The Federal Reserve's dollar swap lines and the European Central Bank in the 2007–2009 crisis

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Abstract — Although the literature has analyzed the role of the Federal Reserve as the global lender of last resort in 2007-2009, many aspects of the Dollar Swap Lines to the European Central Bank need further exploration. Using data from both central banks and transcripts of the Federal Open Market Committee's meetings, we provide original evidence about alloted amounts and interest rates on dollar provision by the Federal Reserve and the European Central Bank. We explore the relation between the Federal Reserve's dollar swap lines and the European Central Bank's dollar provision with regard to the auction formats, the alloted amounts, and the interest rates. We find evidence that there was a financial dilemma creating tension in dollar liquidity needed and the interest rate set by the European Central Bank, and that the Federal Reserve's announcement on October 13, 2008 turned dramatically from one horn of the financial dilemma to the other. Finally, we revisit the literature on the international lender of last resort and enlighten the nature of the relationship of the Federal Reserve with the other central banks in general, and the European Central Bank in particular.

1. Introduction

The Dodd-Franck Act adopted in May 2010 forced the Federal Reserve exceptionally to lift the confidentiality on its credit facility programs (General Accountability Office, 2011). The Federal Reserve was thus accountable to United States Congress for the counterparties and the corresponding amounts. It was then revealed in December 2010 that most of the emblematic operations performed by the Federal Reserve helped out the majority non-US commercial banks and especially the European banks. Moreover, the dollar swap lines granted to fourteen central banks, notably to the European Central Bank, were the most important program representing almost a quarter of the Federal Reserve's total assets between October 2008 and January 2009. Any attempt by Congress to narrow the intervention of the Federal Reserve with respect to the US banking system alone may, however, conflict with the effects of financial

globalization. Actually, the global activities of the banking and financial institutions partly required the Federal Reserve during the 2007–2009 financial crisis to extend its responsibilities not only beyond its ordinary operations, but also beyond the banking system's national borders. So there is a new dilemma – termed here as the financial dilemma – with which the US political and monetary authorities are now confronted: either Congress enforces the mandate given to the Federal Reserve in which case the Federal Reserve cannot fully respond to the needs of the global banking institutions and systemic instability worsens; or the Federal Reserve provides dollar liquidity liberally to foreign global banks and central banks in which case Congress *de facto* slackens the terms of the mandate it gives to the Federal Reserve and moral hazard problem worsens. In the paper, we find evidence that the financial dilemma created tension in dollar liquidity needed and the interest rate set by the European Central Bank, and that the Federal Reserve's announcement on October 13, 2008 turned dramatically from one horn of the financial dilemma to the other.

The phrase *global* lender of last resort (Obstfeld, 2009; Walker, 2010; Mehrling, 2016) tends to replace that of *international* lender of last resort coined by Hawtrey (1932). In the context of the gold standard regime, characterized both by the free movement of capital and the fixed exchange rate, international lending in last resort meant making emergency loans by transferring metallic reserve. In the context of the Bretton Woods system, the controls of international capital movements circumscribed the function of the lender of last resort at the national level and temporary funding was reserved to the International Monetary Fund. In the context of the financial liberalization and the fixed exchange rate adopted by emerging countries in the 1990s, the function of the lender of last resort returned to its international level. One view was to argue that the International Monetary Fund should ensure the role of international lender of last resort (Calomiris, 1998; Fischer, 1999; Goodhart, 1999) and, the other view, that the Federal Reserve should do so (Keleher, 1999). We shall not retrace this debate. Instead, we explore the new scope of the lender of last resort in light of the global financial crisis of 2007–2009. Empirically, we find data about the operations, amounts, and interest rates from the Federal Reserve and the European Central Bank. Hence, we shed light on the international structural relationship of central banking. Analytically, we pay heed to the endogenous process depending on (*i*) financial innovations from the country issuing the international money, (*ii*) international capital flow liberalization, and (*iii*) the ensuing interdependency between US and non-US financial institutions.

Notwithstanding the huge amount of liquidity created through the Federal Reserve's Dollar Swap Lines, the related literature remains relatively scarce. Fleming and Klagge (2010), Goldberg, Kennedy, and Miu (2011) examine the disruptions in the dollar funding markets, the initial structure of the dollar swap line program, and the changes in breadth and volume of the funding conditions

in response to the worsening financial crisis. Allen and Moessner (2010), and Allen (2013) study currency swap arrangements and international liquidity in the financial crisis of 2008–2009 with an emphasis on central bank cooperation. McDowell (2012), Helleiner (2014, pp. 6-7, 43-4), Morelli, Pittaluga, and Seghezza (2015) examine the intervention of the Federal Reserve through the analytical lens of international political economy. Broz (2015) explores the motivations behind the Federal Reserve's global lending, the response of the US Congress in 2010, and the proposal for a Federal Reserve Transparency Act in 2012. Aizenman and Pasricha (2010) analyze the impact of the dollar swap arrangements on the exchange rate in emerging market economies and Bahaj and Reis (2017) on the the euro-dollar swap spread (currency basis). Bordo, Humpage, and Schwartz (2015) offer an overview of the Federal Reserve's swap lines from 1962 to 2009. In the paper, we go beyond this literature and we find original evidence about the operations, amounts, and interest rates with regard to the Federal Reserve's dollar swaps and the European Central Bank's dollar provision. Our findings enlightens the nature of the relationship between the Federal Reserve and the European Central Bank.

In this perspective, the remainder of this paper proceeds as follows. In the second section, we outline the effects of the financial globalization, and the unprecedented policy of the Federal Reserve from 2008 to 2009 in supporting non-US banks. In the third section, we examine the Federal Reserve's dollar swap operations with the other central banks (hereafter, we shall use the term "central banks" to designate central banks other than, and in relation with, the Federal Reserve). In the fourth section, we find evidence about the relations between the Federal Reserve and the European Central Bank. We rely on all transcripts of the meetings and conference calls of the Federal Open Market Committee (hereafter, FOMC Transcripts) from August 2007 to December 2008 in order to discern the Federal Reserve's guidelines. An important issue, not explored in the literature, is to ascertain how the European Central Bank loaned in its jurisdiction dollars received from the Federal Reserve. In the fifth section, we fill this void by presenting original evidence about the dollar provision and the interest rate set by the European Central Bank. In the sixth section, we provide analytical considerations on the financial dilemma that we distinguish from the monetary dilemma formulated by Triffin (1960) at the onset of the Bretton Woods period. In the seventh section, we conclude.

