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INFORMATION INSENSITIVITY, COLLATERAL FLOWS AND THE LOGIC OF FINANCIAL STABILITY

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Parole chiave: Financial Stability; Information Sensitivity; Collateral Flows; Systemic Phenomena; Equilibrium Selection; Market Design; Money.

Information insensitivity, collateral flows and the logic of financial stability

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Abstract. The role of collateralization in the dynamics of credit and liquidity provision is the subject of increasing research interest, for instance concerning the global macroeconomic role of safe assets. Still, when it comes to first principles of financial stability, questions of transparency seem to overshadow the relevance of collateralization arrangements and the specificity of networks of counterparties. According to Holmström (2015), the fact that liquidity requires transparency is a misunderstanding. The paper is meant to deepen the connection between the principle of "no questions asked" (NQA) on collateralized debt and the stabilizing properties of collateral flows in an equilibrium selection perspective. Conceptual and empirical implications are thoroughly discussed, and can be conjectured to represent lines of progress for the logic of financial stability, and for the theory of money as well. In a well known formula, money is a substitute for trust; an analogous role for the NQA principle – collateral is a substitute for questions – can be conjectured to deserve comparable relevance.

Keywords. Financial Stability; Information Sensitivity; Collateral Flows; Systemic Phenomena; Equilibrium Selection; Market Design; Money.

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1 Introduction

The great financial crisis of 2007-2009 has stimulated substantial progresses in our positive understanding of financial instabilities, and, consequently, a normative reconsideration of the first principles of financial stability. The relevance of having first principles to confront with seems to be quite firmly established, witness the perpetual reappraisal of "Bagehot's rule" for lending of last resort (LOLR).[1] As pointed out by Ben Bernanke, it matters for a central banker to have a "playbook" to rely on amid a financial crisis: "the challenge for us at the Fed was to adapt Bagehot's advice to the context of a modern financial system" (Brookings Institution, 2014). In fact, first principles are not meant to embody undisputed truth, and rather to define the logic of theoretical debates and empirical investigations, namely, "right questions" – like LOLR – whose answer depends on the specific context.

Well, in the regulatory response to the crisis, transparency has been repeatedly advocated as a "right answer", on the more or less explicit assumption that increasing transparency reduces the space for inappropriate risk taking (and misbehavior in general) without unpleasant drawbacks. However, such a vision has been challenged on manifold grounds. For instance, a growing literature is currently rebuilding the logic (and the relevance) of *safe assets*, i.e. assets whose value is meant to be scarcely sensitive to accruing information and systemic events (e.g. Gorton, 2017; Caballero et al., 2017). According to Andolfatto (2010), questions of transparency should be approached with an open mind. In line with such a remark, we shall try to ask good questions about information. In particular, we shall be arguing that the information insensitivity of collateralized debt and the stabilizing role of collateral flows represent *right and complementary questions* that impinge on the foundations of financial stability.

As a matter of fact, in response to the crisis, regulators have been largely concerned with placing constraints on banking activities, like "ring-fencing" for UK banks, or the so called Volcker Rule in the US (whose simplification is currently under consideration by US regulators). The rationale for such undertakings, that we may call principle of *insulation*, is reflected in the recent EU regulation of money market mutual funds (MMMFs) and "bail-in" norms, and does not represent a novelty. As pointed out by Diamond and Rajan (2001), after every crisis a number of economists engage in advocating the separation of banking activities. In fact, insulation may be justified by political and social pressure. The principle has been fiercely reaffirmed that failed financial firms should not be bailed out by taxpayers (see for instance Philippon and Salord, 2017), and that regulations and policy commitments should not make room for inappropriate incentives (typically grouped under the heading "moral hazard"). Understandable as it is, however, insulation does not dig deep into the logic of financial stability. Furthermore, its recent implementation has been bitterly criticized; according to King (2016), the disproportionate size of regulations like the Dodd-Frank Act[2] brings the system into disrepute.

