0.164)	(0.216)	(0.037)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.202	-0.251*	-0.618***	-0.007
	(0.221)	(0.151)	(0.199)	(0.034)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.529***	0.411***	-0.434***	0.038**
	(0.114)	(0.078)	(0.102)	(0.017)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.017	0.217***	0.168*	-0.027*
	(0.107)	(0.074)	(0.097)	(0.016)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	0.097	0.441***	0.219	-0.044
	(0.243)	(0.166)	(0.219)	(0.037)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.004	-0.346**	-0.008	-0.001
	(0.212)	(0.145)	(0.191)	(0.033)
$logAssets_{i,t-1}$	-0.210***	-0.136***	0.068	-0.030***
	(0.062)	(0.042)	(0.055)	(0.009)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	-0.008*	-0.004	0.012***	0.001
	(0.005)	(0.003)	(0.004)	(0.001)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	0.100	0.158	0.063	-0.018
	(0.150)	(0.103)	(0.135)	(0.023)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.191**	0.152***	-0.151**	0.003
	(0.083)	(0.057)	(0.075)	(0.013)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	-0.083	-0.051	0.174*	-0.008
	(0.100)	(0.068)	(0.090)	(0.015)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.024	0.019	-0.176***	0.028**
	(0.074)	(0.051)	(0.067)	(0.011)
N	408	408	408	408
within $-R^2$	0.344	0.497	0.202	0.302
Subsample: 3Q2010-1Q2013				
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.515**	0.410**	1.807***	0.005
	(0.219)	(0.176)	(0.212)	(0.027)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.872**	-1.002***	-1.091***	0.013
	(0.405)	(0.325)	(0.391)	(0.049)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.112	0.214**	-0.360***	-0.007
	(0.104)	(0.084)	(0.101)	(0.013)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.153	-0.198*	-0.407***	0.005
	(0.136)	(0.109)	(0.132)	(0.017)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	0.947***	0.608***	-0.085	-0.023
	(0.267)	(0.214)	(0.258)	(0.032)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	1.100***	0.830***	0.730**	-0.027
	(0.341)	(0.273)	(0.329)	(0.041)
$logAssets_{i,t-1}$	0.206***	0.099***	-0.082*	-0.012**
	(0.045)	(0.036)	(0.043)	(0.005)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	0.010	0.019**	0.038***	0.000
	(0.009)	(0.008)	(0.009)	(0.001)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	-0.285	-0.106	0.416**	0.011
	(0.207)	(0.166)	(0.200)	(0.025)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.607***	0.453***	-0.054	-0.003
	(0.129)	(0.103)	(0.124)	(0.016)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	-0.141	-0.167*	-0.232**	0.023
	(0.119)	(0.095)	(0.115)	(0.014)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.253**	0.279***	0.144	-0.002
	(0.114)	(0.091)	(0.110)	(0.014)
N	486	486	486	486
within $-R^2$	0.279	0.278	0.301	0.220

Note: The explanatory variables are concerned with balance sheets of Polish banks in this table. The liquidity shocks are defined as LIBOR-OIS spreads (WIBOR-OIS spreads in case of Polish parent banks) and they are observed on the markets where the parent banks are present. The estimated parameters that are significant at the 10%, 5% and 1% levels are denoted with '*', '**', and '***', respectively. Standard errors of estimated parameters are presented in parentheses.

