

# Interbank Market Structure and the Bank Lending Channel of Monetary Policy Transmission

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**Abstract.** The transformations experienced by the banking systems worldwide over the course of the last three decades have been shifting the paradigm in almost every aspect of the theory of finance. In particular, the system has been identified as a critical structure for the transmission of monetary policy impulses onto the real economy, inspiring dedicated research in characterization of the specific aspects of this relationship. Accordingly, this study examines a simple extension of the theoretical model by Freixas and Jorge on the interbank market lending under perfect and asymmetric information. By allowing for the cross-border interbank market operations between the headquarters and affiliates of bank holding companies it is shown here that the foreign ownership of a considerable fraction of the financial system limits the effectiveness of the monetary policy in the host countries. This result is in line with the prior empirical treatments of the issue and, in spite of its simple setting, contributes to the establishment of a framework for its theoretical treatment.

## I. INTRODUCTION

The structure of the banking system and the related public policy controversies constitute an important part of the research framework traditional to the literature of industrial organization. The economic theory extensively discusses the role of the system's structure in aspects such as market competition, output and costs of particular financial services [1]. Only recently has this research been extended to include the characteristic of banking which gives it a singular interest for economics and public policy - its role in the transmission of monetary policy.

Monetary policy is one of the two main types of macroeconomic government policies used to regulate national economies<sup>2</sup>. It targets the smoothing of the fluctuations in macroeconomic indicators, with a primary goal of price stability. As such, it acts essentially through the change in benchmark and short-term interest rates,

the change in reserve requirements, or the change in the overall money supply [3]. Underlying policy decisions are translated into effect on the real economy through the monetary policy transmission channels (MPTC) [4]. Although the MPTCs are discussed extensively in the economics literature, no conclusive theoretical model exists which can account for the dynamics of their interaction or for their hierarchy [5].

The most commonly indicated MPTCs are: 1) the interest rate channel, 2) the exchange rate channel, 3) the assets price channel, 4) the balance sheet channel and 5) the bank lending channel [6]. The first three channels are part of the standard economic treatise under the money view of monetary policy. This assumes modeling the effects of monetary policy by focusing primarily on the money or loanable funds market, and without attributing any key role to the banks. It is assumed that deposits can be freely substituted with other forms of financing when their availability reduces, e.g. in response to monetary policy tightening [5-7].

The latter two channels come from the credit channel theory which takes into account that the aforementioned assumption is not always valid, as had already been postulated by Bernanke et al. in their seminal papers [8 and 9]. If the information about borrowers is costly to verify, because of the inherent asymmetry of information in the market for loans, then they cannot costlessly change a bank as the source of funding. This can have important consequences under contractionary monetary policy, as banks are likely to reduce the overall supply of credit (bank lending channel), or to react to devaluation of firms' collateral by selectively reducing further lending to them (balance sheet channel). In both cases the reaction can cause further decrease in investment and output, and adversely affect the real economy [5 and 10].

The extent of credit reduction by individual banks varies in accordance with their individual characteristics and financial constraints that they face [11]. Though controversial, the bank lending channel (BLC) is of particular importance as it points out that the structure of the financial system may play a critical role for the impact of monetary policy [12]. The mechanism behind the BLC has also been re-examined a number of times with the swift evolution of the financial systems worldwide. Currently, it is primarily treated in the studies of (international) financial integration and the studies on the impact of financial innovation, e.g. the advances in

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securitization [10, 11, 13–19].

This study aims to build upon the results on the role of the BLC in the transmission of monetary policy across state lines, via interbank markets of internationally operating banks. It follows the work of Freixas and Jorge on the impact of the asymmetry of information in the interbank lending on monetary policy transmission [20], the work of Hale on the formation of crossborder interbank relations and its dependence on the liquidity shocks [21], as well as the work of Cetorelli and Goldberg on the impact of international banking operations on the monetary policy in domestic markets [14]. In a simplified, stylized two country model, this research characterizes the impact of the structural changes within the interbank market (such as financial integration) onto the effectiveness of monetary policy. Furthermore, this study also characterizes the impact of asymmetry of information in the interbank market on the cross-border lending relationships.

Inspiration for the study is drawn directly from the interactions between large open economies (i.e. the U.S. and the EMU), with the adjacent economies in which large fractions of the banking assets are foreign owned (i.e. Latin America and the CEECs) [22–24]. The extent of financial integration during the previous two decades has left the latter economies directly exposed to the developments and shocks experienced in the U.S. and the EMU, and to the policies of the Fed and the ECB. The relationship is characterized by a great level of complexity, particularly because of the development and expansion of international interbank markets. It is therefore of great importance to reach a better understanding of this dependence, so that future practice of monetary policy will be able to account for it.

The study is split into sections as follows. In Section 2, the literature review gives a comprehensive introduction into the state of the research; it explores the principal motivation for the study and builds the argument for the theoretical model. Section 3 presents the model proposed in this study, while Section 4 gives an extensive discussion of the results, supported by the insights from the recent empirical research. Finally, Section 5 provides the concluding remarks and makes recommendations about the directions for future research.