One need not agree with King (2016) to admit that regulations should not add complexity to complexity. No doubt, the complexity of modern markets represents the major challenge for financial stability. For instance,

[1] Recall, one may state the rule as *lend freely*, *at a high rate*, *against good collateral*. The expression "lender of last resort" can be traced to the "dernier resort" discussed by Francis Baring in *Observations on the establishment of the Bank of England* (1797).

[2] Among the major innovations introduced by the Dodd-Frank Act, recall the requirement of annual "rapid resolution plans" (or "living will") for the financial institutions subject to enhanced oversight, the "single point of entry" recapitalization strategy, and the principle that bankruptcy should be the insolvency framework of first resort (Skeel, 2015/2016). The Volcker Rule, part of Dodd-Frank, takes hundreds of pages, and even before the release of its final version, large banks had dedicated compliance officers.

fundamental tensions between micro- and macro-prudential regulations have been thoroughly discussed (e.g. Acharya and Thakor, 2016), and some factors that contribute to the resilience of financial networks under certain conditions have been conjectured to represent sources of systemic risk in different conditions (Acemoglu et al., 2015). On top of that, systemic phenomena are nonlinear, and can hardly be addressed piecemeal, variable by variable. Consider for instance the ongoing debate on bank capital regulation. The basic comparative statics is well known: other things the same, the more risk capital, the more the bank is in a position to absorb unexpected shocks. Still, in and by itself, such a comparative statics does not yield the "magic number" for the correct equity ratio, as pointed out by Aiyar et al. (2015). According to the Authors, right questions on bank capital regulation pertain to the design of "a system of credible, incentive-robust rules that combine valid concepts with objective, market-based information into a simplified and credible regulatory process."

The extant literature displays in fact a significant consensus on the fact that principles and regulations should target the desirable properties of 'good' market phases – not the 'optimal' values of specific variables – as well as the mechanisms that may pivot the system toward desired trajectories. In the words of Bernanke (2013), "objectives are most useful when accompanied by provisional plans for achieving them." Consider the increasing role of "forward guidance" in the conduct of monetary policy by major central banks,[3] which is meant to sharpen beliefs and expectations of market participants so as to "guide" the system towards desirable and sustainable paths. One can think of forward guidance as a means to address an equilibrium selection (ES) problem. ES problems shape landmark models of bank runs, like Diamond and Dybvig (1983), as well as recent advances in the understanding of shadow banking, like Martin et al. (2014). Our approach deals with the conceptual foundations of ES problems in which the stabilizing factors of desirable equilibria are at stake.

In recent years, models of financial contagion and destabilizing spirals have been improved, with more realistic representations of positions, with capital required for both long and short positions (Gârleanu and Pedersen, 2011). The procyclical interaction of funding liquidity and market liquidity has been thoroughly investigated (e.g. Brunnermeier and Pedersen, 2009), and margins have been shown to imply both stabilizing and destabilizing effects, on both theoretical (ivi) and empirical grounds (Martin et al., 2014). True, the major inspiration for the present contribution is the twofold perspective on liquidity spirals discussed by Krishnamurthy (2010). The Author provides engaging re-elaborations of the "balance sheet mechanisms" and "information mechanisms" that the literature has been discussing as basic elements of the amplification and contagion of liquidity shocks. On the one hand, price shocks may drive the emergence of balance sheet constraints that force fire sales, whose further impact on prices may spark a self-reinforcing process. Variations of such a mechanism can encompass leverage, margin requirements and limited capital; to some extent, the basic insight can be traced to the landmark "debt-deflation theory of recessions" set forth by Irving Fisher (1933); see also Eggertsson and Krugman (2012). On the other hand, financial innovation challenges the ability of market participants to design convincing risk management practices; once unexpected news undermine the confidence in a class of securities, agents simply disengage from risk and fly to quality, thereby further reinforcing liquidity stress. In a sense, such information mechanisms represent variations of the problem of "lemons" (see Kurlat, 2018). We shall be arguing

[3] Bernanke (2013) witnesses the attempt to make monetary policy "as transparent and open as reasonably possible." A phase transition has occurred with respect to the opacity of monetary policy not too many decades ago. Interesting as it seems, an evolutionary analysis of such a transition is beyond the aim of the present contribution.

about the relevance of balance sheet and information mechanisms by integrating recent research advances on the role of collateralization.