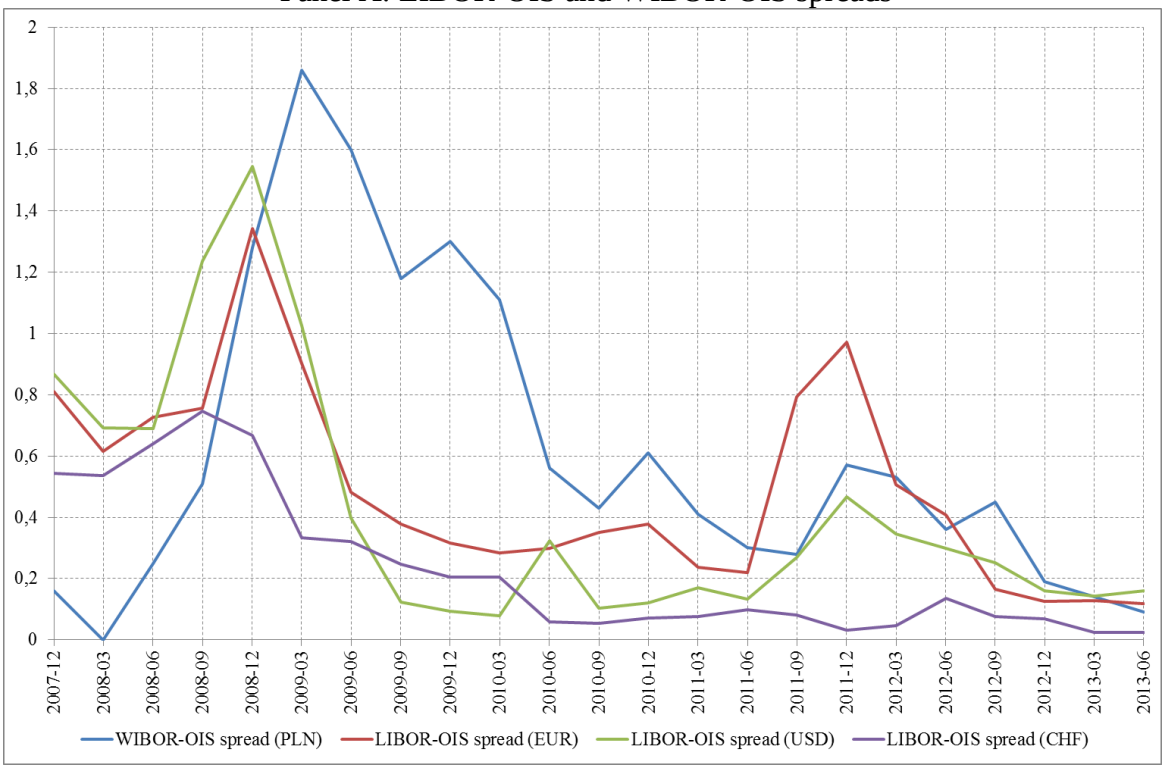
Table 4: Aggregate effects of liquidity shocks in parent institutions on funding and lending activity of Polish banks

	$\frac{\Delta(Funding\_ERA)_{i,t}}{Assets\_ERA_{i,t-1}}$	$\frac{\Delta(FX\_housing\_Loans\_ERA}{Assets\_ERA_{i,t-1}}$	$\frac{\Delta(Loans\_ERA)_{i,t}}{Assets\_ERA_{i,t-1}}$
Subsample: 1Q2008 – 2Q2010	subsidiaries and branches of foreign banks	subsidiaries and branches of foreign banks	subsidiaries and branches of foreign banks
$dependent\ variable_{i,t-1}$	-0,400***	0,845***	-0,015
	(0,067)	(0,074)	(0,095)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	-0,030	0,002	0,056
	(0,215)	(0,012)	(0,121)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0,082	-0,005	0,012
	(0,129)	(0,007)	(0,073)
CapitalAdequacyRatio	0,085	-0,015	-0,211
	(0,333)	(0,018)	(0,190)
$logAssets_{i,t-1}$	0,074	-0,014***	0,003
	(0,080)	(0,004)	(0,048)
FundingGapRatio	-0,030	-0,005	-0,073**
	(0,050)	(0,004)	(0,029)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0,109	-0,009	0,106
	(0,115)	(0,008)	(0,067)
$LiquidityShock_{i,t}$	0,156***	-0,006***	-0,002
	(0,032)	(0,002)	(0,018)
$GDPgrowth_{t-1}$	0,008*	0,000	0,007**
	(0,005)	(0,000)	(0,003)
N	187	123	187
Subsample: 3Q2010 – 1Q2013			
$dependent\ variable_{i,t-1}$	-0,375***	0,637***	0,119*
	(0,045)	(0,066)	(0,065)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0,014	0,001	-0,085
	(0,141)	(0,017)	(0,224)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	-0,067	-0,007	-0,104
	(0,108)	(0,016)	(0,184)
CapitalAdequacyRatio	-0,565***	-0,034	-0,521
	(0,211)	(0,037)	(0,330)
$logAssets_{i,t-1}$	-0,030	-0,005	-0,317***
	(0,064)	(0,008)	(0,088)
FundingGapRatio	0,007	0,006	0,095
	(0,036)	(0,009)	(0,060)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0,025	0,009	-0,209
	(0,096)	(0,012)	(0,154)
$LiquidityShock_{i,t}$	0,010	-0,005*	-0,016
	(0,016)	(0,003)	(0,025)
$GDPgrowth_{t-1}$	-0,002	0,000	-0,009
	(0,004)	(0,001)	(0,007)
N	248	165	248