## II. LITERATURE REVIEW

In 1969, anticipating the escalation of the discussion about the structural reforms of the U.S. financial system, Pelzman pointed out that economic theory had generally neglected the role of the banking system in the transmission of monetary policy [1]. At the time, the central fact about the American banking system<sup>25</sup> was that it was fragmented. The prohibition of branching, both within and across state boundaries, implied that the system was comprised of a larger number of small banks, and that

at the national level there was a great deal of heterogeneity in the structure. Bank markets were thus likely to respond differently to the centralized policy tools, as for example the use of the Fed monetary policy. Moreover, he predicted that a more fundamental change in the banking structure, such as the interstate branching, would imply an increase in bank size, reduction in the number of banks, and the response patterns to monetary policy equivalent to those of the contemporary nationwide branch system<sup>26</sup>. A structural change would thus require adjustments in the conduct of monetary policy to preserve its effectiveness.

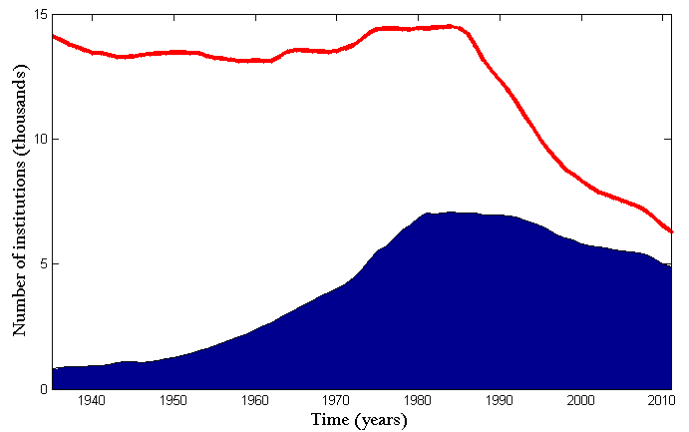


FIG. 1. Number of FDIC-insured commercial banks in the U.S., with the fraction that has branches given in blue. FDIC data 1935–2011

Over the course of the next two decades, foreign competition had stimulated substantially financial innovation and regulatory change in the U.S. This led effectively to the Fed adopting the federal funds rate as the operating target, and to the repeal of both Glass-Steagall (interindustry<sup>27</sup>) and McFadden (interstate<sup>28</sup>) restrictions on bank activities [22]. Consequences of the liberalization included a substantial increase in the merger and acquisitions activity (M&A), as well as aggressive competition in financial markets. The number of FDIC-insured commercial banks decreased radically from close to 14,500 in 1984 to below 6,300 in 2011 [29], see Figure 1. The number of branches, on the other hand, nearly doubled by 2011 to over 83,000. Interestingly, the consolidation occurred primarily within the individual states, and only later across borders. The overall result was a smaller number of large financial institutions, with fairly intricate internal networks of branches and with options to simultaneously engage in a wider spectrum of financial activities<sup>30</sup>[31].

An equivalent process was occurring in the EU, with the main catalysts being the integration of the capital markets in 1994 and the elimination of currency related risks through monetary integration in 1999. The number of separately chartered credit institutions declined from approximately 9,500 in the 1995 to less than 6,400 in 2004,

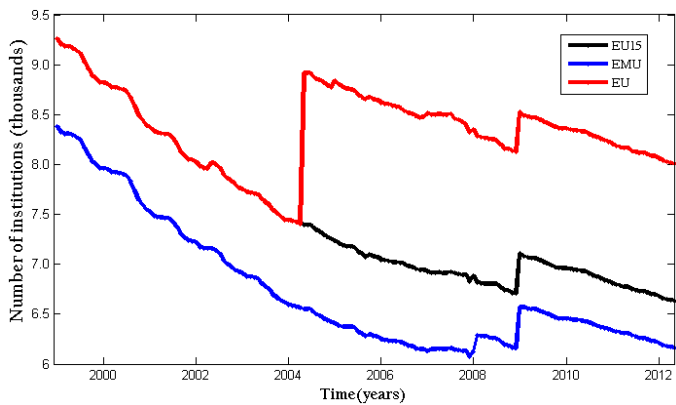


FIG. 2. Number of credit institutions since the introduction of the euro in the EU-15, the EMU and the EU. Peaks denote the 2004 enlargement and over 400 Irish banks that registered in 2009 as credit institutions following the escalation of the GFC. ECB data 1999-2011.

see Figure 2. The transformation was the most extensive in Germany, France and the Netherlands, with more than 40% reduction in the number of independent credit institutions. As in the U.S., the initial consolidation occurred within individual nations themselves, creating large national banks<sup>32</sup> [33]. Simultaneously, by 2006 the number of affiliates soared to more than 210,000 [29].

The dynamic transformations of the banking systems brought about extended interest with regard to the role the financial structure played in the monetary policy transmission. Financial aspects were first reintroduced in the works of Mishikin and Berbanke on macroeconomic models of the Great Depression, which pointed out that the depth and the persistence of the crisis were inherent in the collapse of the financial system [34 and 35]. This work allowed Bernanke et al. to pioneer the credit channel theory of monetary policy transmission and to introduce the idea of the BLC [8 and 9].