On the one hand, Mehrling (2012) sheds new light on the properties of networks of counterparties and collateral flows, and on the relevance of complementing the classical LOLR principle with a companion "dealing of last resort" (DOLR) principle. On the other hand, Holmström (2015) discusses the implications of the sensitivity to information of securities, and the fundamental role of collateralized debt. We shall discuss the relevance and complementarity of such themes in an ES perspective in which the basic question is the potential existence of stabilizing collateral flows that may support states of NQA. On methodological ground, a game-theoretic attitude inspires our logic, somehow along the lines traced by, among others, Diamond and Dybvig (1983), Dang et al. (2017), He et al. (2019). On conceptual grounds, one may notice a recent contribution by Williamson (2016) emphasizing the fact that the ability of banks to gain trust is limited not only by capital, but also, importantly, by the fact that collateral may be in short supply in the aggregate (see also Caballero et al., 2017). In fact, Singh and Alam (2018) elaborate on the global relevance of pledged collateral for nonbank funding to banks.[4] Furthermore, the introduction of Flow of Collateral accounts has been advocated as a significant advance in our understanding of shadow banking (Pozsar, 2014).

In turn, we shall disregard moral hazard and misbehavior. Needless to say, our approach is not meant to dismiss the gravity of misbehavior; our aim is to pursue a methodological line with seemingly far reaching implications for financial stability and monetary theory (see subsection 3.3 below), to which one may subsequently add further elements. Somehow analogously, in the analysis of financial frictions, one considers a subset of frictions at a time (see the recent account by Brunnermeier et al., 2013).

It has been argued – among others, by Hyman Minsky (1986) – that regulations typically build upon some theory about how markets behave, and that poor theories can trigger undesirable regulations. Well, according to Holmström (2015), it is the case that "attempts to reform credit markets in the wake of the recent financial crisis often draw on insights grounded in our understanding of stock markets. This can be very misleading." Furthermore, regulations that constrain balance sheet space of private institutions may impede collateral flows (Singh, 2017). On the other hand, beneficial effects of new regulations have been largely acknowledged, like mandating central counterparties for derivative positions (see for instance Duffie, 2016; FSB, 2018). Hopefully, our approach may shed light on both ups and downs of current and prospect regulations.

The plan of the rest of the paper is as follows. In section 2 we introduce the basic elements of Holmström's (2015) perspective on collateralized debt. In section 3 we sketch the vision on market design set forth by Mehrling (2012), and the connection with Holmström's (2015) analysis. A concluding section envisions lines of progress for our considerations. Evidently, the present short contribution is not meant to provide a comprehensive account of financial stability analysis and prudential regulation; it is a sharp methodological perspective that we shall try to pin down, on the premise that it may be useful to have short and readable accounts of recent research advances. The following sections are meant to justify such a claim, and perhaps the remark by von Thadden (2015) that these are intellectually fascinating issues.

[4] "For example, if Walmart wants to expand in Texas and needs funding from its relationship bank, Citi, the treasurer of Citi can choose to fund its client from deposits or wholesale funding (which are both on balance sheet), or from pledging collateral it has received off-balance sheet to another bank" (ivi, p. 4).