Note: The explanatory variables are concerned with balance sheets of Polish banks (owned by foreign parents) in this table. The liquidity shocks are defined as LIBOR-OIS spreads and they are observed on the markets where the parent banks are present. The estimated parameters that are significant at the 10%, 5% and 1% levels are denoted with '*', '**', and '***', respectively. Standard errors of estimated parameters are presented in parentheses. The estimation method is the Arellano-Bond generalized method of moments. The expression 'ERA' in the names of dependent variables means that our data is exchange rate adjusted (the impact of exchange rate changes is excluded from our data).

Figure 1: Measures of liquidity shocks on the funding market for banks

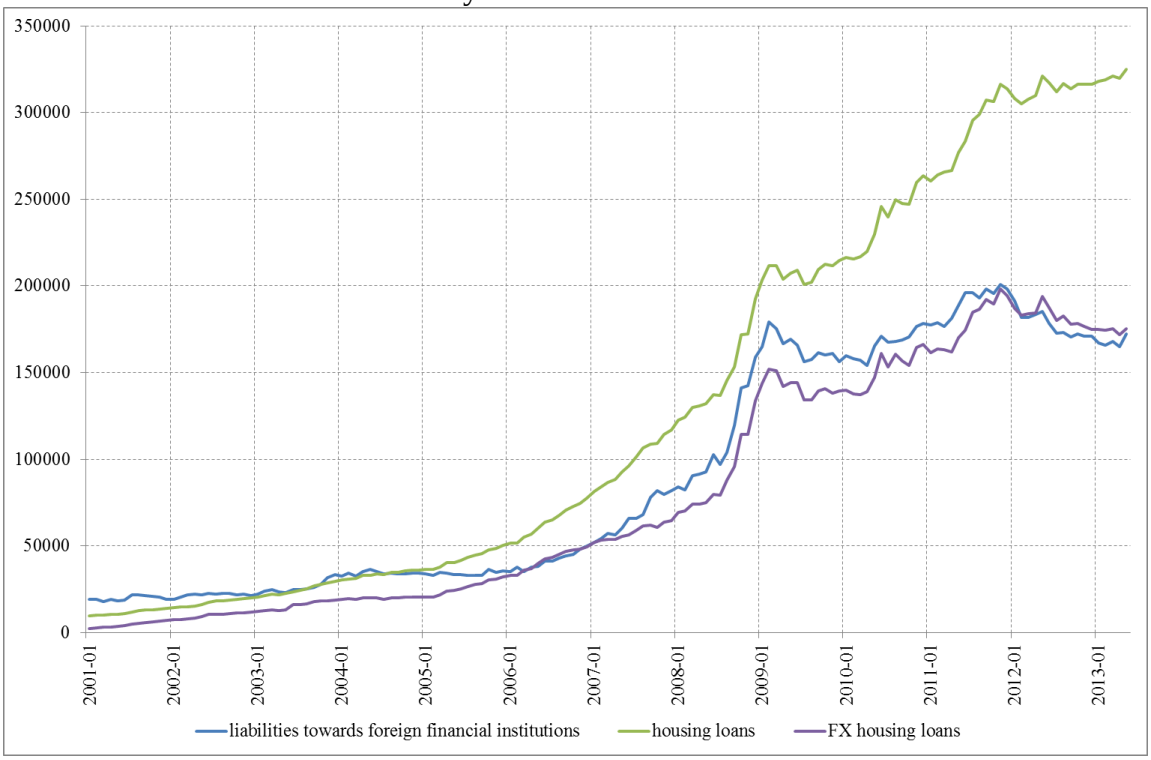
Panel A: LIBOR-OIS and WIBOR-OIS spreads



