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Article

Net Interoffice Accounts of Global Banks: The Role of Domestic Funding

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Abstract: Existing literature has identified domestic restrictive monetary policy and deteriorating funding conditions as the predominant factors explaining the increase in *net interoffice accounts* of global banks, that is, the net liabilities of parent offices due to their related foreign offices. The purpose of this research is twofold. Firstly, it quantifies the responsiveness of net interoffice accounts to variations in different types of domestic funding. Secondly, the paper assesses whether the relationship between net interoffice accounts and domestic policy-steered rates depends on cross-sectional differences in the funding structure of global banks. Using US banks' balance sheets data collected by the Federal Financial Institutions Examination Council, the results highlight the importance of domestic repo borrowings in explaining net interoffice accounts, especially for larger banks during the crisis. On the other hand, a negative relationship between policy rates and net interoffice accounts is observed only for those global banks with a relatively higher share of repo borrowings.

Keywords: US global banks; bank funding; monetary policy; repurchase agreements; panel data

JEL Classification: F33; F34; F42; G21

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1. Introduction

The current dimension of international banking has no historical precedents. The great majority of large modern banking groups have an institutional structure that goes beyond national borders: global

banks hold more than $10 trillion assets through their foreign-related offices. The drivers of banking internationalization, through the establishment of affiliates, branches, and/or subsidiaries abroad [1], have changed considerably over the years, especially since the 1970s. Before the collapse of the Bretton Woods system, the growth in international banking activities was primarily driven by the need to support colonial expansion and to facilitate and finance trade and investments abroad [1]. Also, the opening-up of foreign facilities could allow banks to take advantage of more favorable foreign regulations and taxes, expand their activities by attracting local customers, and foster capital flows from high to low-savings countries.

In the last 30 years, banking internationalization has been greatly affected by financial liberalization, which has enabled foreign offices to engage in varied and more complex operations on behalf of the parent bank, such as currency carry trade activities [2–4] and the settlement of currency positions in the FX markets [5]. Also, foreign offices have allowed banks to hold a more diversified and less volatile portfolio on a consolidated basis [6–9].

More recently, the possibility of exploiting an internal capital market has been found to be an additional advantage enjoyed by global banks. De Haas and Lelyveld [10] show that parent offices reallocate capital among foreign subsidiaries depending on the phase of their business cycles, stimulating, in this way, cross-border contagion of shocks. Subsidiaries are found to react to balance sheet expansions of related institutions of the same banking group located elsewhere by enhancing their credit supply in the host country. However, during the latest financial crisis, De Haas and Lelyveld [11] find that subsidiaries have been affected by the financial instability experienced at the group-level and internal capital markets have been used by parents to import liquidity from subsidiaries.

Parent offices themselves can also benefit from borrowing through internal capital markets, as this allows them to cushion against domestic adverse monetary policy or funding shocks. Cetorelli and Goldberg [12] show that US parent offices increase their net liabilities due to their related foreign offices in response to negative monetary policy shocks, impairing the effectiveness of the domestic bank lending transmission channel. Cetorelli and Goldberg [13] have further showed that, during the latest crisis, US-located offices have resorted to borrowing from internal capital markets in order to avoid considerable deleveraging when hit by funding shocks.

It is only recently that net interoffice accounts have attracted notable attention, especially in those studies aimed at assessing cross-border contagion (such as [14] and [15]) and global imbalances [16]. This measure was formally used by Hattori and Shin [3] to understand the scale of carry trade activities of foreign banks located in Japan, especially during the years in which the Bank of Japan engaged in quantitative easing (2001–2006). More recently, [17] have also looked at net interoffice positions of global banks when investigating the behavior of foreign banks located in the US during the dollar funding crisis in 2009.

The purpose of this paper is twofold. Firstly, it aims to investigate the sensitivity of net interoffice accounts to different types of domestic funding, *i.e.*, obtained through repurchase agreements, interbank markets, and private sector deposits. In this regard, this research represents a first attempt to link net interoffice accounts to disentangled sources of domestic funding. Cetorelli and Goldberg [12] find significant responses of global banks' borrowings from internal capital markets to funding shocks;

[1] Unless otherwise mentioned, throughout this paper these three entities are defined collectively as "*foreign offices*."

however, they aggregate all banks' liabilities due to both domestic and foreign sectors. De Haas and Lelyveld [11] have looked at different sources of funding, such as wholesale debt; however, they investigated their effect on lending of parent and foreign offices rather than on net interoffice accounts. Understanding which type of domestic funding dry-up might induce global banks to increase their borrowings from related offices can help to better predict the extent of the cross-border propagation of shocks.

Secondly, this paper explores whether cross-sectional differences in funding through repurchase agreements of global banks result in heterogeneous responses of net interoffice positions to domestic monetary policy. This analysis is motivated by the intention to clarify the puzzling behavior of US banks' net interoffice accounts observed during the latest crisis. Indeed, previous findings suggest that net interoffice accounts fall during a period of monetary expansion; they reached their historical high of $583 billion in the last quarter of 2008, in the same quarter in which total borrowings of depositary institutions from the Federal Reserve reached the unprecedented level of $667 billion and the effective federal funds rate stood at only 0.2%. As showed by Cetorelli and Goldberg [13], during the crisis US global banks have increased their net interoffice debt because of deteriorating domestic credit conditions. It is, however, of interest to understand whether, as a general result, the funding structure of global banks should be taken into account when considering the responsiveness of global banks to monetary policy stances. Global banks that rely more on wholesale funding, for instance, might adjust their borrowings via internal capital markets according to the extent of liquidity in domestic non-deposit credit sources. An increase in the policy-steered rate, featured by inflating asset prices, might, indeed, lead those global banks with a high share of secured funding to borrow less from their internal capital markets. This would result in a negative relationship between the federal funds rate and net interoffice borrowings.