The original credit channel theory addresses the role of the banking system under asymmetric information, with external finance premium<sup>36</sup> as the key for understanding the transmission mechanisms [5]. The underlying assumption is that monetary policy can alter the supply of external finance, as its effects are unevenly distributed across economic agents [37]. The two subchannels identified within this framework are the balance sheet channel and, the topic of this inquiry, the bank lending channel. The two key assumptions built in the original BLC are that 1) bank loans and market finance<sup>38</sup> are imperfect substitutes and 2) banks react to a restrictive monetary policy by cutting down their lending to firms. The underlying reasoning is that firms without sufficient capital or reputation cannot issue direct debt, but rely instead on financial intermediaries and establish strong relationships with them. Financial intermediaries other than banks can, in principle, perform this role, but the relationship banking appears to dominate [39 and 40].

Firms with easy access to alternative sources of funding should be less sensitive to the changes in monetary policy. To identify the original BLC implies therefore to show that banks with different capacities to substitute funding sources for loans respond differently to monetary policy shocks [11].

The original BLC is rather controversial because of the mixed empirical evidence for its existence and importance [41]. In the early 1990s a series of research on the episodes of restrictive monetary policy found no support for the channel [42–44]. On the other hand, examinations of the composition of credit between bank and nonbank sources revealed that monetary contraction can lead to shifts in U.S. firms' mix of external financing, extending the issuance of commercial paper while reducing bank loans and limiting investment options [45].

Other successful studies focused primarily on the heterogeneous effects on different classes of agents that could signal a potential role for bank specific channels. They explored the cross-sectional heterogeneity in banks' characteristics which are considered critical for the banks' response to monetary shocks - bank size, liquidity, capitalization and efficiency. Kashyap and Stein found that small U.S. banks tend to be more sensitive to monetary policy shocks as compared to larger ones [46], in addition to the sensitivity being higher for the less liquid U.S. banks [47 and 48]. Peek and Rosengrin showed that poorly capitalized U.S. banks can have limited access to non-deposit financing under monetary contraction and could therefore be forced to reduce their loan supply by more than their well capitalized peers [49 and 50]. Finally, Jeon and Miller noted that Korean banks with better asset and liquidity management were less affected by the monetary policy shocks during the 1997-8 Asian crisis [51].

None of these effects appear to be universal across all economies though. They rather reflect the heterogeneity in the functioning and the organization of the national financial systems. At the turn of the century a considerable effort was invested into country-by-country empirical trials. The BLC channel has been identified repeatedly in a number of developed economies other than the U.S., e.g. in Austria, Belgium, Germany, Greece, France, Italy, Japan, the Netherlands and Switzerland [37, 48, 52–61]. Recently, the evidence for the channel has also been confirmed for a great number of developing countries in Latin America, Central and Eastern Europe and in Southeast Asia [62–76].

The cross-national heterogeneity in the operation of the banking based MPTCs brought about the recognition that surveying for the responses of the representative banks is not enough. To properly account for the role of the banking system in the transmission of monetary policy one needs to take into account the characteristics of the wider architecture of the financial system. As an example, Baglioni studied the propagation of monetary policy impulse through the loan market and showed that

under monopolistic competition<sup>77</sup> the strategic complementarity of the well-capitalized banks leads to the impulse amplification. In the Cournot oligopoly<sup>78</sup> framework the effect is of the opposite sign due to strategic substitutability [79]. Moreover, he showed that, under both frameworks, the well-capitalized banks are more important in shaping the system's adjustment to changes in monetary policy than what could be implied from their relative number in the system.

Following the GFC, the term financial architecture is largely synonymous with the network of lending relations between the financial institutions. In the case of the banking system this is the interbank lending market. International financial integration created systems in which banks are more likely to be dependent on one another, have correlated portfolios or be more exposed to systemic instabilities [80]. On the other hand, the interbank relations act to mitigate the asymmetry of information and can stabilize reactions of individual agents to a variety of financial shocks. In terms of monetary policy this primarily implies that banks affiliated to a larger bank holding company are less sensitive to contractionary monetary policy than the unaffiliated banks [48, 81–83]. Moreover, banks that are part of an active (national) interbank lending system, as is the case for the majority of banks operating in Austria, Finland and Germany, are less sensitive to the monetary policy shocks [84].

Critical for macroeconomic analysis is the international aspect of interbank markets. Namely, with the internal financial integration in the U.S. and the EU as well as the advance of financial integration of the emerging economies, ever larger number of bank holding companies headquartered in the developed countries have entered the developing markets via takeovers or greenfield positioning. In fact, foreign ownership of the bank assets totals to more than 80% in almost all of the CEECs and to over 60% in a number of Latin American economies [11].

This situation has raised questions about the effects of the international presence of large financial institutions on the monetary policy practices, both at home and in the host economies. Cetorelli and Goldberg show that the large U.S. banks with global operations experience a weaker BLC compared to the large U.S. banks with domestic operations [85]. Canova shows that financial channels play a crucial role in the transmission of U.S. monetary shocks to Latin America [23]. Moreover, by examining banking systems of emerging economies<sup>86</sup> Arena et al. and later Wu et al. reach the conclusion that domestic and foreign banks respond differently to changes in monetary policy [11 and 69]. Foreign banks are less sensitive to contractionary monetary policy in host countries compared to domestic banks. This effect is driven by factors independent of banks size, liquidity, capitalization or efficiency, implying that overall the original BLC has declined in strength. Nevertheless, the macroeconomic conditions and the changes in the deposit base in

the home country do affect the lending of foreign banks in host countries. The foreign banks may therefore have a stabilizing role for the host economy during banking crisis periods, but can also act to transmit shocks from the home country [11]. This study aims at giving a further theoretical examination of this mechanism.