Panel B: WIBOR-OIS spread and excess claims of NBP toward banks

Note: Data on spreads came from the Federal Reserve Bank of Cleveland and from the National Bank of Poland. Data on excess claims of the National Bank of Poland towards local banks came from the National Bank of Poland. Excess claims of the NBP are calculated as deviations of the NBP claims from the long-run trend (using the linear trend model and the quantile regression estimation method). Spreads are presented in percentage terms and excess NBP claims are presented in billions of PLN (Polish złoty).

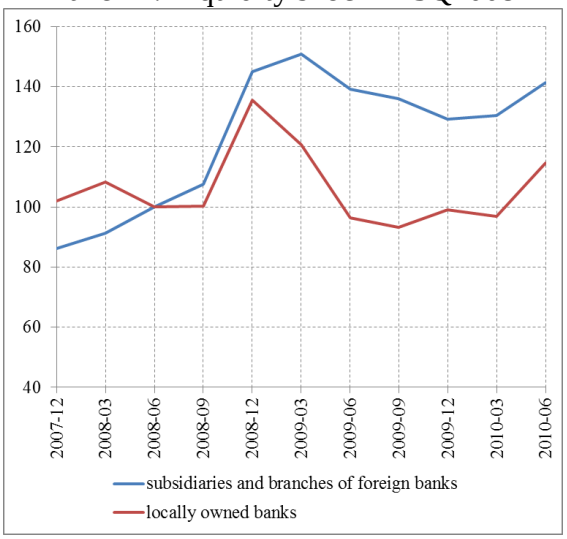
Figure 2: Foreign currency housing loans and funding from foreign financial institutions
by Polish banks



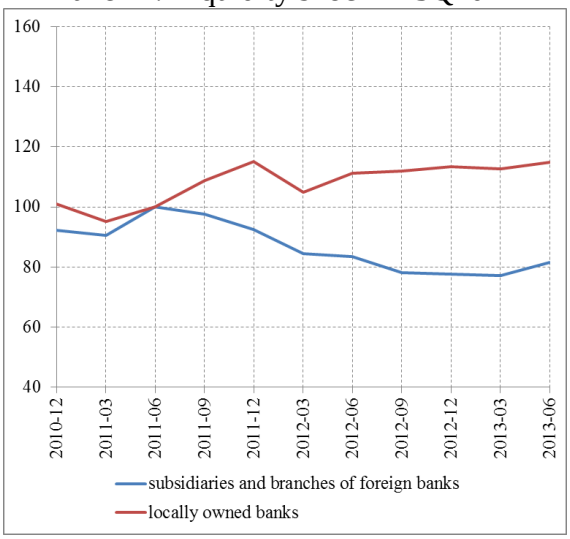
Note: All data come from the National Bank of Poland. The values are presented in millions of PLN.

Figure 3: The effects of liquidity shocks on funding from foreign financial institutions to Polish banks