2. The Federal Reserve and financial globalization

The Federal Reserve's global lending results from a twofold evolution of the international monetary and financial system. The first evolution is related to the international status that the US dollar has retained since the end of the Bretton Woods system (Goldberg, 2010; Eichengreen, 2011). In the meantime, deposits

and credits in dollars outside the United States – the Euromarkets – have grown tremendously, especially in Europe. Notwithstanding the development of the Euromarkets and the concomitant indebtedness of the non-US banks from the 1970s onwards gew temendously (Gibson, 1989), it has not yet put the Federal Reserve in the position of the global lender of last resort. The foregoing leads to the second evolution and the crucial role of financial globalization. Financial innovations such as securitization and credit derivatives (asset- and mortgage-backed securities, collateralized debt ogligations, etc.) have grown in the United States (Ashcraft and Schuermann, 2008; Pozsar, Adrian, Ashcraft and Boesky, 2010). Owing to the liberalization of international capital flows, European commercial banks held these US financial products through cross-border banking and shadow banking, and financed them with short-term funding *vis-à-vis* US banking institutions in the repurchase agreement or commercial paper markets (Acharya and Schnabl, 2010; Shin, 2012). McGuire and von Peter (2009) describe net dollar-denominated foreign positions (long-term assets minus short-term liabilities) of European banks and, in passing, they give evidence of the diversity of ways in which those banks met their dollar funding requirements.

One measure of the dollar shortage in 2007-2009 is the increase in the spread between the term interbank (Libor) rate and the overnight-index-swap (OIS) rate (Taylor and Williams, 2008). Another measure is the increase in the euro-dollar swap spread, which ordinarily converges to zero once arbitrage in foreign exchange markets can take place, but deviates from the interest rate parity in stressed conditions, when arbitragers cannot borrow enough dollars (Baba and Packer, 2009; Coffey, Hrung, and Sarker, 2009). However, these two measures of liquidity shortage do not take into account the effect related to the commercial banks' jurisdiction (US and non-US). To capture the jurisdiction effect, Fleming and Klagge (2010, p. 5) examine the spread between the average borrowing rate of the thirteen non-US banks and the average borrowing rate of the three US banks among the sixteen banks of the dollar Libor panel. The spread rose at the onset of the financial crisis in August 2007 and soared in the wake of the Lehman brothers collapse in September 2008. Actually, European banks and their subsidiaries mainly funded their long-term assets purchases by the intermediary of the repurchase agreement and commercial paper markets (wholesale funding), whereas US banks could rely to a greater extent on dollar deposits (retail funding) covered by supervisory authorities. Insofar as runs took place in the wholesale markets (Gorton and Metrick, 2012), European banks rolled over their short-term debts in dollars with difficulty (Baba, McCauley, and Ramaswamy, 2009). In turn, US banks were exposed to high counterparties risk inasmuch as they significantly held claims on European banks.

So the twofold evolution of the international monetary and global financial system respectively created both a "supply" of (owing to the dollar internationalization), and a "demand" for (owing to financial globalization) the global lender of last resort whenever the dollar funding markets collapsed. As

Minsky (1985, pp. 13) foresaw, the Federal Reserve is, from the supply-side, "responsible not only for maintaining orderly conditions in the domestic money market but for a vast network of offshore banking that is denominated in its currency and which leads to serious positions by offshore banking institutions in its domestic money market." Then, "the Federal Reserve is the de facto lender of last resort to the international financial structure […], to the world dollar-denominated banking system, regardless of where the banks that have the dollar book are domiciled" (ibid, p. 15). And, from the demand-side, "the US financial structure depends on the continued use of the dollar as the international currency of denomination," and in fine on the action in last resort of the Federal Reserve "not just for US chartered organizations but for all banks that run dollar-denominated books" (ibid, p. 16). In a similar line of reasoning, Mehrling (2016, p. 169) argues that, "[b]ecause the funding of the global shadow banking system was reliant on the Eurodollar market, the question of global lender of last resort was really a question about backstop for that market."

From the operational standpoint, the Federal Reserve's policy moved toward the enlargement of the spectrum of collateral, and for a broader range of counterparties (US and non-US). Non-US primary dealers could obtain dollars via the Term Securities Lending Facility (TSLF) and the Primary Dealers Credit Facility (PDCF). Moreover, non-US banks received almost 65% of the amounts alloted via the Term Auction Facility (TAF) and 60% of those alloted via the Commercial Paper Funding Facility (CPFF) (Table 1). The Term Auction Facilities and the Commercial Paper Funding Facilities were the most substantial of the Federal Reserve's main facility programs between 2007 and 2010 (Government Accountability Office, 2011, p. 137). It may be point out that the interest rate set by the Federal Reserve under these facility programs followed auction or market format, and was similar (single price) for all banking institutions (US or non-US). Although all of the facility programs were publicly announced when they were initiated from 2007 to 2009, the names of the counterparties were disclosed to Congress only in December 2010, that is, two years after the height of the financial turmoil. According to the Board of the Governors of the Federal Reserve (2011, p. 1), the confidentiality about the names of the counterparties and borrowers remained consistent with the central banks' practice: "Releasing the names of these institutions in real-time, in the midst of the financial crisis, would have seriously undermined the effectiveness of the emergency lending and the of investors and borrowers."[1]

[1] On the Federal Reserve's facility programs, Armentier, Krieger, and McAndrews (2008), Adrian, Burke, and McAndrews (2009), Fleming, Hrung, and Keane (2010), Cecchetti and Disyatat (2010), Adrian, Kimbrough, and Marchioni (2011), General Accountability Office (2011), and Acharya, Fleming, Hrung, and Sarkar (2014). The Government Accountability Office (2011, pp. 196, 231) mentions most principal non-US banks that get dollar liquidity through the TAF and the CPFF and also through the discount window. Also Shin (2012, p. 168) for amounts outstanding.

Table 1: Total amount by parent banks' domiciliation for TAF and CPFF (in percent)

TAF		CPFF	
United States	35	United States	41
United Kingdom	17	United Kingdom	18
Germany	16	Belgium	10
Japan	8	Germany	9
France	7	Switzerland	9
Others	16	Others	13
Total	**100**		**100**

Source: Government Accountability Office (2011, figure 10, p. 134)