Finally, a number of authors suggested that the mechanism behind the BLC has evolved far beyond its original framework. Firstly, there are arguments for extending the BLC to account for the effects of the asset price drops on the bank capital. Namely, a fall in asset prices can trigger losses in the banks' loan portfolios which can further result in the diminution of bank capital<sup>87</sup> and reduction of its supply [7 and 88]. Secondly, securitization and technological advances allowed for a wider set of institutions to become engaged in expanding credit<sup>89</sup> and for borrowers to bypass the banks as the key source of external finance<sup>90</sup>. Asset securitization has acted to reduce banks' funding needs in the event of monetary tightening and to reduce the regulatory requirements on capital [16, 48, and 91]. All this has evidently attenuated the original BLC. The recent post-GFC shrinkage of the "shadow banking system" however, points out that the BLC mechanism could be relevant to a wider set of financial intermediaries, not exclusively banks [7, 92, and 93] and that future research efforts should focus on understanding the structural impact of these processes on monetary policy transmission. These issues are beyond the scope of this study but remain relevant for the discussion of its results.

### III. MODEL

#### 1. Perfect Information in the Interbank Markets

The core of this study bridges the insights from the Freixas and Jorge's (FJ) model on credit rationing in the interbank markets and the simple stylized model by Hale on the establishment of cross-border interbank lending relationships [20 and 21]. The FJ model is extended to allow for the interbank markets of two countries to interact via the cross-border internal capital markets established between a headquarter bank and its affiliate. On the other hand, the work of Hale, in its simplest form, was used to characterize the properties of internal capital market linkages.

The two countries are Home and Foreign<sup>94</sup> (H & F). Their policy rates are  $r$  and  $r^*$ , where  $r, r^* \geq 0$ . By controlling the policy rates, central banks can affect the opportunity cost of holding deposits. In both countries there exists a continuum of firms with fixed size projects, 1 for each firm. The countries have independently functioning banking systems and interbank loan markets, as specified in FJ [20]. However, F is a developing economy with considerable unexplored investment opportunities and with a higher rate of return on projects  $R_0^*$  com-

TABLE I. Timing of Decisions and Events for the Key Agents in the Model - Perfect Information

Date	0	1 (liquidity shock at F)	2
Firm at F	Borrows 1 from the bank	If $\nu \leq \frac{Y^* - R_0^*}{1+r_L^*}$ borrows $\nu$ at rate $r_L^*$ , to continue with the project	If operational earns $Y^*$ and returns $R_0^* + (1+r_L^*)\nu$ to the bank
Domestic bank at F	Collects $D_0^*$ in deposits Lends 1 to firms Invests in securities	Return $B_0^*$ on securities. Change in deposits $D^* = D_1^* - D_0^*$ . Pursues the project if $\frac{Y^* - R_0^*}{1+r_L^*} \leq \nu \leq \frac{Y^*}{1+r_L^*}$ . Interbank market: Borrows $L^*$ at rate $r_L^*$ or invests for portfolio return $\rho_L$	Return on securities $B_1^*$ . If firm operates receives $R_0^* + (1+r_L^*)\nu$ . If only project is continued earns $Y$ . Repays $D_1^*$ for deposits. Interbank market: Earns $(1+\rho_L)L^*$ or returns $(1+r_L^*)L^*$
Affiliate at F	Ibid	Ibid Internal capital market: Borrows $L^*$ at rate $r_L$	Ibid Returns $(1+r_L)L^*$
Headquarters at H	Collects $D_0$ in deposits	Return $B_0$ on securities. Change in deposits $D = D_1 - D_0$ . Supports affiliate via internal capital market. Borrows additional $L$ in the interbank market in H. Invests $\mathcal{X}$ in F via affiliate	Earns $R_0 + B_1 + (1+r_L)L^* + (1+\rho_L)\mathcal{X}(r_L^* - r_L)$ . Returns $D_1(r) + (1+r_L)L$

pared to  $R_0$  in H. H is a developed economy, with larger, well functioning, saturated financial markets and overall better availability of financial information. In addition to that, the policy rate is lower for H, as is the rate for investments in its interbank markets,  $r_L \leq r_L^*$ .

In both countries there exists a large number of identical and risk neutral banks. Many of the banks in H are however clustered into large bank holding companies and, hence, the number of independent banking institutions  $N$  in H is lower than  $N^*$  in F. Under the assumption that each bank lends to firms with perfectly correlated portfolios, these firms can effectively be treated as a single firm. This allows for a 1-to-1 correspondence between banks and firms. The underlying framework is assumed to be that of relationship banking, where a bank has a perfect knowledge about the firm, while the firm is effectively the "captive" of the bank and cannot costlessly switch to another bank.

Fraction  $\alpha$  of all banks in F is foreign owned, i.e. there exist banks in H with affiliates in F,  $\alpha N^*$  of them. The affiliates of the same bank are considered to make highly correlated investments and are thus represented as a single bank unit in F. Since  $N \leq N^*$  there should, in principle, exist unaffiliated banks in F. The cross-border investments are unfeasible without own affiliates due to the "noise" in cross-border information exchange. Cross-border ownership on the other hand completely eliminates the asymmetry of information between the head bank in H and the affiliate in F.