Panel A: Liquidity shock in 3Q2008

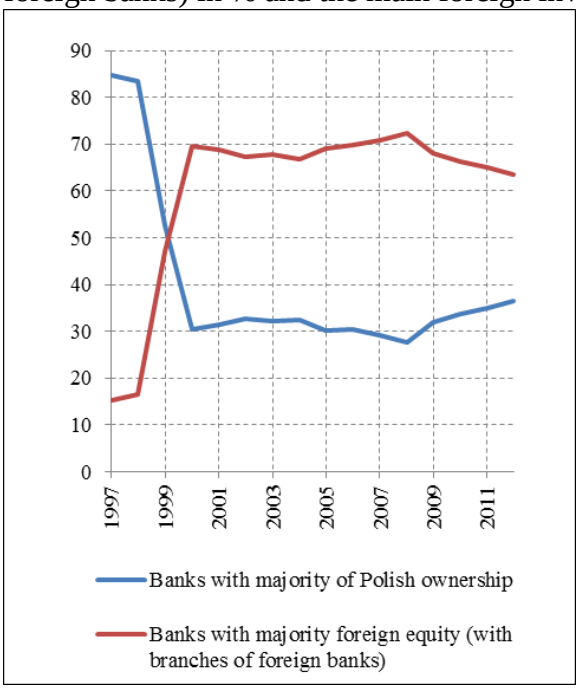


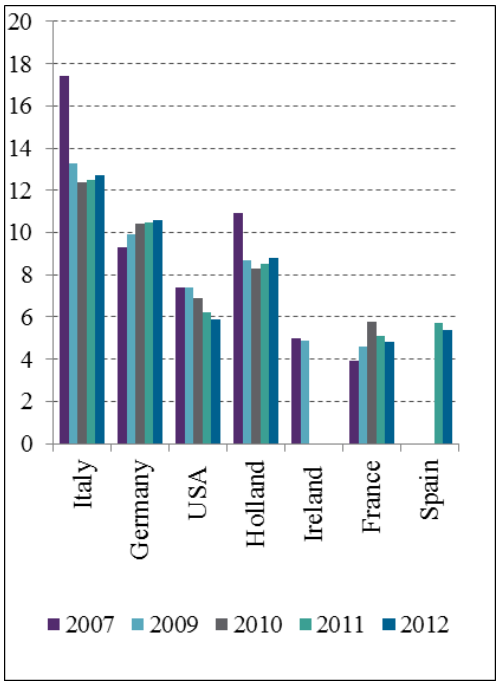
Panel B: Liquidity shock in 3Q2011



Note: In both panels the graphs present values of aggregate funding from foreign financial institutions to Polish locally owned banks and to Polish foreign owned banks, respectively. The aggregate funding is divided by the value of assets and is rescaled to equal 100 one quarter before the shock takes place.

Figure 4: Banks with a majority of foreign equity (subsidiaries and branches of foreign banks) in % and the main foreign investors in Poland in %





Source: NBP, PFSA.

Appendix A. Data sources

Table A1: Definitions and sources of variables used in our investigation

Variable	Definition	Source
$Commit$	Committed credit lines to the nonfinancial sector	National Bank of Poland
$IlliquidAssets$	Total assets less liquid assets. Liquid assets are government and central bank debt securities, current accounts in monetary financial institutions, cash and 1-day deposits in a central bank.	National Bank of Poland (Bankscope - for parent banks)
$Capital$	Tier 1 regulatory capital of a bank	National Bank of Poland (Bankscope - for parent banks)
CapitalAdequacyRatio	Tier 1 capital adequacy ratio	National Bank of Poland
Credit	Loans and committed credit lines to nonfinancial sector	National Bank of Poland
$Deposits$	Deposit assumed to be stable - the estimated (on the basis of survey) proportions of households and corporate deposits	National Bank of Poland (Bankscope - for parent banks)
$NetDueTo$	Liabilities to foreign financial institutions (FFIs). These FFIs are normally parent banks of Polish affiliates or banks in the same banking group.	National Bank of Poland
$Assets$	Total assets of banks	National Bank of Poland
$Liabilities$	Total Liabilities	National Bank of Poland
$Loans$	Total loans (to financial sector, nonfinancial sector and general government entities)	National Bank of Poland
FundingGapRatio	Funding gap ratio defined as the ratio of deposits less loans to loans	National Bank of Poland
$LiquidityShock$	LIBOR (3 month) – OIS (3 month) spread in the appropriate currency of the market where the shock took place. In the case of Polish parent banks the measure of liquidity shocks is the WIBOR-OIS spread	Federeal Reserve Bank of Cleveland and National Bank of Poland
$\Delta(NetDueFrom-To)$	Changes in liabilities to foreign financial institutions (i.e., usually parent banks in the case of foreign owned banks) less changes in claims to foreign financial institutions	National Bank of Poland
$\Delta(Funding)$	Changes in liabilities to foreign financial institutions (i.e., usually parent banks in the case of foreign owned banks)	National Bank of Poland
$\Delta(LendingToBanks)$	Changes in loans to banks	Bankscope
$\Delta(NetLendingToBanks)$	Changes in loans to banks less loans from banks	Bankscope
$\Delta(Loans)$	Changes in total loans of a bank to all sectors	National Bank of Poland
$\Delta(LiquidAssets)$	Changes in liquid assets	National Bank of Poland
$\Delta(FXHousingLoans)$	Changes in FX housing loans to the household sector	National Bank of Poland