The two aims of the paper are pursued with the estimation of a two-step Generalized Methods of Moments dynamic regression [18] and [19] and a Panel Threshold Regression Model [20] respectively. Both empirical approaches use bank-level balance sheet information contained in the quarterly Consolidated Report of Condition and Income *(Call report)* collected from the Federal Deposit and Insurance Corporation (FDIC) database (https://www2.fdic.gov/call_tfr_rpts/).

The results show that net interoffice accounts increase when global banks reduce their borrowings from both the private sector (via sight deposits) and repo markets. This effect is more pronounced during the period 2007–2010 and for the largest 15 global banks. As expected, the effect of the federal funds rate on net interoffice accounts ceases to be significant during the crisis. In the second part of the empirical analysis it is found that an increase in the policy rate causes net interoffice accounts to increase for those banks that have a low repo funding-to-assets ratio. On the other hand, an increase in the policy rate causes net interoffice accounts to fall for those banks that have a high repo funding-to-assets ratio. These results point to a tight relationship between net interoffice accounts and collateral values: those global banks that have a relatively higher share of repo borrow more from their foreign counterparts whenever their collateral value deteriorates and financing via collateralised markets becomes more costly.

The article is organized as follows. Section 2 proposes a number of stylized facts that support the following empirical analyses and reports two sets of regression estimates. First, it presents the estimates of a dynamic panel regression in which net interoffice accounts are explained primarily by

US global banks' balance sheets' funding variables. Second, it reports the estimates of a threshold model aimed at assessing whether cross-sectional variations in funding structure result in different behavior of global banks *vis-à-vis* domestic monetary policy. Section 3 concludes.

2. Data Analysis and Model Estimations

2.1. Stylized Facts on Net Interoffice Accounts in the US

In the US globalization is a predominant feature of the banking sector: 17 of the 20 largest banks had foreign-related offices in 2007. Foreign operations of US banks are mostly conducted by their branches, which are domestically regulated and report on a quarterly basis to the Federal Financial Institutions Examination Council (FFIEC, form 030, US). Among all non-resident counterparties, foreign-related offices are the largest lenders to US financial institutions: in 2011 over 50% of gross foreign-held debt was due to own foreign offices. In net terms, domestically-located offices of US global banks are net borrowers to their foreign offices. As shown in Figure 1, net interoffice accounts, equal to the difference between interoffice liabilities and interoffice assets, are made up mainly of interoffice liabilities, while interoffice assets have historically been relatively low.

The biggest increase in interoffice liabilities of US banks was over the period 2002 to 2008, up by 550%. There are a number of possible factors that could potentially explain this trend: restrictive domestic monetary policy, carry trade activities, unsynchronized business cycles, and domestic funding conditions. However, a closer look at the stylized facts suggests that funding availability of US banks has been the most prominent factor in explaining the sustained increase in interoffice liabilities. First, the global dimension of the latest crisis weakens the hypothesis of capital re-allocation among offices located in countries experiencing different phases of the business cycle [10]. Europe and the UK, the two non-offshore foreign banking systems to which US banks have the largest inter-office debts, for instance, were experiencing economic downturns as well. [2] Second, the carry trades explanation [3] could not justify this increase either, given that worldwide interbank interest rates have been converging and exchange rate volatilities increasing, resulting in large FX position unwinds [21]. Policy interest rate differentials *vis-à-vis* the euro area and the UK, for instance, have remained positive or null during the whole crisis. Third, interoffice liabilities could not have been stimulated by a restrictive domestic monetary policy: from late 2007 they have kept rising despite the rapid and drastic cut in the federal funds rate and several emergency liquidity injections by the Fed. Figure 2 below shows the evolution of interoffice liabilities in relation to the federal funds rate: over the *great moderation* period, characterized by low interest rates and steady credit expansion, the growth in interoffice liabilities was rather contained. In late 2004, however, interoffice liabilities started to escalate following the gradual rise in the federal funds rate. This evidence is in line with the argument that when domestic monetary policy is tighter, liquidity flows from foreign-related offices to parents are higher [12]. However, the crisis period has shown a reversal in the relationship between these two series: interoffice liabilities have kept on increasing, notwithstanding the low levels of the federal funds rate.

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[2] The majority of interoffice liabilities of US banks are owed to offices located in off-shore centres. Thus, the exact location from which the debt originates cannot be exactly established (see [2]).