The head bank in H is assumed to manage the capital globally, while its affiliate is focused on the local markets

in F. There is an internal capital market link between the head bank and the affiliate. The link operates at the lower of the two interbank market rates,  $r_L$ , which can also account for the exchange rate risk. The head bank uses this link to support its affiliate and to participate in the interbank market in F, since  $r_L \leq r_L^*$ . The profits from the latter investment are assumed to be directly attributed to the head bank and do not stick with the affiliate. The head bank can also borrow in the interbank market in H to invest in the interbank market in F.

There are three dates: 0, 1 and 2. Table I provides the detailed specification for the decisions taken by the key agents in the model. At date 0, firms establish project funding credit lines with respective banks with repayments due at date 2. Banks receive initial deposits ( $D_0 > D_0^*$ ) and allocate these funds between illiquid loans of unit size, which finance the projects of the firms, and liquid securities<sup>95</sup>, which on the other hand finance future liquidity shocks. The value of liquid securities of a bank at date 1 is  $B_0^*$ , which is uniformly distributed across banks so that  $[B^*, \bar{B}^*]$ ,  $0 \leq B^* \leq \bar{B}^*$ .  $E[B_0^*] = \frac{(B^* + \bar{B}^*)}{2}$  and has the variance  $\sigma_{B^*}^2$ . Realizations of  $B_0^*$  are hard information and are observable.

At date 1 firms in F suffer liquidity shocks. The shocks are denoted by  $\nu$ , and are identically and independently distributed across firms with a uniform distribution  $[\underline{\nu}, \bar{\nu}]$ ,  $\underline{\nu} \leq 0$ ,  $\bar{\nu} \geq 0$  and  $\underline{\nu} + \bar{\nu} \geq 0$ . Upon a shock, banks assess whether to support the firm, to liquidate the firm and take over the project, or to liquidate the firm and project all together and pursue investments

in interbank/securities market.

$B_0^* + D^*$  is the liquidity available to a bank in F at date 1. For shocks larger than this value banks support the projects by borrowing in the interbank market in F. Investments in the interbank markets bring effective portfolio rates  $\rho_L, \rho_L^*$  which are not necessarily equal to the direct borrowing rates,  $r_L$  and  $r_L^*$ . FJ assume that banks cannot borrow in interbank markets to invest in T-bills, i.e.  $L^*B_1^* \leq 0$  when  $r_L^* = r^*$ . To assure that the interbank market will exist in F, there has to be at least one bank that will not have enough liquidity to finance profitable projects, i.e.  $B^* + D^* \leq \min(\bar{\nu}, \frac{Y^*}{1+r^*})$ . However, central banks do not set the policy rates to generate a liquidity crisis, i.e.  $E[B_0^*] + D^* \geq 0$  in F. The market for bank loans is competitive and hence at date 1 the bank loan rate will be equal to the interbank lending rate, i.e.  $r_f^* = r_L^*$ <sup>96</sup>. To allow for the credit rationing there is an upper limit to the size of the loan  $L^*$  a bank can take in the interbank market,  $\bar{L}^*$ .

Following the logic in FJ, it is assumed that in order to obtain the key decisions related to the project, it suffices to investigate the optimal decision taken by a single integrated entity, which unites the firm and its bank. For simplicity reasons this is referred to as the "bank". The profit function of a bank in F is given then by the following expression:

$$\pi = Y^* - (1 + \gamma^*)(\nu - B_0^* - D^*) - D_1^*(r^*) \quad (1)$$

which should be maximized under

$$\nu + B_1^* = B_0^* + D^* + L^* \text{ and } L^* \leq \bar{L}^* \quad (2)$$

where

$$\gamma^* = \begin{cases} \alpha r_L + (1 - \alpha)r_L^* & \text{if } L^* \geq 0 \\ \rho_L^* & \text{if } L^* < 0 \end{cases} \quad r_L^* \geq \rho_L^* \quad (3)$$

or

$$\pi = (1 + \rho_L^*)(B_0^* + D^*) - D_1^*(r^*) \quad (4)$$

if the project is liquidated at 1. The expression for the project liquidation threshold is:

$$\nu = \begin{cases} \frac{Y^*}{1 + \rho_L^*} & \text{if } \nu \leq B_0^* + D^* \\ \frac{Y^* + (r_L \alpha + (1 - \alpha)r_L^* - \rho_L^*)(B_0^* + D^*)}{1 + \alpha r_L + (1 - \alpha)r_L^*} & \text{if } \nu > B_0^* + D^* \end{cases} \quad (5)$$

The latter expression shows that illiquid entity has a tougher liquidation policy than a liquid entity. The fact that  $\alpha$  appears in the expression (3) is indicative of the effect the presence of affiliates has on the convergence between the interbank interest rate in F and in H.