Appendix B. Additional empirical results.

Question 1: Is there a role for foreign parent institutions during liquidity shocks in the Polish banking sector?

We estimate the effects of liquidity shocks in the Polish banking sector on funding needs of local banks. This allows for us to determine whether funding from parent institutions increases abnormally during these liquidity shocks. Again, we distinguish between locally owned banks and the group of subsidiaries and branches owned by foreign banks.

We estimate regression models presented in formula (1) and the control variables are set the same as in Section 4. However, the measure of liquidity shocks ($LiquidityShock_{i,t}$) is taken from the Polish market now (cf., Figure 1, Panel B). The use of the dependent variables $\Delta(Funding)_{i,t}$ and $\Delta(NetDueFrom-To)_{i,t}$, measures funding from the parent banks to their Polish affiliates and the net funding from parent banks, respectively. This allows us to investigate whether the foreign parent banks help their Polish affiliates to mitigate the effects of liquidity shocks.

It is clear that liquidity shocks in global banks did indeed spill over to the Polish banking sector in 2008. However, subsequent problems within some Eurozone markets had a much weaker (and delayed) direct effect on the Polish inter-bank market (cf., both panels of Figure 1). In our answer to Question 1, we check to see if there is evidence for special treatment of Polish affiliate banks by their parent institutions during the turbulent periods in the Polish inter-bank market. Again, we find that only liquidity shocks taking place in the first phase of the crisis (i.e., in the years 2008-2009) force a change in the funding behavior of Polish affiliates of international banks and banks owned by Polish proprietors (cf., Table B1). No parameters of the variables multiplied by the $LiquidityShock_{i,t}$ variable are significant in the latter subsample.

Question 2: How did the transmission of liquidity shocks to Polish affiliates differ across countries where parent banks were located during the sovereign debt crisis ?

Our dataset enabled us to investigate the transmission of liquidity shocks from multiple banks and from several countries to Polish banks. Some of the foreign

countries and banks have been seriously hit by the recent financial crisis and we were able to identify calm and crisis countries as well as well doing and trouble banks. We focused on the sovereign debt crisis in some Eurozone countries and identified the group of so-called 'PIIGS' crisis countries: Portugal, Ireland, Italy, Greece, and Spain.

We analyzed the different reactions of Polish banks to shocks originating in banks located either in countries hit most severely by the Eurozone crisis or in relatively calmer markets. In the group of banks with parents located in PIIGS countries, no sign of changes in the liquidity structure of assets or in the net borrowing behaviors from parents are observable as the result of the liquidity shock (cf., the upper panel of Table B2). Such changes are clearly present amongst Polish banks owned by parents from relatively calm markets. Banks with more commitments towards nonfinancial sectors are able to expand lending more than other banks. Larger banks on the other hand increase funding and increase liquid assets more than smaller banks. In the case of the parent banks located in crisis (PIIGS) countries, affiliate banks with a relatively large deposit base and greater capital ratios tended to limit their borrowing from parent banks more than other banks. This suggests that parent banks have supported mainly weaker banks (in terms of capital or deposit base). At the same time, larger banks and banks with larger commitments increased their funding more than other banks with crisis-hit-owners.