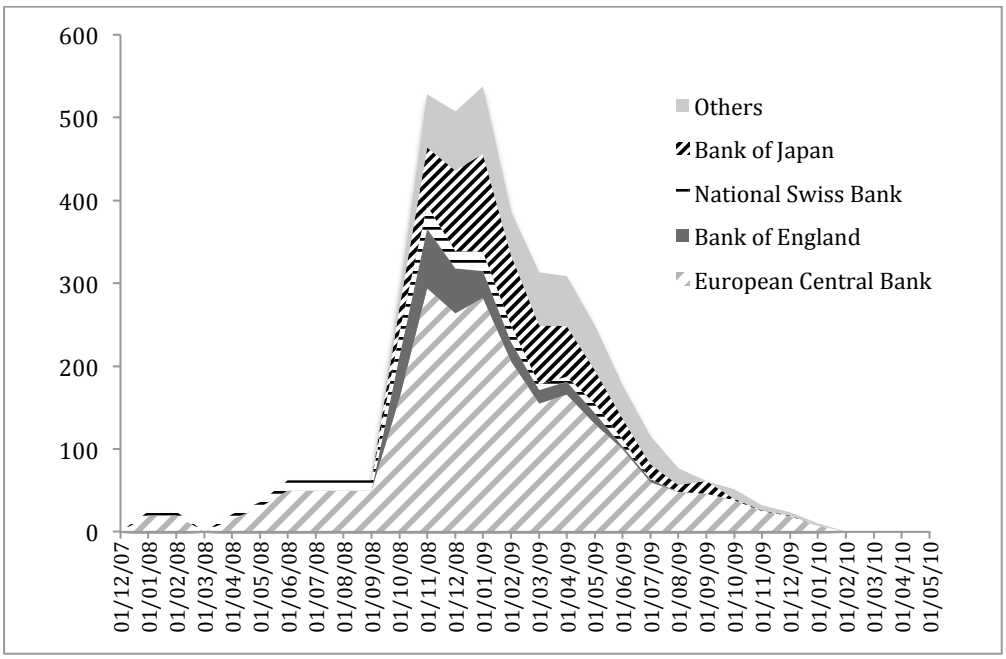
Since the onset of financial crisis in 2007, the members of the Federal Open Market Committee were aware that European banks met growing difficulties in the dollar funding markets (FOMC Transcripts, 2007: Dudley, Aug. 16, p. 15; Bernanke, Aug. 10, p. 11; Bernanke, Sep. 18, p. 14; Dudley, Dec. 6, p. 4; Dudley, Dec. 11, p. 8). In consequence, many of them asked for and obtained liquidity at the discount window of the Federal Reserve (FOMC Transcripts, 2007: Rosenberg, Sep. 18, p. 55; Lacker, Sep. 18, p. 146). Then, once they were implemented, the Term Auction Facilities were "dominated by European institutions" (FOMC Transcripts, 2008: Lacker, Apr. 29-30, p. 13). The Dollar Swap Lines (DSL) program was therefore recognized as a better operational design, whereby the Federal Reserve could transfer counterparty and asset risks to other central banks.

3. The Federal Reserve and the Dollar Swap Lines

Until the 1990s the currency swap agreements between central banks were put in place to circumvent tension on the foreign exchange market (Bordo, Humpage, and Schwartz, 2015). During the 2007–2009 experience, foreign exchange swap lines were different both in degree (unprecedented in monetary history) and in nature (mainly depending on financial globalization). Their aim was henceforth to allay pressure in the dollar funding markets, and they became an important source of dollar funding and accounted for almost 25% of the Federal Reserve's total assets over the period from October 2008 to January 2009 (Figure 1). The temporary currency swap line agreement was decided on December 6, 2007 and it was designed as follows. At the contract date, currency swaps were set at the prevailing market exchange rate and, at maturity, dollars were repurchased at the same exchange rate, so that the Federal Reserve did not bear the exchange risk.

In addition, the Federal Reserve provided dollars to central banks, which loaned them in determining the eligible counterparties and collateral, so that the Federal Reserve did not bear credit and asset risks (FOMC Transcripts, 2007: Johnson, Sep. 18, p. 133; Geithner, Sep. 18, p. 139; Sheets, Dec. 6, p. 7; Bernanke, Dec. 11, p. 4; Board of Governors of the Federal Reserve System, 2007). Ultimately, the Federal Reserve defined the dollar swap line format and ensuing amounts and interest rate.

Figure 1: Dollar swap lines with central banks (December 2007 – May 2010, in billion dollars)



Source: Government Accountability Office (2011, figure 25, p. 201)

Note: Dollar Swap Lines (DSL) were implemented from December 17, 2007 to February 1, 2010. Fourteen central banks progressively participated in the program, namely (by date of announcement): the European Central Bank and the Swiss National Bank (December 12, 2007), the Bank of Canada, the Bank of England, and the Bank of Japan (September 18, 2008), the *Danmarks Nationalbank*, the *Norges Bank*, the Reserve Bank of Australia, and the *Sveriges Riksbank* (September 24, 2008), the Reserve Bank of New Zealand (October 28, 2008), the *Banco Central do Brasil*, the *Banco de Mexico*, the Bank of Korea, and the Monetary Authority of Singapore (October 29, 2008).

The design of the central bank liquidity swap agreements described above deserves a remark about the distinction between lending in last resort and market making in last resort. Regarding, the emergency injection of *domestic* liquidity by any central bank (for instance, the dollar provision by the Federal Reserve or the sterling provision by the Bank of England), both functions are integrated since the banking system is based on the private and risky securities markets. That is, the central bank provides at the same time funding liquidity

and market liquidity by purchasing private and risky securities to domestic banking and financial institutions (Le Maux, 2017). Regarding the emergency injection of *international* liquidity, the design of the dollar swap line arrangements separates the function of the issuing of international liquidity (for instance, the dollar provision of the Federal Reserve to the Bank of England) and the function of sustaining market liquidity in last resort (for instance, the loans in dollars by the Bank of England to British banks against private security collateral). In other words, the Federal Reserve did not bear counterparty and asset risks but only took on the role of issuer – and lender – in last resort at the international level, while the other central banks could not issue dollars but plainly took on the role of primary dealers or market makers in last resort at their own level of jurisdiction.[2] All in all, the Federal Reserve played in last resort the role of the global lender and market maker through the Term Auction Facility and Commercial Paper Funding Facility programs, and that global lender through the Dollar Swap Lines program.

Another set of question relates to the nature of the relations between the Federal Reserve and other the central banks, especially in Europe, the literature suggests two approaches. The first approach claims that the currency swap arrangements corresponded to an international cooperation based on reciprocity (Allen and Moessner, 2010; European Central Bank, 2014, 2016). This cooperation approach suggests that the Federal Reserve was not so much a lender of last resort as a participant among others in organizing the global safety network notably around reciprocal swap line agreements.

However, evidence for 2008–2009 shows that the currency swap arrangements went in one direction only: the Federal Reserve widely granted dollar swap lines, while the other central banks did not grant swap lines in their own currency to the Federal Reserve. Furthermore, the Federal Reserve's policy was not more cooperative towards the central banks via the Dollar Swap Line program than it was towards non-US banking institutions via the Term Auction Facility or the Commercial Paper Facility programs: in both cases, the market format initially prevailed. The Federal Reserve's policy was even more liberal for commercial banks than for central banks: in effect, the central banks swapped their own currency at a fixed rate, while the non-US banks posted private and risky securities as collateral. In fact, the cooperation argument had been made so as to avoid the stigma associated with the de facto unilateral swap lines. As the Federal Open Market Committee stated, the response of the Federal Reserve to the European Central Bank's proposition was to pursue "some sort of a cooperative arrangement" (FOMC Transcripts, 2007: Sheets, Dec. 6, p. 18, added italics), a response "which symbolizes the cooperation and coordination of the two central banks" (FOMC Transcripts, 2008: Bernanke, Sep. 16, p. 13, added italics).

[2] Bordo, Humpage and Schwartz (2015, p. 366) have a different interpretation in claiming that, under the 2007–2009 dollar swap line arrangements, "the foreign central banks acted as the lender of last resort; the Federal Reserve acted as the financier."