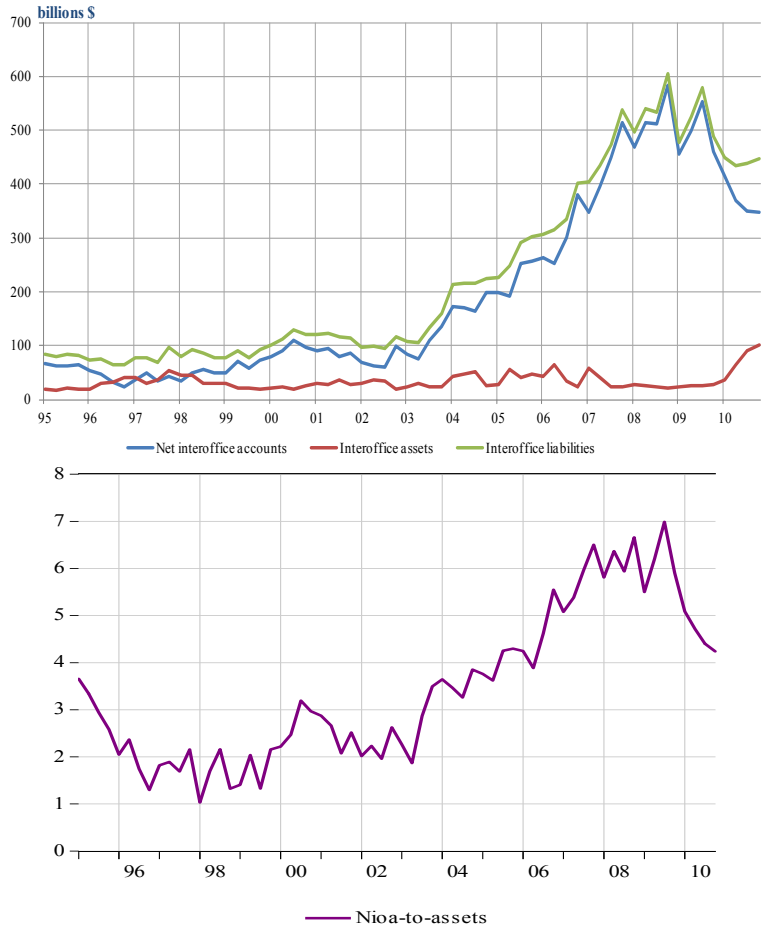

Figure 1. Net interoffice accounts of US global banks. (Source: Federal Reserve Board and Call Report. Note: Net Interoffice Accounts have been computed by the author as the difference between interoffice liabilities and interoffice assets.)

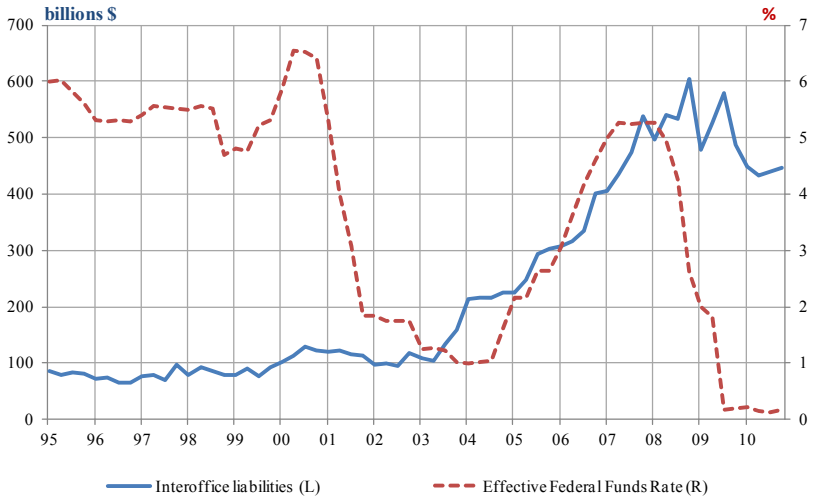

Figure 2. Interoffice liabilities and the Federal Funds Rate. Source: Federal Reserve Board and Call Report.

The disconnection between interoffice liabilities and policy interest rates during the crisis can be attributed to disruptions in funding markets. The level of the federal funds rate, indeed, does not yield

adequate information on the ease of obtaining funding from sources other than the central bank. In particular, during the crisis, the Fed's non-conventional interventions, *i.e.*, in the form of considerable liquidity injections, pushed the federal funds rate to historically low levels while funding from other sources was disrupted. Falling asset prices and difficulties in pricing some illiquid securities held on the banks' balance sheets had, indeed, notable consequences on both secured and unsecured borrowings.

The tensions in the unsecured credit markets, particularly in interbank markets, since the outburst of the subprime crisis were mainly generated by the increase in counterparty risk, which resulted in rising margin requirements and widening of Libor-OIS spreads [22]. As shown in Figure 3a below, when unsecured funding illiquidity resulted in considerable spikes in the Libor and Libor-OIS spreads, changes in interoffice liabilities have followed a similar path to that of those spreads. Indeed, the peak of the interoffice liabilities in 2008 coincided exactly with the historically high level of the LIBOR-OIS spread, which reached over 3.5% in the last quarter of 2008. Interoffice liabilities started to decrease only in the second quarter of 2009 when the Libor-OIS spread in the US returned to levels below 1%.

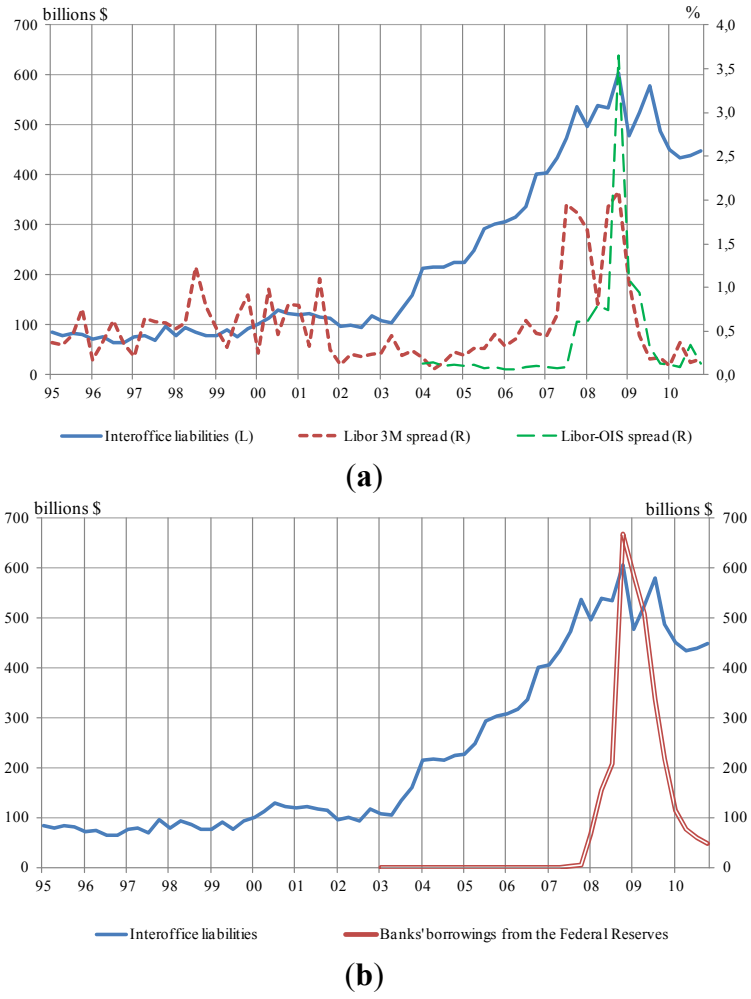

Figure 3. Interoffice liabilities and the Libor and 3M Libor-OIS spreads (**a**) and borrowings from the FED (**b**). Source: Federal Reserve Board, Datastream and Call Report.