Table B1: Liquidity shocks on the Polish market and funding from foreign financial institutions to Polish banks

	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$
Subsample: 1Q2008 – 2Q2010	subsidiaries and branches of foreign banks	subsidiaries and branches of foreign banks	banks with Polish owners	banks with Polish owners
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.613***	0.738***	-0.166	0.076
	(0.120)	(0.202)	(0.122)	(0.345)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.099	-0.269	0.165*	0.201
	(0.098)	(0.165)	(0.091)	(0.257)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.103***	-0.078	0.013	0.039
	(0.040)	(0.067)	(0.048)	(0.137)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.050	0.086	0.077**	0.101
	(0.044)	(0.074)	(0.035)	(0.100)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	0.145	-0.213	0.014	-0.152
	(0.088)	(0.149)	(0.085)	(0.241)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.413***	0.261	-0.052	-0.251
	(0.128)	(0.215)	(0.089)	(0.253)
$logAssets_{i,t-1}$	0.168***	0.020	-0.002	0.015
	(0.025)	(0.043)	(0.022)	(0.062)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	-0.002	-0.001	0.003	0.014
	(0.003)	(0.005)	(0.004)	(0.011)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	0.070	-0.229**	0.125	-0.027
	(0.063)	(0.105)	(0.097)	(0.276)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.037	0.134	-0.036	-0.078
	(0.049)	(0.082)	(0.025)	(0.070)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.614***	0.327***	0.972***	0.363***
	(0.041)	(0.069)	(0.047)	(0.134)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.012	0.150**	-0.012	-0.049
	(0.034)	(0.058)	(0.023)	(0.065)
N	386	386	114	114
$within - R^2$	0.705	0.371	0.925	0.437
Subsample: 3Q2010 – 1Q2013				
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.554***	0.429***	-0.048	-0.166
	(0.046)	(0.100)	(0.151)	(0.262)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.036	-0.052	0.287	0.419
	(0.061)	(0.132)	(0.360)	(0.623)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.034	0.054	0.067	0.092
	(0.024)	(0.053)	(0.074)	(0.128)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.031	-0.049	-0.226	-0.226
	(0.028)	(0.060)	(0.152)	(0.263)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	-0.122	-0.068	0.080	0.117
	(0.096)	(0.208)	(0.154)	(0.267)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.042	0.113	0.104	0.142
	(0.074)	(0.161)	(0.196)	(0.340)
$logAssets_{i,t-1}$	0.046***	-0.041*	0.007	-0.032
	(0.011)	(0.024)	(0.018)	(0.031)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	-0.002	0.003	0.000	0.013
	(0.002)	(0.004)	(0.010)	(0.017)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	-0.128**	0.211*	0.133	0.373
	(0.051)	(0.111)	(0.143)	(0.248)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.005	-0.023	0.012	0.065
	(0.019)	(0.042)	(0.047)	(0.081)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.838***	0.502***	1.132***	1.192***
	(0.027)	(0.058)	(0.111)	(0.193)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.000	0.020	-0.039	0.011
	(0.020)	(0.043)	(0.093)	(0.162)
N	435	435	117	117
$within - R^2$	0.834	0.320	0.633	0.448

Note: These estimates are used to analyze Question 1 and all definitions of the variables apply to this question. The explanatory variables are concerned with the balance sheets of Polish banks in this table. The liquidity shocks are observed on the Polish market (where all analyzed affiliate banks are present) and they are measured with the WIBOR-OIS spread. The estimated parameters that are significant at the 10%, 5% and 1% levels are denoted with '*', '**', and '***', respectively. Standard errors of estimated parameters are presented in parentheses.

Table B2: The effects of liquidity shocks in parent institutions on funding from foreign financial institutions and the lending activity of Polish banks during the crisis in the Eurozone between 3Q2010 and 1Q2013.