The second approach considers that the currency swap arrangements were not the result of a cooperative relationship (and not that of a benevolent hegemon), and that the Federal Reserve's intervention was motivated by defensive reasons and concerns about the interest of the major US banking institutions (McDowell, 2012; Broz, 2015; Helleiner, 2014, pp. 43-4). This approach mainly claims that the appearance of *ad hoc* cooperation among central banks was in fact possible only because of the convergence of participants' interests, but it does not characterize the nature of the central banking relation and especially between the United States and Europe.

All these approaches or interpretations do not examine in detail the procedures and their timing, the alloted amounts and the interest rates on the dollar swap lines. So, further investigations are necessary, from empirical and analytical points of view, in order to discern *in fine* the nature of the relationship between the Federal Reserve and the European Central Bank. In the following sections, we provide original evidence about the Federal Reserve's dollar swaps and the European Central Bank's dollar provision, and we hence shed light on the international relationship of central banking.

4. The Federal Reserve and the European Central Bank

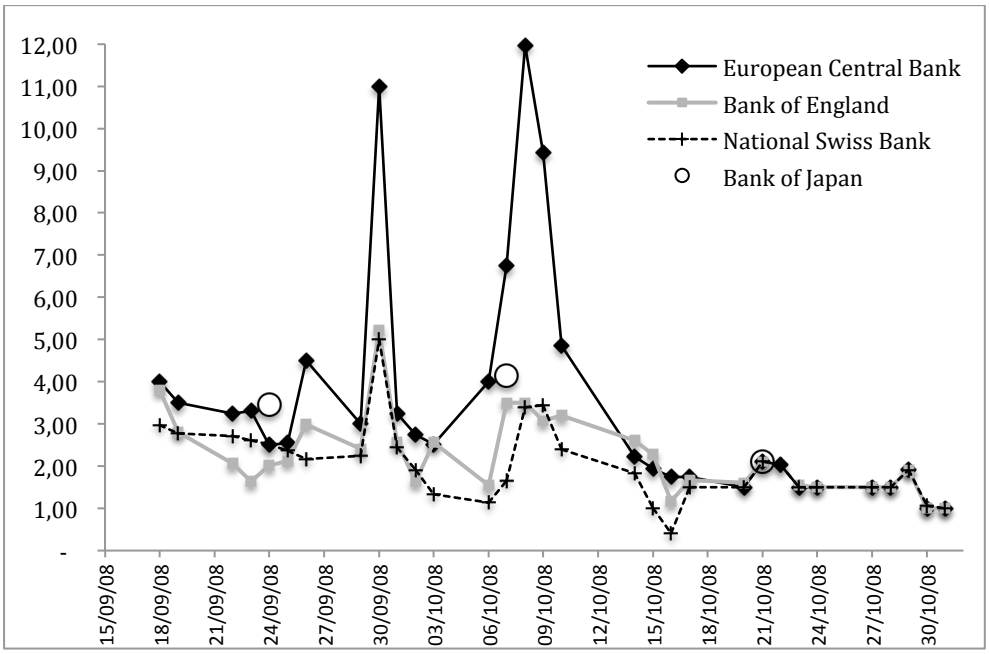
Among the fourteen central banks participating in the currency swap arrangements, the European Central Bank received in 2008–2009 almost 80% of the dollar swap lines from the Federal Reserve (Government Accountability Office, 2011, Table 24, p. 205). The Federal Reserve could choose two auction formats to carry out its facility programs in general and the dollar swap lines in particular (Goldberg, Kennedy, and Miu, 2011). The first is the market format auctioning limited dollar amounts: within this market format, pricing can be either at a single interest rate (single price) and all allocations are made at the lowest bid interest rate, or at multiple interest rates and all allocations are made at the respective bid interest rate of subscribers (multiple price). The second is the full-allotment format: there is simply a fixed interest rate and all bids are satisfied.

Until October 10, 2008 the Federal Reserve adopted the market format with multiple prices so that each central bank paid a different interest rate on dollar swap lines (Figure 2).[3] There was a significant difference from September 30 to October 10 between the interest rate paid by the European Central Bank on the one side, and the Bank of England, the Bank of Japan, and the Swiss National

[3] The Dollar Swap Line program prior to October 13, 2008 has been likened to Term Auction Facilities (Goldberg, Kennedy, and Miu, 2011, p. 14). There was indeed a common feature, namely, the auction format. The two programs differed, however, with regard to the way interest rates were set: there was a multiple-price format under the Dollar Swap Line program and a single-price format under the Term Auction Facility program.

Bank on the other side. On September 30 and October 8, the interest rate paid by the European Central Bank became exorbitant, soaring above 10%. In accordance with its announcement on October 13, and in order to stabilize the swap interest rate, the Federal Reserve radically modified the auction format to the European Central Bank and also the Bank of England, the Bank of Japan, and the Swiss National Bank. Then, the dollar swap lines corresponded to the full-allotment format at a fixed interest rate equal to the OIS rate plus 100 basis points (Board of Governors of the Federal Reserve System, 2008). The change in the Federal Reserve's policy contributed to reducing the volatility of the interest rates, which declined by around 2% on October 14, and below that in the following days and weeks. Notwithstanding the importance of the action taken after October 13, a complete examination and systematic analysis is still lacking.

Figure 2: Interest rate set by the Federal Reserve on dollar swap lines (September 18 – October 30, 2008, in percent)



Source: Board of Governors of the Federal Reserve System, "Central Bank Swap Lines."

The very high interest rates and the reaction delay of the Federal Reserve raise the question of the Federal Open Market Committee's guidelines. The Federal Open Market Committee's discussion prior to the announcement on October 13, 2008 was not so significant as it had been prior to the decision of December 6, 2007. A resolution was passed unanimously on September 16: that is, "to provide to the Foreign Currency Subcommittee [that consists of the Chairman of the Board, the Vice Chairman of the FOMC, and the Vice Chairman of the Board] the authority to enter into swap agreements with the foreign central banks as needed to address strains in money markets in other

jurisdictions. […] *The amounts are unlimited in principle*, *but the decisions will be made by the Foreign Currency Subcommittee as needed and as appropriate for the particular circumstances*" (FOMC Transcripts, 2008: Bernanke, Sep. 16, p. 18, added italics, also p. 3). A similar resolution was passed unanimously on September 29: the Federal Open Market Committee "authorizes the Federal Reserve Bank of New York to take the following actions to *amend* the existing temporary swap arrangements with foreign central banks" and "extends the current delegation of authority to Foreign Currency Subcommittee until April 30, 2009" (FOMC Transcripts, 2008: Madigan, Sep. 29, pp. 9-10, added italics). As paradoxical as it may appear, the Federal Open Market Committee undertook a short discussion on October 28-29 about the change in the Federal Reserve's swap lines policy for the European Central Bank, the Bank of England, the Bank of Japan, and the Swiss National Bank.[4] What can be found is the information that the "fixed-rate tender dollar auctions were implemented […]. The ECB swap size is currently about $280 billion, more than half the total amount of swaps outstanding", which "led to rapid expansion of [the Federal Reserve's] balance sheet" (FOMC Transcripts, 2008: Dudley, Oct. 28-29, pp. 4-6). Again, it was recommended that "the FOMC delegate to its Foreign Currency Subcommittee the authority to approve these drawings" (FOMC Transcripts, 2008: Sheets, Oct. 29-30, p. 10).