The cross-border differential in the interest rates orients the head banks in H to invest their pledgeable liquidity in the interbank market in F via their affiliates. As no shock occurred in H, the head bank will not have to invest additional funds into its firm's project. It will

have its liquidity at date 1,  $B_0 + D(r)$  available to invest into supporting the projects funded by its affiliate. If  $B_0 + D(r) \leq \nu - B_0^* - D^*(r^*)$  then the head bank considers borrowing L in the interbank market in H to support the affiliate. Moreover, it can borrow the additional amount  $\mathcal{X}$  to invest in the interbank market in F via its affiliate. The profit function for the head bank in H, integrated with its firm, is then given by the following expression:

$$\pi_H = Y - (1 + \gamma)(\nu - \Lambda) - D_1(r) - B_1^*(1 + \gamma) + (1 + r_L)L^* + \mathcal{X}(\rho_L^* - \gamma), \quad (6)$$

with the following constrains:

$$\nu - \Lambda = L - B_1^* - \mathcal{X} \quad (7)$$

$$L \leq \bar{L} \text{ and } L^* \leq \bar{L}^* \quad (8)$$

where the liquidity available to the holding at date 1 is

$$\Lambda = B_0 + D_0(r) + B_0^* + D_0^*(r^*) \quad (9)$$

and

$$\Delta = D_1(r) + D_1^*(r^*) \quad (10)$$

and

$$\gamma = \begin{cases} r_L & \text{if } L \geq 0 \\ \rho_L & \text{if } L < 0 \end{cases} \quad (11)$$

The profit function for the holding's global operations is

$$\pi_T = Y + Y^* - (1 + \gamma)(\nu - \Lambda) - \Delta - (\gamma^* - \gamma)B_1^* + (r_L - \gamma^*)L^* + \mathcal{X}(\rho_L^* - \gamma), \quad (12)$$

Using the profit function it is possible to determine the conditions for the liquidation of any or both of the projects ran by the holding. In the expressions that follow total output is denoted with  $\mathcal{Y}$ , while  $\nu$  denotes the shock at the head bank's firm,  $\nu^*$  the shock at the affiliate's firm, and the cumulative shock is denoted by  $\mathcal{N}$ . The thresholds for supporting the project in F are

$$\nu^* = \begin{cases} \frac{Y^*}{1 + \gamma} & \text{if } \nu^* < B_0^* + D^* \\ \frac{Y^* + (r_L - \rho_L^*)(B_1^* - L^*)}{1 + \gamma} & \text{if } \nu^* \geq B_0^* + D^* \end{cases} \quad (13)$$

The thresholds for supporting the project in H are

$$\nu = \begin{cases} \frac{Y^*}{1 + \rho_L} & \text{if } \nu < B_0 + D \\ \frac{Y^* + (\rho_L^* - r_L)(B_1^* + \mathcal{X})}{1 + r_L} & \text{if } \nu \geq B_0 + D \end{cases} \quad (14)$$

The thresholds for supporting both projects

$$\mathcal{N} = \begin{cases} \frac{\mathcal{Y}}{1 + \rho_L} & \text{if both liquid} \\ \frac{\mathcal{Y} + (\rho_L^* - r_L)(B_1^* + \mathcal{X} - \Lambda)}{1 + r_L} & \text{only F liquid} \\ \frac{\mathcal{Y} + (\rho_L^* - r_L)(\bar{L}^* - B_1^*)}{1 + \rho_L} & \text{only H liquid} \\ \frac{\mathcal{Y} + (\rho_L^* - r_L)\bar{L}^* + (\rho_L - \rho_L^*)B_1^* + (r_L - \rho_L)(\Lambda - \mathcal{X})}{1 + r_L} & \text{if both illiquid} \end{cases} \quad (15)$$

assuming that the head office will use the opportunity to borrow from H and invest in F.

If there is perfect information in the interbank market, then every bank knows about the cost overrun suffered by the projects of its peers and only banks which can fully repay their interbank loans can obtain funds in the interbank market. Perfect information will eliminate all the risk premia in F and hence  $\rho_L^* = \alpha r_L + (1 - \alpha)r_L^*$ . Furthermore, assuming that there is no shortage in liquidity in the system, the latter rate should be equal to the risk-free rate  $r^*$ . For  $\alpha$  approaching 1 this would imply convergence between the interbank market rate at H and the policy rate in F. Assuming that  $r_L$  is exogenous for the monetary authority in F, this simplified setting with perfect information implies that the authority will be facing an external pressure to adjust its policy rate.

## 2. Asymmetric Information in the Interbank Markets

The previous case considered extensively the operations of the cross-border banks and their effect on the monetary policy of a host economy under perfect information. This setting allowed for a more uniform effect of the financial integration on the banking system in F, but it is more likely that the integration process will not make all the banks in F equally better/worse off. If the information symmetry is broken so that the value of the shock a firm incurs is not known to the banks that are not working with the firm, the entire setting becomes more complex. The discussion in this section focuses on the cases in which there is asymmetry of information between a bank and its peers. The asymmetry allows for market inefficiencies such as gambling for resurrection by insolvent banks and pursuit of private benefit projects by bank managers.

FJ take into consideration the latter effect and allow for bank managers to pursue an alternative project which brings a pledgeable return  $K^* < Y^*$  and amount  $\mu L^*$  in private benefits. The amount of private benefits is proportional to the loan size, so managers of highly insolvent banks will be likely to use this option as their exit strategy. The present value of the banks' collateral, which can be appropriated by the interbank lenders in case of the default, is given by the following expression

$$\hat{L}^* = \frac{K^* - D_1^*(r^*)}{1 + r_L^*} \quad (16)$$

with the minimal amount of liquidity the bank is guaranteed to have access to as:

$$\hat{F}^* = B_0^* + D^* + \hat{L}^* \quad (17)$$

FJ then consider a specific case where only the riskless competitive contract menu (RCCM) is offered to the potential borrowers. The RCCM basically means that the lending is limited to the present value of bank collateral

( $\hat{L}^*$ ). This implies that, despite the interbank lending being unsecured, there are no spreads in the interbank market. Since the loans lower than  $\hat{L}^*$  are riskless, the competition equates the interbank lending rate and the return rate on interbank portfolios, i.e.  $r_L = \rho_L$ . This setting requires a great deal of additional assumptions which make the transition to the two country case rather difficult. Even further, the overall analysis focuses on the estimates of aggregate net demand for the interbank market and uses these estimates to express the RCCM equilibrium interbank rate  $r_L^*$  analytically in terms of the policy rate  $r^*$ .