Figure 3b shows that the relatively large decline in interoffice liabilities at the beginning of 2009, *i.e.*, the first time since the beginning of the crisis, also coincided with the introduction of the *Term*

Asset-Backed Securities Loan Facility (*TALF*) *program*. With the TALF, conditions in funding markets started to ease as banks were granted additional funds of $1 trillion, together with the possibility of borrowing from the Fed by using a much wider class of collateral (including mortgage-backed ABSs). Borrowing through repurchase agreements, which constitute a prominent source of funding for US banks, were also severely hit by the turmoil as activity in repo markets dried up and repo transactions were limited to those involving very short-term maturities and highest-quality collateral. As can be seen in Figure 4 below, until late 2006, interoffice liabilities and securities sold under agreements to repurchase (levels) were moving at a similar pace. Afterwards, repo borrowings by US global banks have slowed down, keeping steady at about $300 billion until sample-end while net interoffice liabilities have kept on increasing. In particular, since 2006 the quarterly growth rates of the two series have moved in opposite directions, suggesting a certain degree of substitution between the two funding sources.

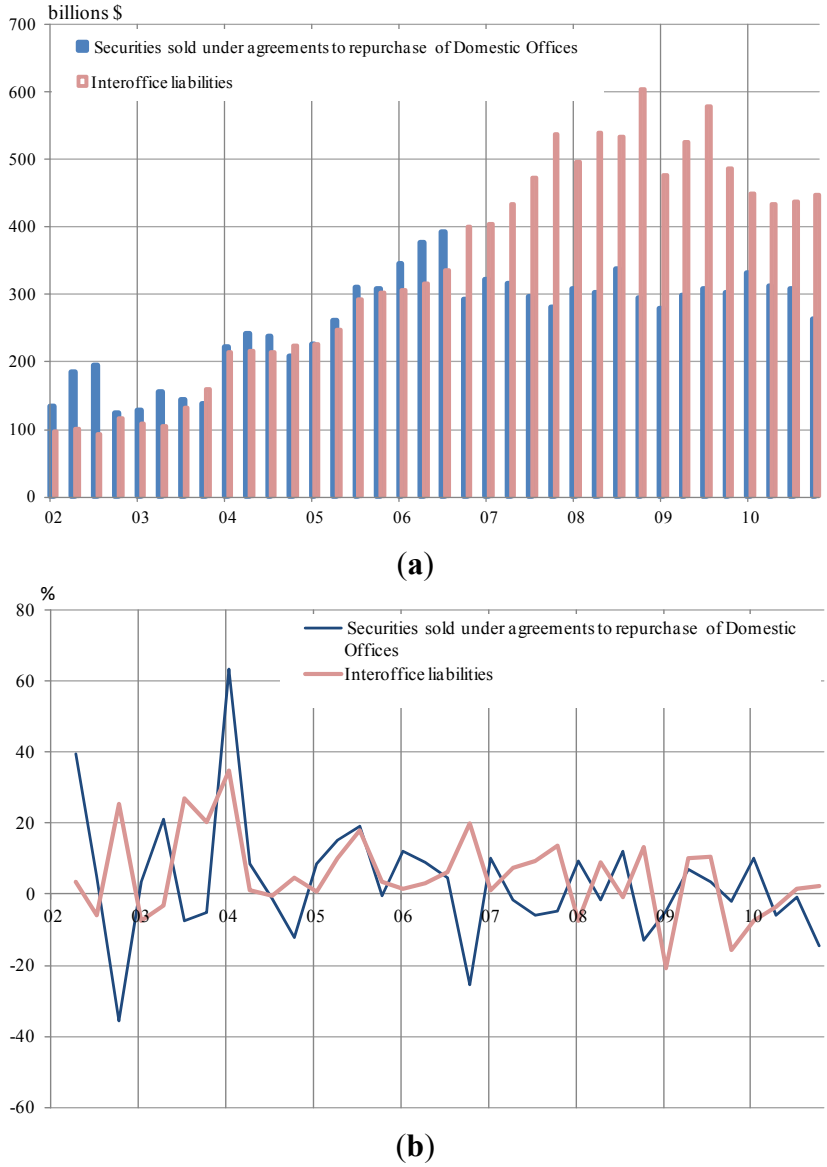

Figure 4. Interoffice liabilities and securities sold under agreements to repurchase: (**a**) levels; (**b**) quarterly growth rates. Source: Call Report.

2.2. Empirical Investigation

2.2.1. Variables and Sample

The econometric analysis presented in this paper is centered on several bank-level variables available from the quarterly *Report of Condition and Income*, or *Call Report*, collected by the Federal Financial Institutions Examination Council (*FFIEC*).

A bank is defined as *global* whenever it has non-zero values of *net due to*/*from own foreign offices, Edge and Agreement subsidiaries, and IBFs* (Schedule RC-H [3]) at some point of the chosen sample. The dependent variable is Net Interoffice Accounts, *nioa*, which is constructed as the difference between "*due to*" and "*due from*" own foreign offices, Edge and Agreement subsidiaries, and IBFs so that it takes on a positive (negative) value whenever parent offices are net borrowers (lenders) *vis-à-vis* their foreign offices.