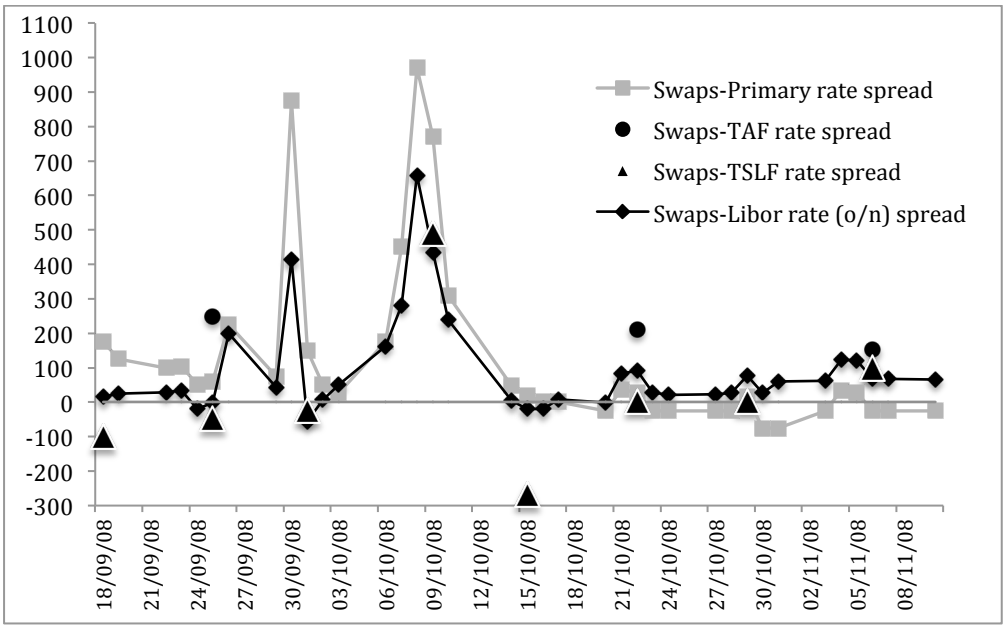
So the outstanding question concerns the rule governing the Federal Reserve's interest rate policy.[5] First, regarding the liquidity facilities granted directly to the primary dealers and commercial banks, the Federal Reserve did not strictly practice the rule of the *penalty* interest rate (Hogan, Le, Salter, 2015). Second, the question regarding the dollar swap lines granted to central banks has not been examined in depth in the related literature. So we compute the spread between the swap interest rate paid by the European Central Bank and other interest rates set by the Federal Reserve (primary rate, TAF rate, TSLF rate) or interbank market rates (one-month Libor rate and overnight Libor rate) (Figure 3). One interpretation is that the Federal Reserve allegedly applied Bagehot's dictum of the *very high* interest rate in order to discourage central banks from demanding dollars at its desk too promptly. Another interpretation is that it supposedly attempted to counter moral hazard by applying a *penalty* rate. Had

[4] The Federal Open Market Committee (FOMC, 2008, Oct. 28-29, pp. 10-35) however spent a long time discussing the dollar swap lines for central banks in emerging market economies and the role of the International Monetary Fund.

[5] Here is not the place to review thoroughly the literature on the lender of last resort and Bagehot's dictum. We stress however that the rule of the *very high* interest rate formulated by Bagehot (1873, p. 197) aims at discouraging banks from demanding liquidity in first resort at the central bank's desk, while the *penalty* rate formulated by the contemporary analysis aims at confining moral hazard. See Humphrey and Keleher (1984, pp. 301-2), Meltzer (1986, p. 83), Keleher (1999, p. 3), Martin (2009, p. 399). See also Bernanke (FOMC, 2007: Sept. 18, p. 147, 162), Fisher (FOMC, 2007: Sept. 18, p. 154), Bernanke (2008), Madigan (2009).

that been the case, we can then point out a threefold inconsistency in the Federal Reserve's policy. First, the rule confining moral hazard by means of a penalty rate would have been applied to central banks only (through the Dollar Swap Line program), and not to commercial banks (through the Term Auction Facility program). Second, such discrimination would have been all the more paradoxical because central banks swapped their own currency against dollars (with no exchange risk borne by the Federal Reserve), whereas the commercial banks posted private and risky securities against liquidity in dollars (with high asset risks borne by the Federal Reserve). Third, unlike central banks, commercial banks can be insolvent (with higher counterparties risks concerning non-US banks and their subsidiaries).

Figure 3: Spread between the swap interest rate and other interest rates set by the Federal Reserve (primary rate, TAF rate and TSLF rate), and by the funding market (Libor rate) (September 18 – November 9, 2008, in basis points)



Source: Authors' calculation based on Board of Governors of the Federal Reserve System, "Central Bank Swap Lines", Federal Reserve Bank of New York, "Markets", Datastream.

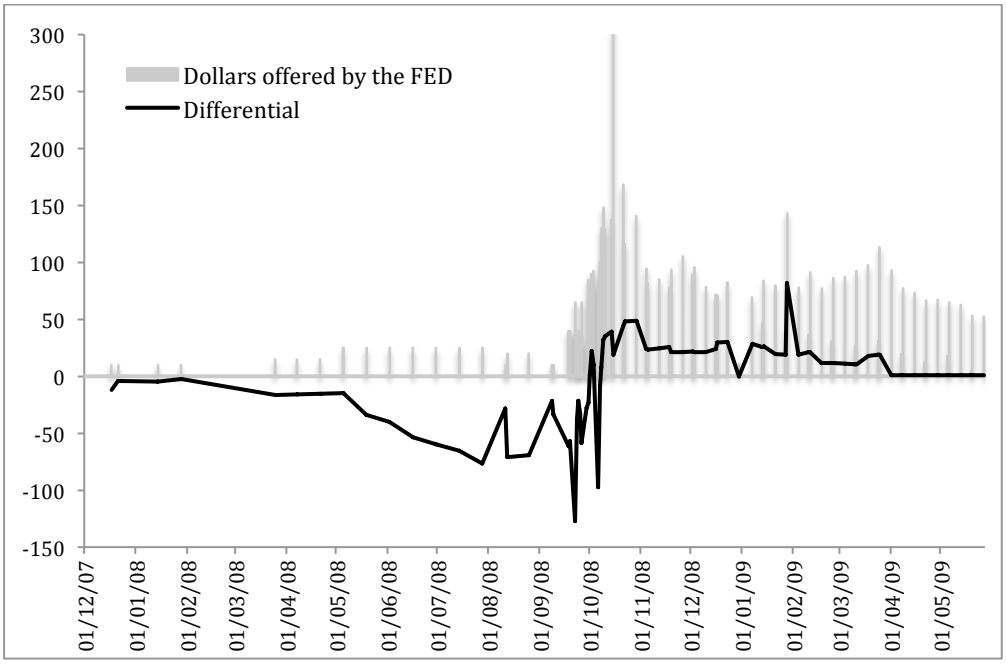
All things considered, the interest rate set by the Federal Reserve was so chaotic over the period from September 30 to October 15, 2008 that Bagehot's dictum or penalty-rate argument must be handled with care. Prior to October 13, the auction format and the delay during which the Federal Reserve decided to switch toward the full-allotment and fixed-rate format contributed to triggering the very high interest rate. After October 13, the interest rate paid by the European Central Bank remained higher than the market OIS rate and the

TAF rate paid by commercial banks at the discount window, and similar to the TSLF rate paid by the primary dealers. Put differently, the Federal Reserve took time to recognize that the market format applied to dollar swap lines did not address the difficulties met by the European Central Bank.