As the generalization of the RCCM is overly complex for the two country case, the goals of this section are reduced to estimating the effect of the change in the interbank lending rate on the net bank lending in F given set values of  $r^*$  and  $r_L^*$ . These values are taken as the boundary values for  $r_L$ , as in case  $r_L < r^*$  the existence of cross-border interbank links would support excess demand in the affiliates. On the other hand,  $r_L > r_L^*$  would make the internal capital market useless for the affiliate. The drawback of this approach lays in the fact that the model is a 3 dates model and does not specify the intuitively expected adjustments of  $r_L^*$  upon the changes of  $r_L$ . It however provides an indirect estimate of how the change in the  $r_L$  affects the credit rationing implied in the FJ model. The affiliated and unaffiliated banks are considered separately.

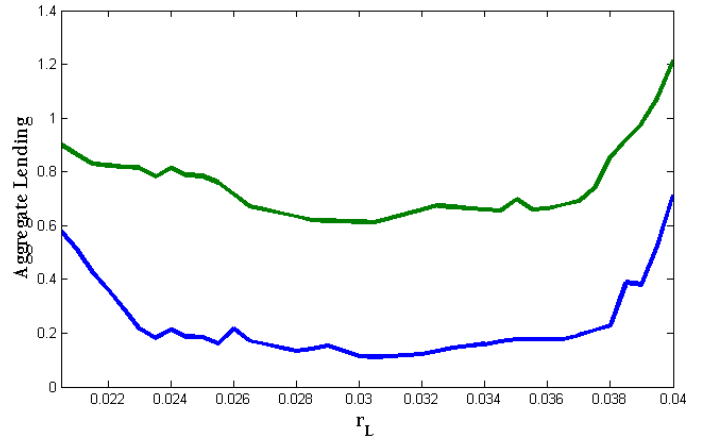


FIG. 3. Aggregate lending in F (in thousands of U.S. dollars), given as a function of  $r_L$ , by affiliate (in blue) and by other banks (in green).  $\alpha = 0.3$ ,  $r^* = 0.02$ ,  $r_L^* = 0.04$

The simulation is essentially a multiagent model, with agents representing individual banks. There are 100 banks in F and 80 in H. Parameter  $\alpha$  takes two values: 0.3 and 0.6. For each agent the return on the initial investments in securities,  $B_0^*$  or  $B_0^*$ , the value of the shock,  $\nu$ , and the production worth of the project,  $Y$ , are assigned from the uniform distribution specified in FJ. Similarly, the value of  $K$  is taken, but with  $\frac{2}{3}Y$  as its maximal and one as the minimal value, while the potential private

benefits are constrained by the determination of the loan requirements given below. The value of initial deposits  $D_0$  or  $D_0^*$  is fixed and equal for all banks, while deposits at date 1 are taken from the uniform distribution about the initial value, with the maximum  $D_0(1+r)$ . The simulation starts with a random assignment of affiliations to a specified fraction of banks in F. In continuation, each agent explores the strategy given in FJ and determines optimal  $B_1$  or  $B_1^*$  and  $L_1$  or  $L_1^*$  respectfully, and in addition,  $\mathcal{X}$  is optimized for H banks. The strategy provides the parameters that guarantee the highest benefits.

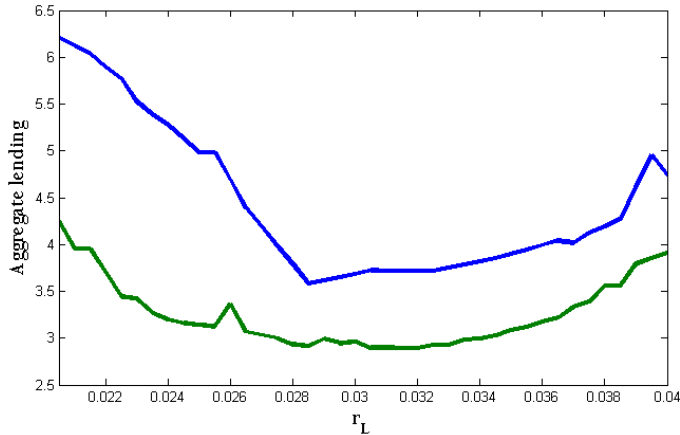


FIG. 4. Aggregate lending in F (in thousands of U.S. dollars), given as a function of  $r_L$ , by affiliate (in blue) and by other banks (in green).  $\alpha = 0.6$ ,  $r^* = 0.02$ ,  $r_L^* = 0.04$

With this completed, it is straightforward to determine who should and can borrow, as well as who should and can lend. Borrowers and lenders are not matched across borders, unless they have established internal capital markets within one bank holding. This link has a priority. The asymmetry of information is only assumed for the banks in F. Borrowers in F with the lending requirements lower than  $\hat{L}^*$  have the priority in the assignment of credits, in accordance with credit rationing incentive under asymmetric information. Furthermore, it is assumed that affiliated banks can provide the credit lines slightly beyond the RCCM to attract some of the borrowers which are rationed out. The banks in F that are not awarded funding in the initial distribution are then given the  $K^* - D_1(r^*)$  from which some private benefits can be obtained that however are collateralized. To observe the effect of the financial integration on the aggregate lending, the aggregate of the actually provided lending is plotted for different values of the interbank lending rate at H. This rate is simultaneously the internal market lending rate for the holding, see Figures 3 and 4.