	$\frac{\Delta(Funding)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(NetDueFrom-To)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(LiquidAssets)_{i,t}}{Assets_{i,t-1}}$	$\frac{\Delta(Loans)_{i,t}}{Assets_{i,t-1}}$
Parent banks from PIIGS countries	all banks	all banks	all banks	all banks
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	-0.073	0.952**	1.787***	-0.193
	(0.162)	(0.389)	(0.650)	(0.297)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	1.042**	-0.974	-1.025	0.055
	(0.411)	(0.984)	(1.638)	(0.036)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	0.140	-0.129	0.395	0.663***
	(0.095)	(0.226)	(0.378)	(0.179)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.006	-0.132	-0.629	-0.090
	(0.150)	(0.360)	(0.601)	(0.067)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	-0.521**	-0.034	-0.665	0.709
	(0.196)	(0.471)	(0.788)	(0.572)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.707**	-0.025	1.143	0.166**
	(0.339)	(0.812)	(1.541)	(0.070)
$logAssets_{i,t-1}$	-0.005	0.053	-0.015	0.070
	(0.023)	(0.054)	(0.092)	(0.075)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	0.019*	-0.014	-0.042	0.001
	(0.010)	(0.024)	(0.044)	(0.002)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	-0.080	0.054	-0.247	0.740**
	(0.123)	(0.294)	(0.490)	(0.367)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.258***	-0.047	0.272	0.014
	(0.091)	(0.218)	(0.363)	(0.035)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.841***	0.133	0.126	-0.073
	(0.057)	(0.136)	(0.325)	(0.114)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.049	-0.220	-0.086	0.009
	(0.109)	(0.261)	(0.524)	(0.037)
N	82	82	80	80
$within - R^2$	0.959	0.352	0.519	0.689
Parent banks from other countries				
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}}$	0.610***	0.214*	1.870***	0.335*
	(0.074)	(0.123)	(0.241)	(0.194)
$\frac{Commit_{i,t-1}}{Commit_{i,t-1}+Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.486***	0.207	-1.081**	0.078***
	(0.143)	(0.238)	(0.464)	(0.025)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}}$	-0.137***	-0.084	-0.387***	-0.094
	(0.035)	(0.058)	(0.112)	(0.097)
$\frac{IlliquidAssets_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.049	-0.129*	-0.420***	-0.016
	(0.045)	(0.075)	(0.145)	(0.015)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}}$	0.132	-0.158	-0.027	1.030***
	(0.090)	(0.150)	(0.292)	(0.262)
$\frac{Capital_{i,t-1}}{Assets_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.131	0.161	0.697*	-0.023
	(0.115)	(0.192)	(0.373)	(0.031)
$logAssets_{i,t-1}$	0.037**	-0.063**	-0.084*	0.159***
	(0.015)	(0.026)	(0.050)	(0.050)
$logAssets_{i,t-1} \cdot LiquidityShock_{i,t}$	0.012***	0.001	0.038***	-0.001*
	(0.003)	(0.006)	(0.011)	(0.001)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}}$	0.017	0.159	0.467**	-0.422*
	(0.068)	(0.113)	(0.220)	(0.236)
$\frac{Depostis_{i,t-1}}{NonRelatedLiabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	0.024	-0.024	-0.096	0.004
	(0.045)	(0.074)	(0.144)	(0.014)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}}$	0.812***	0.672***	-0.282**	-0.226*
	(0.041)	(0.068)	(0.133)	(0.135)
$\frac{NetDueTo_{i,t}}{Liabilities_{i,t-1}} \cdot LiquidityShock_{i,t}$	-0.015	-0.052	0.148	0.011
	(0.040)	(0.066)	(0.130)	(0.009)
N	410	410	406	406
$within - R^2$	0.665	0.303	0.315	0.250

Note: These estimates are used to analyze Question 2 and all definitions of variables apply to this question. The explanatory variables are concerned with the balance sheets of Polish banks in this table. The liquidity shocks are defined as LIBOR-OIS spreads (WIBOR-OIS spreads in case of Polish parent banks) and they are observed on the markets where the parent banks are present. The estimated parameters that are significant at the 10%, 5% and 1% levels are denoted with '*', '**', and '***', respectively. Standard errors of estimated parameters are presented in parentheses.