5. The European Central Bank and emergency dollar provision

An important issue, not fully explored in the literature, is to ascertain how the European Central Bank loaned in its jurisdiction dollars received from the Federal Reserve. Data about dollars subscribed by the European Central Bank at the Federal Reserve's desk are not publicly available over the period. In order to gauge the European Central Bank's trouble, we compute the differential between the dollar amount alloted by the Federal Reserve to the European Central Bank and the dollar amount alloted by the European Central Bank to Eurozone banks (Figure 4). The differential indicates that dollar funding pressure met by the Eurozone banks worsened from March 2008 onwards. After stopping dollar funding auctions from late January to late March, the European Central Bank restarted them and even requested a rise in the dollar swap lines, to which the Federal Reserve responded but sparingly (FOMC Transcripts, 2008: Bernanke, Mar. 10, pp. 3, 36; Dudley, Apr. 29-30, p. 7-8; Dudley, Jun. 24-25, pp. 6, 8; Dudley, Jul. 24, p. 6). The differential thus indicates dollar rationning (from March 2008 to September 2008) followed by dollar abundance (from October 2008 to March 2009), with a very unstable transitory period. The negative differential did not result from the interest rate that would not have been high enough to induce Eurozone banks to revert to the dollar funding markets: over-subscription showed rather how they met a severe coordination problem in the dollar funding markets, and very high rates thus showed how the European Central Bank did not handle dollar shortage. The positive differential resulted from the application of the full-allotment and fixed-rate format by the Federal Reserve, and the Eurozone banks received all the dollar liquidity they demanded from the European Central Bank: over-liquidity finally indicated how the Federal Reserve dramatically changed the terms of the financial dilemma.

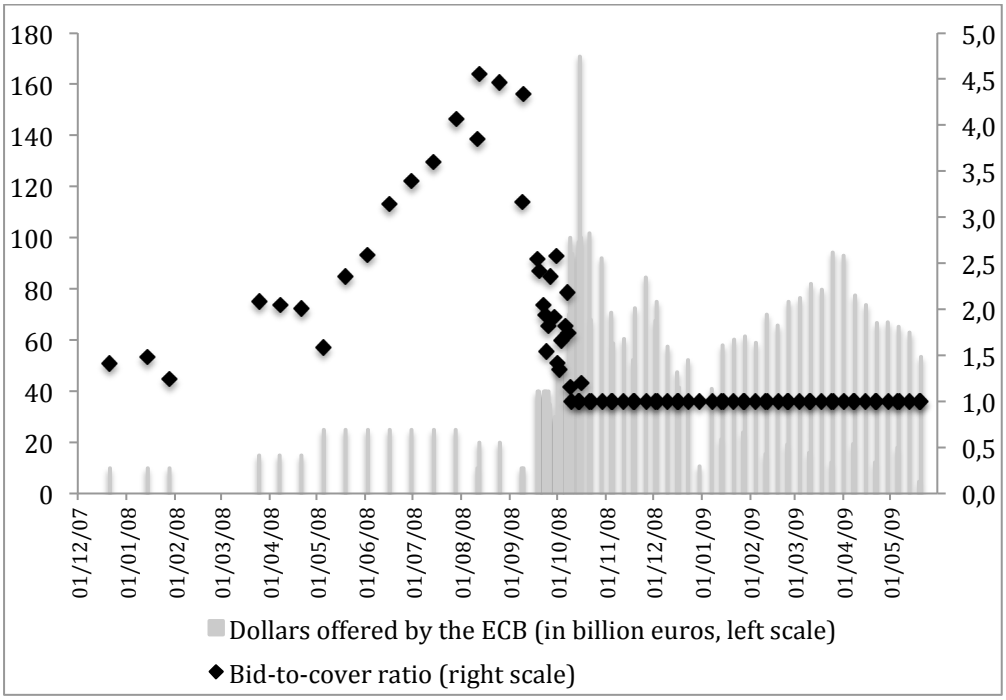
Figure 4: Dollars provided by the Federal Reserve to European Central Bank and differential with dollars provided by the European Central Bank to Eurozone banks (December 2007 – May 2009, in billion dollars)



Source: Authors' calculation based on Board of Governors of the Federal Reserve System, "Central Bank Swap Lines", and European Central Bank, "History of all ECB Open Markets Operations."

The sequence from dollar rationning to dollar adundance impacted the ratio of the subscribed amounts by the Eurozone banks to the offered amounts by the European Central Bank (hereafter, the ECB bid-to-cover ratio). The conjunction of the dollar shortage in Europe and the European Central Bank's impossibility to get more dollars at the Federal Reserve's desk triggered a dramatic increase in the ECB bid-to-cover ratio, which climbed from 2 in March to 4.5 in August 2008 (Figure 5). Although it remained at around 2 during the transitory period from September 30 to October 10, 2008, the ECB bid-to-cover ratio was rather unstable because the European Central Bank attempted to respond to dollar demands but at high interest rates. Then, the Federal Reserve massively alloted on October 15 a total amount of 310 billion dollars to the European Central Bank, which in turn immediately supplied the same amount to Eurozone banks, so that the ECB bid-to-cover ratio rapidly converged to 1.

Figure 5: Dollars provided by the European Central Bank to Eurozone banks and ECB bid-to-cover ratio (December 2007 – May 2009)



Source: Authors' calculation based on European central bank, "History of all ECB Open Markets Operations."