Since  $r_L^* > r^*$  there is a liquidity shortage in the interbank market in F. The results suggest that having affiliates in the system supports considerably the overall lending in the system, particularly when  $r_L$  approaches

$r^*$ . At this end, the demand for liquidity of the affiliates is the lowest and hence they forward credit to other borrowers in F. The nearly parallel trend, which is evident as  $r_L$  approaches  $r_L^*$ , is due to the fact that the liquidity shortage is prominent among both groups of banks and the fact that the affiliates do not forward much of the credit further into the system. Overall, the effect is stabilizing for the system as the liquidity shortage is addressed more effectively. Finally, the fact that affiliates are accountable to their head banks contributes additionally to the mitigation of moral hazard and of managerial pursuit for private benefits.

#### IV. DISCUSSION

In the previous section, the original model by the FJ was extended to account for the option that some of the banks in the given interbank system might be affiliates of foreign bank holdings located in the economies with more advanced financial markets and better financial information. Two settings were considered, perfect and asymmetric information. In the perfect information case it was possible to analytically derive the threshold values from which local and global liquidity shocks act to disrupt operations of the holding. Furthermore, it was inferred that even in this very simplified setting a strong involvement of the foreign financial institutions limits the effectiveness of the policy rate. This is due to the stable supply of more affordable interbank market capital, that in spite of the capital being unsecured, makes local banks forbear investments in riskfree securities.

For the case of asymmetric information, the setting is considerably more intricate. In the FJ model the authors restricted themselves to a specified setting in which the riskless competitive contract menu (RCCM) characterizes a unique equilibrium set of contracts offered in the interbank market. Introduction of foreign based holdings into the model, as well as the affiliation of a certain fraction of local banks to them, necessarily breaches this setting by allowing two things: for the affiliates to borrow beyond the scope of RCCM and to borrow at lower prices. Exiting the RCCM setting limits the study's ability to effectively account for the spread between the policy rate and the interbank rate under liquidity shortage, as done analytically in FJ. However, the simulation provided for some interesting insights in the effect that the presence of the foreign affiliates in the system exerts on the credit rationing, as predicted by the FJ model.

The simulation does not restrict the structural arrangements in interbank relations. This could have been accounted for via proxies of real financial dynamics in some of the CEECs, by means of regression analysis, or by introducing specific assumptions about the relations, as in the work of Baglioni [79]. Furthermore, the interbank market is considered in its entirety rather than separating it into alternative interbank arrangements like in Freixas and Holthausen [97]. Nevertheless, the limited access



to relevant data reinforced the decision to treat both of these issues in a more general context.

The study is innovative in the way that it bridges the incentives from the work on the interbank market studies and the work on the international financial integration. It also provides the initial treatment of the fund allocation in multinational bank holdings, a field of work which has brought about a number of interesting results in the last couple of years [98–100]. The extensions which should be considered include a more detailed account of the inflows and the outflows of the funds from the host market. For some external financial holdings the host market can be perceived as a strategic sink for investment while for others it can be the principal source of funding. This has the potential to reflect differently upon local and universal shocks.

## V. CONCLUSION

In an effort to address the issue of the impact of financial integration and foreign banks asset ownership on the monetary policy transmission, this study considered an extension of an already established model for credit rationing in the interbank markets by Freixas and Jorge. The proposed variation on the model allows for the establishment of cross-border internal capital markets between a headquarter and a foreign affiliate and its exploitation under liquidity shocks. This variation affects the monetary policy goals for the banking system in the host economy, as it attenuates the response of the affiliated fraction of the banks to local liquidity and policy shocks. The results from the perfect information case support this hypothesis. The asymmetric information case provides evidence that the presence of the affiliates of the external holdings attenuates the effect of credit rationing by supporting the aggregate net lending among the banks in F. The explored setting, even though a very simplified interpretation of the conditions in the real financial markets, is relevant as it provides an initial rationale for how cross-border internal capital markets can be accounted for in the study of national and international interbank markets. Moreover, it gives an insight into the role this particular aspect of financial integration has on the practice of monetary policy in the nations with dominant foreign ownership of banking assets. Finally, a set of ideas is presented for future development of the model.

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## A. APPENDIX

### 3. List of Abbreviations

BLC - bank lending channel  
 CEECs - Central and East European countries  
 FDIC - the Federal Deposit Insurance Corporation  
 GFC - the Global Financial Crisis of late 2000s  
 ECB - the European Central Bank  
 EMU - the European Economic and Monetary Union  
 EU - the European Union  
 Fed - the Federal Reserves Bank  
 FJ - the model by Freixas and Jorge  
 M&A - merger and acquisition activities  
 MPTC - monetary policy transmission channels  
 RCCM - riskless competitive contract menu  
 U.S. - the United States of America

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