The descriptive statistics of *nioa* reported in Table 1 show that despite the fact that in 15 years the number of US global banks has almost halved (201 in 1995 *vs.* 113 in 2010), aggregated net borrowings owed to foreign offices have more than tripled from 2002 to sample-end. In 2008 *nioa* reached its historical high of $583 billion; in the two following years it diminished slightly but still remained higher than the levels observed before 2006. There is large cross-sectional variation in *nioa*, as can be noticed from the very low values of mean and median and very large minimum and maximum values, more marked towards the end of the sample.

Table 1. Descriptive Statistics for net interoffice accounts (NIOA), $Bn.

Year	Sum	Mean	Median	Min	Max	Std. Dev.	Obs.
1995	63.1	0.3	0.0	−6.0	8.9	1.2	201
1996	23.0	0.1	0.0	−16.5	7.1	1.6	188
1997	43.6	0.3	0.0	−12.5	11.5	2.3	152
1998	62.0	0.5	0.0	−4.2	8.1	1.5	134
1999	81.5	0.6	0.0	−3.0	11.9	1.8	131
2000	110.4	0.9	0.0	−3.4	20.7	2.7	128
2001	96.0	0.8	0.0	−3.7	18.8	2.8	122
2002	99.1	0.9	0.0	−7.4	21.2	3.0	116
2003	140.4	1.3	0.0	−7.4	16.3	3.6	111
2004	197.9	1.8	0.0	−9.0	48.4	6.4	107
2005	255.4	2.1	0.0	−30.2	65.1	8.5	124
2006	378.4	3.3	0.1	−8.2	81.0	11.7	115
2007	513.0	4.4	0.1	−12.1	87.7	14.6	117
2008	583.0	5.0	0.1	−10.8	116.5	18.5	117
2009	459.6	4.0	0.1	−13.1	103.5	14.0	116
2010	346.9	3.1	0.1	−73.2	111.6	16.3	113

Source: Call report. Notes: Net interoffice accounts refer to the FDIC series "Net due to own foreign offices, Edge and Agreement subsidiaries and IBFs" (ffiec code rcon2941) minus "Net due from own foreign offices, Edge and Agreement subsidiaries and IBFs" (ffiec code rcon2163). Figures relate to amounts reported in the fourth quarter of the corresponding year.

[3] In particular, banks with foreign offices complete the FFIEC 031 reporting form, containing the Schedule RC-H.

As shown in Table 2, the larger the global bank (*i.e.*, in terms of total assets) the more it borrows in net terms from its foreign offices; in particular, in 2008 70% of *nioa* was due from the six largest banks with total assets of more than $200 billion. The bottom of Table 2 shows the *nioa*-to-assets ratio by bank size in order to gauge the relative importance of *nioa* in financing assets. The six largest global banks have a positive *nioa,* which depicts a relatively contained variability around the mean: between 2% and 14% of assets are financed by *nioa*. Medium-sized banks, on the other hand, have an average *nioa*-to-assets ratio equal to 0.073 but the degree of heterogeneity is more important. For some banks, *nioa* are a very important source of funding, financing up to 31% of assets. Medium-sized banks do not depict large net outflows to their related offices: the largest negative *nioa* is equal to only 0.08. Small banks, on the other hand, have the highest heterogeneity in terms of relative importance in *nioa* as a source of funding: while on average only 5.5% of assets are financed by *nioa*, this source of funding can be extremely important for some banks, going up to 80% of total assets. Among all global banks, small banks depict important net lending to their foreign related offices via their internal capital markets: their largest negative *nioa* is equal to 0.44.

Table 2. *Nioa* and bank size as of the first quarter of 2008.

Total Assets Range ($bn)	***Nioa***	**Number of Banks**	**% of Total**
>200	304	6	70
>100 and ≤200	78	7	18
≤100	54	60	12
		***Nioa*-to-Assets**	
Total Assets Range ($bn)	**Mean**	**Max.**	**Min.**
>200	0.064	0.14	0.02
>100 and ≤200	0.073	0.31	−0.08
≤100	0.055	0.80	−0.44

Source: Author's calculation based on data from FFIEC.

The quarterly unbalanced panel considered in the estimation contains 102 global banks over the period 1995 to 2010; the banks included in the sample are those for which at least seven years of consecutive data points of *nioa* are available.

The bank-level balance sheet variables considered primarily capture the ease of obtaining funding from a variety of channels. Funding of domestic offices is broken down into borrowings in the form of domestic inter-bank debt, private sector deposits, and repurchase agreements. The former two types of funding are further classified into demand and term deposits. Funding availability at foreign offices is proxied by total deposits. The effective federal funds rate is used to keep close track of the central bank's steered policy rate. A number of macroeconomic variables were initially incorporated to the analysis to capture other possible determinants of *nioa*, such as interest rate differentials, exchange rates, and real GDP, but they were not found to significantly explain changes in *nioa* over the sample considered. Details and summary statistics on all the variables kept in the analysis are reported in Table 3.

Total deposits held by foreign offices have expanded greatly over the years, reflecting the growing importance of banking globalization: they quadrupled over the period 2001–2009 reaching $1.3 trillion. Funding obtained by domestic offices from domestic markets comes mainly from transaction deposits of the private sector ($383 billion in 2009) and securities sold under repo agreements ($256 billion in

2009). Funding though interbank deposits has increased notably over the years, reaching a total of almost $50 billion in 2009 (transactional and non-transactional confounded).

Table 3. Summary statistics and source of other balance-sheet variables, $Bn.

Total		Source	Code	Availability
	Total deposits at foreign offices	Call Report	rcfn2200	1995–2010
1995	226.89			
2001	469.36			
2009	1301.43			
	Non-transaction deposits at domestic offices of the private sector	Call Report	rcon2385	1995–2010
1995	0.08			
2001	1.52			
2009	10.52			
	Transaction deposits at domestic offices of the private sector	Call Report	rcon2215	1995–2010
1995	129.52			
2001	250.12			
2009	383.00			
	Interbank non-transaction deposits at domestic offices	Call Report	rconb552	2001–2010
1995	-			
2001	5.04			
2009	22.67			
	Interbank transaction deposits at domestic offices	Call Report	rconb551	2001–2010
1995	-			
2001	17.28			
2009	25.06			
	Securities sold under agreements to repurchase at domestic offices (*)	Call Report	rconb995	2002–2010
1995	-			
2001	128.20			
2009	255.96			

(*) Figures for 2001 refer to those of the first quarter 2002.