These findings over the period from March to August 2008 are consistent with data that the Federal Open Market Committee authorized for public released about the ratio of the subscribed amounts by the European Central Bank to the offered amounts by the Federal Reserve (hereafter, the FED bid-to-cover ratio). Indeed, the FED bid-to-cover ratio of the Dollar Swap Lines climbed from 2 in March to 4 in August.[6] For comparison, over the same period of time, the bid-to-cover ratio of the Term Auction Facility declined from 2.2 to 1.1 (calculation from Federal Reserve Bank of New York, "Markets"). Notwithstanding Eurozone banks' difficulty, the Federal Open Market Committee worried that the European Central Bank's auction on dollar provision was "noncompetitive": "The bids are prorated, and the [Eurozone] banks pay the US stop-out rate. Larger bids by European banks in the ECB auction do not affect the interest rate they pay for such funding, and that encourages more-aggressive bidding. Conversations with the ECB staff indicate that they are concerned that the outcome could be a bidding spiral. Individual banks could keep raising the size of their bid submissions to ensure a stable

[6] The corresponding chart (FOMC, 2008: Materials, Aug. 5, Figure 18, p. 136) plots the FED bid-to-cover ratio of the Dollar Swap Lines from March and August 2008, but the full series over the Dollar Swap Line period are not publicly available.

amount of dollar funding" (FOMC Transcripts, 2008: Dudley, August 5, p. 6). Thus, until its resolution passed on September 16, the Federal Open Market Committee did not recognize that amounts alloted through the dollar swap lines were not sufficient to mitigate the problems that the European Central Bank faced in dealing with the Eurozone banks' need for dollar funding. Furthermore, between September 18 and October 10, the Federal Reserve maintained the market format with limited amounts and, despite that it accelerated the provision of dollar to the European Central Bank, the swap interest rate climbed to very high level.

The sequence from dollar rationning to dollar abundance thus impacted the evolution of the interest rate set by the European Central Bank. Until October 3, as point out by the Federal Open Market Committee (FOMC Transcripts, 2008: Dudley, August 5, p. 6), and without a dialogue with the Federal Reserve, the European Central Bank chose the "noncompetitive" format for providing dollars, that is, applied the same interest rate as was paid to the Federal Reserve. In other words, the European Central Bank worked as the conveyor belt of the Federal Reserve's policy. Then, the mechanism failed: the margin, here defined as the difference between the interest rate on dollar provision set by the European Central Bank and the interest rate on the dollar swap lines set by the Federal Reserve, became negative (Table 2). The difference in maturity of the dollar provision does not explain the negative margin insofar as the European Central Bank applied the same maturity as the Federal Reserve (except on October 6). Because the interest rate paid to the Federal Reserve was exorbitant, the European Central Bank oddly accepted to bear a negative margin so as to allocate a larger dollar amount. And because the European Central Bank provided dollar funding at a loss, there are reasons to think that it put pressure on the Federal Reserve in order to offer dollars in accordance with the Eurozone banks' bids – but there is no readly available evidence. One observation is that the full-allotment and fixed rate format was an European Central Bank's concept that the Governing Council implemented several times in the euro funding markets and especially from October 8 onwards (European Central Bank, "Communication"). In any case, the change in the Federal Reserve's policy from October 13 onwards contributed to lowering the swap interest rate and the European Central Bank resumed its work as the conveyor belt.

Table 2: Interest rate on dollar swap lines set by the Federal Reserve, the interest rate on dollar provision set by the European Central Bank, and the margin (Octobre 3 – Octobre 21, 2008, in percent)

Date	Federal Reserve		European Central Bank		
	Maturity (days)	Rate (1) (%)	Maturity (days)	Rate (2) (%)	Margin (2)–(1) (%)
October 3	3	2,51	3	2,51	0
October 6	1	4,0	85	1,39	–2,61
October 8	1	11,96	1	9,5	–2,46
October 9	1	9,44	1	5,0	–4,44
October 10	4	4,85	4	0,5	–4,35
October 14	1	2,23	1	0,2	–2,03
October 15	1	1,94	1	0,5	–1,44
October 21	28	2,11	28	2,11	0

Source: Authors' calculation based on Board of Governors of the Federal Reserve System, "Central Bank Swap Lines", and European Central Bank, "History of all ECB Open Markets Operations."

In sum, the currency swap arrangments placed the Federal Reserve at a higher level with respect to the other central banks: at the apex, it is the Federal Reserve that determines at discretion the dollar swap line format and the ensuing allocated amounts and interest rates; in an intermediate position, the other central banks, the primary dealers, and commercial banks that have access to the Federal Reserve's desk; at the base, the other non-US banks that revert to the central banks of their jurisdiction to obtain dollar funding. The hierarchical structure we analyze rests notably on the institutional criterion of access (or not) to the Federal Reserve's desk. However, it does not strictly take into account the different levels of interest rate set by the Federal Reserve for central banks or for commercial banks. So it might be stressed that the interest rate on Dollar Swap Lines charged to central banks (with multiple prices) was higher than the interest rate on Term Auction Facility charged to non-US banks (with a single price). Moreover, the collateral posted by non-US banks or primary dealers was riskier (the private and risky securities, sometimes with no market valuation) than that swapped by the central banks (their own currency, with no exchange rate risk). Therefore, the hierarchical structure departed from any cooperative arrangement – *ad hoc* or institutionalized cooperation – and was rather the adjustment whereby the US monetary authorities cope with the financial dilemma.

6. From the Triffin dilemma to the financial dilemma?

The dilemma that Robert Triffin (1960) examined arose under the Bretton Woods regime featured by fixed exchange rates with the US dollar as the key-

currency, and by international capital flow controls. In the present day, the floating exchange rate system and financial globalization have transformed the nature of the dilemma, which is no longer a *monetary* question (how to ensure international monetary stability in accordance with multilateral exchange rate agreements and dollar parity?) but a *financial* one (how to ensure global financial stability in accordance with the Federal Reserve's mandate as the national lender of last resort?) The financial dilemma we discern may be hence formulated as follows: either the Federal Reserve decides to ration its dollar provision in order to conform to its mandate and to contain moral hazard, but it may thereby worsen systemic instability; or the Federal Reserve provides dollar liquidity liberally during financial crises in order to maintain global banks under perfusion, but it thereby departs from its mandate and deeply encourages risk taking. We have subsequently found that Minsky (1985, p. 17) foresaw such a dilemma in the following terms: On the one hand, "there is an open question of kow the US central bank can fulfill its duties as lender of last resort without encouraging banks to adventure; there is a 'moral hazard' problem with regard to the protected multibiilion-dollar banks that does not exist for smaller banks"; on the other hand, "the Federal Reserve cannot stand aside and ignore desbilizing developments in dollar-denominated banking in London or Singapore, for instability abroad will quickly be felt in New York" as was the case when the "run from abroad on the liabilities of Continental [Illinois in 1984] forced the Federal Reserve's hand." The further step of the financial globalization is the run in the US repurchase agreement and commercial paper markets, which especially concerns non-US banks and directly destabilizes the US banking institutions in New York.

The Federal Open Market Committee early and implicitly expounded the financial dilemma: on the one hand, it worried that "we're subsidizing foreign banks without really doing anything to mitigate [moral] hazard" and it was not sure that "the public understands that"; on the other hand, it was recognized that "we all understand that we have systemic responsabilities" (FOMC Transcripts, 2007: Fisher, Sep. 18, p. 154). The first option could operate in two ways. The extreme way was to let foreign central banks manage dollar shortages with their own dollar reserve holdings (FOMC Transcripts, 2007: Poole, Dec. 6, p. 16; Dec. 11, p. 8). The moderate way, decided on December 6, 2008, was to supply dollar swap lines to central banks with limited amounts and market auction format (FOMC Transcripts, 2007: Resolutions, Dec. 6, p. 18; Dec. 11, p. 14). The second option, announced on October 13, 2008, was the full-allotment format with fixed rate. And the reason for the second option was clearly exposed concerning the emerging market economies and the European countries as well: "the privilege of being the reserve currency of the world comes with some burdens. Not that we have an obligation in this sense, but we have an interest in helping these guys mitigate the problems they face in dealing with currency mismatches in their financial systems. We have an interest in helping them meet that in some sense. It's not our obligation. We have the same

basic interest that led us to be responsive to the European need in some cases" (FOMC Transcripts, 2008: Geithner, Oct. 28-29, p. 21).