2.2.2. Model Estimation I

The inference is based on the following autoregressive-distributed lag model:

$$nioa_{i,t} = \beta_j nioa_{i,t-1} + \mu_p dep^F_{i,t} + \kappa r_{i,t} + \Phi'_{i,t}\lambda + \alpha_i + v_{it}, \quad (1)$$

where i is the index for each bank such that $i = 1,...,N$ and t is the time index. The variable *nioa* represents net interoffice accounts and $dep^F_{i,t}$ are deposits at foreign offices. The vector $\Phi_{i,t}$ mainly contains those variables that refer to different sources of funding available to domestic offices: demand

and term deposits of both the private sector and domestic banks and collateralized borrowings (*i.e.*, under repurchase agreements). $r_{i,t}$ is the federal funds rate and α_i is the unobserved bank-specific effect.

Judson and Owen [18] suggest that in a dynamic setting with an unbalanced panel and a small time sample, the *Generalized Method of Moments (GMM) is the most suitable framework for estimating asymptotically efficient estimators*. Here the Arellano-Bover/Blundell-Bond two-steps estimator [19] has been employed in order to overcome the weak instrument problem that might arise when the dependent variable is highly persistent and/or the ratio of the variance associated to the fixed effect to the variance of the idiosyncratic error is too large. The standard errors are corrected for heteroskedasticity and serial correlation and the Sargan test is carried out in order to test the validity of specification of the estimated model.

The first column of Table 4 reports the GMM estimates of (1) with a limited set of variables (*i.e.*, excluding interbank and repo domestic borrowings), that is, all those series that are available over the whole sample 1995–2010 (see Table 2 for details). The second and third columns report the estimates of (1) over the samples 2002–2010 and 2007–2010, respectively; the former sample is chosen according to the availability of the repo debt and interbank borrowings variables.

Table 4. GMM Estimation, Dependent variable: *nioa*.

Variables	Sample 1995–2010	Sample 2002–2010	Sample 2007–2010
$nioa_{t-1}$	0.830 *** (0.000)	0.833 *** (0.000)	0.259 (0.318)
Foreign deposits	0.038 *** (0.000)	0.054 *** (0.000)	0.420 ** (0.204)
Federal funds rate	25323.43 *** (14.59)	91384 *** (25.84)	−77270 * (39689)
Non-transaction deposits	0.548 *** (0.000)	0.565 *** (0.000)	1.679 * (0.860)
Transaction deposits	−0.039 *** (0.000)	−0.161 *** (0.000)	−0.514 * (0.279)
Interbank non-transaction deposits	-	0.640 *** (0.000)	0.620 (0.710)
Interbank transaction deposits	-	1.183 *** (0.000)	0.221 (1.706)
Repo debt	-	−0.068 *** (0.000)	−0.554 *** (0.071)
Cross-sections included	102	92	48
Sargan test *p*-value	0.566	0.737	0.939

Notes: Table 4 reports the estimates of a dynamic Generalized Methods of Moments (GMM) regression where Net Inter-Office Accounts (*nioa*) is the dependent variable. Standard errors and covariance are corrected for heteroskedasticity and serial correlation [23]. Standard errors in parentheses. As in Arellano and Bover [19] and Blundell and Bond [24] the instruments used are the lagged differences (for the level equation) and lagged levels (for the differenced equation). A two-steps estimator is computed and the fixed effect is removed with orthogonal deviations. The Sargan test for over-identifying restriction is distributed according to a χ^2 distribution. The crisis dummy takes the value of 1 over the period 2007 quarter 3–2010 quarter 4 and 0 otherwise. ***, **, * refer to statistical significance at the 0.001, 0.05, and 0.1 level, respectively.

Availability of deposits available at foreign offices has a positive and significant effect on *nioa* in each of the three regressions; however, during the crisis, the estimated coefficient of foreign deposits is much larger and equal to 0.420 compared to 0.038 in the overall sample period. This result implies that *nioa* is positively related to the availability of stable liquidity funding such as deposits available at foreign offices. During the crisis, this relationship is even stronger, reflecting an intensified redistribution of liquidity among banking groups via internal capital markets; this result is similar to the findings by Cetorelli and Goldberg [13]. Moreover, this result supports the possibility of a

flight-to-safety effect witnessed during the financial crisis; that is, foreign depositors might have switched their deposits away from US branches in favor of domestic banks, triggering a fall in *nioa*. The effect of the federal funds rate is positive and significant over the whole sample: an increase in the federal funds rate by 1% increases the average *nioa* by over $25 billion. This result confirms the previous findings that global banks respond to a domestic restrictive monetary policy by importing liquidity via their internal capital market. During the crisis, however, this general result does not hold anymore: the estimated coefficient of the federal funds rate is negative and marginally significant. This result reflects the fact that domestic funding conditions, such as those in repo markets, rather than the monetary policy stance, have been an important driver of *nioa*, notwithstanding the low level of the federal funds rate. This result is in line with the findings by De Haas and Lelyveld [11] and is further confirmed by the estimated coefficient of repo debt, which is negative and strongly significant in both samples. The estimated coefficient suggests a sizable degree of substitution between funding through repo and internal capital markets, especially during the crisis, when every $1 fall in repo debt increased *nioa* by $0.56. Therefore, the reduction of liquidity in repo markets, caused by the deterioration of banks' balance sheets and uncertainty about the fundamental value of some assets, has led global banks to tap this drop in funding by withdrawing funds from their foreign offices.

Transaction deposits are also negatively related to evolution in *nioa*; its estimated coefficient is four times larger during the crisis than over the sample 2002–2010 even if it is significant at the 10% level. Lastly, it is interesting to note that the other types of funding—non-transactional deposits and interbank markets—have positive and significant coefficients over the sample 2002–2010. This positive relationship can be explained by the fact that not all changes in funding are replaced by *nioa*. As found in De Haas and Lelyveld [11], during stable economic conditions internal capital markets are used to redistribute liquidity across the banking group. Therefore, during buoyant economic conditions in which savings are high and interbank markets are functioning correctly, the increase in *nioa* is due to liquidity redirection through internal capital markets rather than compensating for the loss of a domestic funding source.

Most of the regression estimates of (1) during 2007–2010 are either not significant or become marginally significant. This is probably due to the fact that there are important cross-sectional responses in the way *nioa* was affected during the crisis. Most notably, it could be argued that the large degree of substitution between repo debt and *nioa* could be more important for larger banks that rely more on wholesale funding.

Table 5 below replicates the estimation in the last column of Table 4 by bank size over the period 2007–2010. The first column reports the estimates of (1) for the four largest banks, those with average total assets over $1 trillion; the second and the last columns report the estimates for the banks with average assets equal to more than and less than $1 billion, respectively. For larger banks, the increase in *nioa* during the crisis was primarily explained by the contraction in funding from repo markets. In the sample of the largest 15 global banks, however, the fall in transaction deposits also significantly affects the increase in *nioa*. Smaller banks, on the other hand, have significantly increased their net borrowings from their internal capital market, however, not to respond to a particular domestic funding constraint. The increase in *nioa* for this subset of global banks was motivated by the availability of foreign deposits, implying that the liquidity that was imported was mainly driven by either a precautionary motive or to restore their balance sheet following increasing defaults. Smaller banks

were not affected as much as large banks by the dry-up in wholesale funding markets; however, they still needed to raise external funds to cover the losses brought about by nonperforming assets. The estimated effect on *nioa* reflects the increase in uncertainty witnessed in financial markets, translated into the greater difficulty for smaller banks of raising additional unsecured funding.

Table 5. GMM Estimation. Dependent variable: *nioa*, sample 2007–2010.

Variables	Largest 4 Banks	Largest 15 Banks	Other Banks
$nioa_{t-1}$	0.763 *** (0.216)	0.716 *** (0.163)	−0.029 (0.082)
Foreign deposits	0.110 (0.159)	0.140 (0.164)	0.857 *** (0.145)
Federal funds rate	1799562 (2583567)	−19287 (326006)	−25767 (11214)
Non-transaction deposits	−0.084 (1.510)	1.234 (0.888)	0.019 (0.150)
Transaction deposits	−0.313 (0.286)	−0.376 ** (0.156)	0.223 (0.183)
Interbank non-transaction deposits	0.525 (0.659)	0.456 (0.482)	0.686 (0.862)
Interbank transaction deposits	−0.326 (2.236)	−0.220 (1.683)	−0.848 (0.851)
Repo debt	−0.400 *** (0.093)	−0.432 *** (0.041)	−0.113 (0.128)
Cross-sections included	4	15	63
Sargan test *p*-value	0.565	0.206	0.649

Notes: Table 5 reports the estimates of a dynamic Generalized Methods of Moments (GMM) regression where Net Inter-Office Accounts (*nioa*) is the dependent variable. Standard errors in parentheses. Banks are ranked by their asset size and then classified as the largest four (assets on average greater than $1 trillion), the largest 15 (assets on average greater than $100 billion), or other banks (assets on average less than $100 billion). Standard errors and covariance are corrected for heteroskedasticity and serial correlation [23]. As in Arellano and Bover [19] and Blundell and Bond [24] the instruments used are the lagged differences (for the level equation) and lagged levels (for the differenced equation). A two-steps estimator is computed and the fixed effect is removed with orthogonal deviations. The Sargan test for over-identifying restriction is distributed according to a χ^2 distribution. The crisis dummy takes the value of 1 over the period 2007 quarter 3–2010 quarter 4 and 0 otherwise. ***, **, * refer to statistical significance at the 0.001, 0.05, and 0.1 level, respectively.

2.2.3. Model Estimation II

In the previous sub-section it has been argued that domestic funding conditions can be important determinants of *nioa*. Estimates from Table 4 point to the existence of a non-linear effect of the federal funds rate on *nioa*, while in Table 5 it has been shown that during the crisis the monetary policy rate does not significantly explain *nioa*. This section aims at shedding some light on whether the impact of the federal funds rate on *nioa* varies across banks depending on their funding structure rather than on their size. There is, indeed, still a large heterogeneity of banks in the group of small banks, some of which are also highly reliant on wholesale funding. Most notably, the focus will be here on funding through securities sold under repo agreements, which constitutes for many global banks an important source of funding, and, as shown in Table 4, has a negative and strongly significant effect on *nioa*. However, there are important cross-sectional differences in the ratios of repo funding-to-total assets in the considered sample of global banks, which can vary between 0 and 0.5.

Therefore, it might be interesting to investigate whether when the central bank reduces its steered rates to stimulate interbank borrowing and lending during a banking crisis, collateral deterioration

leads those global banks that finance a greater share of their assets through repo markets to rely relatively more on interoffice borrowings.

A Panel Threshold Regression Model (PTRM), as proposed by [20], is used to test whether the effect of policy rates on *nioa* differs when accounting for cross-sectional variations in funding through repo markets of global banks. The variables are divided by total assets as the focus here is on the relative importance of repo in a bank's funding structure.