The foreign exchange swap arrangements were initially presented as a reciprocal assistance framework, a horizontal safety network resting on a auction format, with rationed currency amounts. However, the tension created by the financial dilemma was at its height between September 30 and October 6, 2008, when the European Central Bank paid very high interest rate and bore negative margins. On October 13, 2008, the Federal Reserve passed from one horn of the financial dilemma to the other so that the dollar funding in the Eurozone passed from scarcity to abundance. To put it differently, the endogenous process set in motion by the financial globalization drove the Federal Reserve to respond to an intense dollar shortage and to change at its discretion its dollar swap line policy from a market-auction to a full-allotment format. Therefore, the Federal Reserve endogenously rose to the highest hierarchical level and the European Central Bank was the transmission channel of its global lending policy.

From the foregoing, the financial dilemma raises the question of the nature of the international relation of central banking. Keohane (1984) draws another perspective of the international political economy in stating that hegemony is neither a necessary nor a sufficient condition for cooperative relationships. Whereas it does not specifically deal with the international lender of last resort, Keohane's contribution echoes with the view that the reciprocal safety network corresponded to an attempt to organize central banks' cooperation thus establishing a cooperative relationship, that it remained horizontal without any hegemonic or hierarchical relation (Allen and Moessner, 2010; European Central Bank, 2014). However, the foreign exchange swap arrangements in 2008–2009 ran in one direction only – which is nonsensical for a network. In fact, there are reason to think that the cooperation argument had been made so as to avoid the stigma associated with the *de facto* unilateral swap lines.

Kindleberger (1973, 1978, 1981, 1983, 1986) examines on several occasions the issue of the international lender of last resort. In Kindelberger's view, the worsening of the Great Depression in the 1930s might be explained by the unwilingness of the United Kingdom and the United States to act as the leadership in general, and as the international lender of last resort in particular (in contrast, the US monetary authorities clearly acted as *the* international lender of last resort in 2008–2009 and contributed to some extent to stabilizing the international financial system).[7] Kindleberger (1973 [1986], p. 11) indeed argues

[7] The literature on the international political economy has often associated Kindleberger's contributions with the hegemonic stability theory and with the hypothesis of the benevolent hegemon. To be fair, however, Kindleberger (1981, p. 248) does not strictly endorse the benevolent-hegemon hypothesis and adopts a more discerning view: on the one hand, "the leader of the alliance pays more than a pro rata share of the general benefits of the alliance because of the free rider principle", but on the other hand, any country "powerful enough to take leadership responsibility may discharge it, may become corrupted

that "the international economic and monetary system needs leadership, a country which is prepared, consciously or unconsciously, under some system of rules that it has internalized, to set *standards of conduct* for other countries and to seek to get *others to follow them*, to take on an undue share of the burdens of the system" (italics added). The phrase "to take on an undue share of the burdens of the system" has led to the interpretation that the leadership would be or should be benevolent. More important in our perspective is the idea that the leadership "set the standards of conduct" that other countries "follow." This was typically the case under the Dollar Swap Lines before and after October 13, 2008. The Federal Reserve set the format – and decided at its discretion to change it – and the other central banks just followed, working as the conveyor belt.

As we find above, the relationship among central banks with regard to the auction format and interest rate policy, before and after October 13, 2008, reflected a hierarchical structure among central banks, which departs from both the cooperative relationship and the benevolent hegemon. On one hand, the hierarchical framework is not a cooperative network insofar as the Federal Reserve unilaterally provides international liquidity and determines at discretion the allotment format and interest rate on dollar swap lines. On the other hand, the hierarchical structure does not arise from any benevolent attitude insofar as it derives from the endogenous process set in motion by financial globalization, that is, the liberalization of international capital flows and the financial innovations produced by the US banking industry.

The hierarchical structure analysis that we propose seems at first sight similar to Kindleberger's proposal that some form of leadership is necessary to stabilize the international financial system. Notwithstanding the similarity with Kindleberger's view, our analysis emphasizes that the US banking industry is the driving force for the production of financial innovations and their spread within globalized finance creates the need for global lending in last resort that the Federal Reserve finally *in fine* fulfills as the ultimate option of the financial dilemma. Our approach finally differs from Kindleberger's in two respects. The first difference is analytical. The emergence of the global lender of last resort and the ensuing hierarchical structure is endogenous with the financial innovations and globalization, while the leadership *à la* Kindleberger proceeds from multilateral policy, institutionalized practices, and finally is exogenous *vis-à-vis* international finance. The second difference is historical. Our approach is set in the context of the financial liberalization that took place after the 1976 Kingston conference, while Kindleberger's approach resonates with the spirit of the 1944 Bretton Woods conference.

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into taking dominant advantage of it." Furthermore, Kindleberger (1986, p. 10) is actually skeptical about the concept of "hegemon" and prefers the concepts of "leadership" or "stabilizer" especially when the international lender of last resort is concerned.

7. Conclusion

The dollar is our currency, but your problem. The famous quip by the United States Treasury Secretary John Connally in Rome in 1971 followed the Nixon administration's unilateral decision to suspend the convertibility of the dollar into gold. It referred to the international status the dollar had held since the Bretton Woods agreements and, in some respects, made sense within the institutional framework marked by significant international capital flow controls. Western countries were bound to each other by multilateral international trade agreements but had not then achieved the degree of financial globalization observed at the onset of the twenty-first century. Thirty-six years after the end of the Bretton Woods system, the financial crisis and the Federal Reserve's unprecedented policy from 2007 to 2009 tended to bring the international problem of the dollar back to the United States. The institutional response of the Federal Reserve in 2008–2009 to the global dollar shortage relied on the emergency lending programs, notably some facility programs that non-US banks benefited from in their majority, and the dollar swap line program with full-allotment and fixed rate when the European Central Bank met serious difficulties in distributing dollars in its jurisdiction. We have explored in this paper the relation between the Federal Reserve's dollar swap lines and the European Central Bank's dollar provision with regard to the auction formats, the alloted amounts, and the interest rates. We have found that relations between the two central banks seemed rather hierarchical: the Federal Reserve changed at discretion the auction format of the dollar swap lines and the European Central Bank deeply depended on its global lending policy. We have also found that, when the European Central Bank paid very high swap interest rates and distributed dollars to Eurozone banks at a loss, the Federal Reserve finally decided on October 13, 2008 to implement the full-allotment and fixed-rate format.

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