The PTRM estimated has the following form:

$$\left(\frac{nioa}{a}\right)_{it} = \mu_i + \beta_1' r_t I((\frac{repo}{a})_{it} \le \gamma\ ) + \beta_2' r_t I((\frac{repo}{a})_{it} > \gamma\ ) + \beta_3' z_{it} + \varepsilon_{it}, \quad (2)$$

where I() is an indicator function, a_{it} stands for total assets of bank i at time t, r_t is the effective federal funds rate at time t, and $repo_{it}$ are securities sold under agreements to repurchase at domestic offices of bank i at time t. The vector z_{it} contains regime-independent variables such as the ratio of foreign deposits-to-total assets as well as additional regressors to reduce the possibility of spurious correlations.[4] ε_{it} is the vector of disturbances of bank i at time t and γ is the threshold of the variable *securities sold under agreements to repurchase-to-total assets*. Specification (2) allows the coefficient of r_t to depend on a *threshold variable*, which is the ratio of repo funding-to-total assets. Table 5 shows the regression slope estimates of (2) and the estimated threshold, γ, for the balanced quarterly panel over the period 2002 to 2010, which includes 51 global banks. The estimated coefficient of $r_t I((\frac{repo}{a})_{it} \le \gamma)$ is positive and significant at the 5% significance level, equal to 0.12. This result suggests that those banks that finance their assets with a lower share of borrowings through repo agreements, equal to 20% or less of their total assets (as found by the estimate of the threshold at the bottom of Table 6), adjust their *nioa* in the same direction of federal funds rates. For this kind of bank, then, the general result found in [12] holds: a loosening in domestic monetary policy results in a reduction in net borrowings of domestic banks from their foreign affiliates. The estimated coefficient of $r_t I((\frac{repo}{a})_{it} > \gamma)$, on the other hand, is negative and significant at the 5% significance level, equal to −0.35. That is, banks that finance more than 20% of their assets with borrowing through repo agreements react differently to a change in domestic policy rate: a fall in federal funds rate results in an increase in *nioa*.

This set of results confirms the prediction that those global banks that finance a greater share of their assets through repo markets borrow more from their foreign affiliates when their collateral deteriorates during a banking crisis. The negative and significant effect of federal funds rates on *nioa* for those banks can be explained as follows. The slow increase in the federal funds rate from 2003 happened in conjunction with inflating asset prices, which enhanced the value of banks' collateral. During this period, those global banks that were greatly reliant on borrowing from repo markets had strong collateral and borrowing from foreign affiliates was diminishing. However, as the federal funds rate started to fall dramatically in 2008 and the banking crisis had deteriorated banks' balance sheets,

[4] These regressors include the square and the cube of deposits at foreign offices and repo funding as well as the product of these two variables, as in [20].

global banks started borrowing more from their foreign affiliates, given the rising difficulty in borrowing from repo markets. Since regression (2) considers the variables normalized by total assets, the results in Table 5 might be driven entirely by the asset side of the bank balance sheet for high-repo-funded banks, rather than a shift in the *nioa*. Therefore, for robustness check, Table 7 below reports the two sets of estimates of a linear version of (2) in which the variables are not normalized by assets. The estimates of the first column refer to the sample of global banks with the highest gross amount of repo borrowings; the second column shows the estimates of the model for all other banks. The estimated coefficient of the federal funds rate is significant in both instances and is negative for the sample of banks with the largest amount of outstanding repo debt and positive for all other banks.

Table 6. Panel threshold regression estimation.

Dependent variable: *nioa*-to-assets		
Regime-dependent variable	**Repo financing**	**Estimate**
Federal funds rate	low	0.116 ** [0.049]
Federal funds rate	high	–0.352 ** [0.152]
Regime-independent variable		**Estimate**
Foreign deposits-to-assets	-	0.640 *** [0.070]
Threshold		
γ		0.202

Notes: The table reports the estimates of a Panel Threshold regression where NIOA-to-assets is the dependent variable. In brackets White standard errors, *i.e.*, corrected for heteroskedasticity and serial correlation [23]. ***, **, * refer to statistical significance at the 0.001, 0.05 and 0.1 respectively.

Table 7. Estimation by repo funding. Dependent variable: *nioa*.

Variables	Higher Repo	Lower Repo
Foreign deposits	0.354 *** (0.056)	0.263 *** (0.023)
Federal funds rate	−8283027 ** (3680297)	1268646 * (668641)
Cross-sections included	9	95

Notes: Table 7 reports the estimates of a Panel Two-Stages EGLS (cross-section random effect) regression where Net Inter-Office Accounts (*nioa*) is the dependent variable and the sample period 2002–2010. A constant (unreported) is included in the regressions. Banks are ranked according to their repo borrowings as higher (on average greater than $1 billion), and lower repo. Standard errors and covariance are corrected for heteroskedasticity and serial correlation [23]. The instruments used are assets and deposits held at foreign offices (sight and non-transactional. ***, **, * refer to statistical significance at the 0.001, 0.05, and 0.1 level, respectively.)

3. Conclusions

This paper contributes to further understanding the reasons why US banks borrow from their foreign offices. The first part of the empirical methodology focuses on banks' access to domestic funding, both from secured and unsecured markets, and its role in explaining changes in net interoffice accounts (*nioa*), that is, the net liabilities of parent banks due to their foreign offices. It is shown that

variations in domestic sight deposits and securities sold under repurchase agreements significantly affect *nioa* with a negative sign. Given their highest reliance on wholesale funding, this effect is more pronounced for the sample of large banks. However, the US global banks in the sample considered have a funding structure that varies considerably across institutions. Therefore, the second part of the empirical investigation shows that domestic monetary policy, proxied by the federal funds rate, affects positively and significantly net interoffice accounts only for those global banks whose funding structure entails relatively less borrowing through repo markets. This result suggests that cross-sectional differences in the funding structure of global banks are an important factor to be taken into account when investigating the dynamics of interoffice lending and borrowings.

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Conflicts of Interest

The author declares no conflict of interest.

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