2 Information and collateral

The first pillar of our conceptual framework pertains to the role of information in financial markets. Recall, the 'information revolution' of the 1970s had a substantial impact on financial economics, for instance concerning the analytical representation of learning and herding behavior (see Vives, 2008). True, over the last few years, the positive relevance of information-theoretic models has been significantly reassessed. The problem of lemons (Akerlof, 1970) has been diagnosed at the roots of the great financial crisis (e.g. BdF, 2008; Tirole, 2011), and sophisticated refinements of such insights have been discussed as fundamental elements of liquidity dynamics (e.g. Kurlat, 2018). However, it is more basic grounds that Holmström's (2015) framework is meant to tread, namely, the relevance of economizing on information.

Economists have long recognized that economic efficiency has to do, among other things, with economizing on information. For instance, standardization paves the way to *anonymous* trade, which is crucial for the development of markets and the very emergence of economies of scale. Correspondingly, the logic of a contract is to reduce the space of an economic interaction to a well defined – and, hopefully, quite limited – number of *publicly verifiable* variables that trigger both the well functioning of the relation and the space for litigation in case of delinquency. For instance, it is impossible to write insurance contracts in which the payoff depends directly on private information (Diamond and Dybvig, 1983). Recall, further, that the standardization of risk profiles magnifies the potential for liquidity transformation; a notorious example is given by the securitization practices that produce inputs (e.g. collateralized debt obligations) for the shadow banking system.

Beyond efficiency, though, stability does matter, in particular for financial relations in which economizing on information boils down to pursuing the information insensitivity of claims. As a well known example, bank money *should be* information insensitive in order to enable the bank to trade currency and deposits at par on demand, irrespective of the (fair) value of its assets. In recent years, the foundations of such a normative precept have been devoted renewed interest. For instance, DeAngelo and Stulz (2015) set forth a normative model of banking in which a perfect hedging of the bank's assets guarantees the information insensitivity of liabilities, whereas Dang et al. (2017) represent the incentives for a bank to keep secret the quality of the loans that it has extended. Well, from a financial stability standpoint, the problem is the *tension* between the normative precept of insensitivity of bank money and the positive evidences about its contingent sensitivity. A number of Authors have in fact addressed the sense(s) in which financial fragility is a desirable characteristic of banks (e.g. Diamond and Rajan, 2001). Well, bank runs have been represented as a (strategic) regime switch in which depositors lose confidence and develop incentives to run on the bank; panics are information events (Holmström, 2015). In such respect, the effectiveness of deposit guarantees has been widely acknowledged, and rationalized as analogous to LOLR (Diamond and Dybvig, 1983) – see Acharya and Mora (2015) for the effectiveness of US government deposit guarantees introduced after the Lehman collapse.

2.1 No questions asked

It has been long established that stock markets, among other things, perform a decentralized information processing that results in "efficient" prices, i.e. prices that embody all of the available information on the

fundamentals underlying different stocks. Stock markets produce a symmetrization of information, and common knowledge thereof. It is as well known, on the other hand, that collateralized debt economizes on information, in that collateral secures the lender from the potential consequences of default of the borrower; opacity, in a well defined sense, enhances credit extension and liquidity provision, much like insurance provides a solution to the problem of lemons and deposit guarantees prevent runs. That being the case, in the words of Holmström (2015), *no questions asked* (NQA). Noticeably, a sort of oblivion about such well established facts features in some financial debates. "People often assume that liquidity requires transparency, but this is a misunderstanding" (ivi). It is misleading to advocate transparency as an overarching principle of financial stability, as if financial markets were fundamentally homogenous. In order to deepen the implications of such considerations, Holmström (2015) fixes a sharp perspective on money markets.

To begin with, the Author fixes a number of opposite properties that mark the aforementioned dichotomy between markets for risk sharing and markets for liquidity. For instance, in the former, trade is unstable and requires a significant investment in information, whereas in the latter it is highly stable (think of the demand for overnight liquidity) and, in principle, requires little investment in information. Then, in order to pin down the information-theoretic content of the NQA principle, Holmström (2015) envisions the value of debt as a function of the value of collateral as a put option whose qualitative representation is given in Figure 1 below.

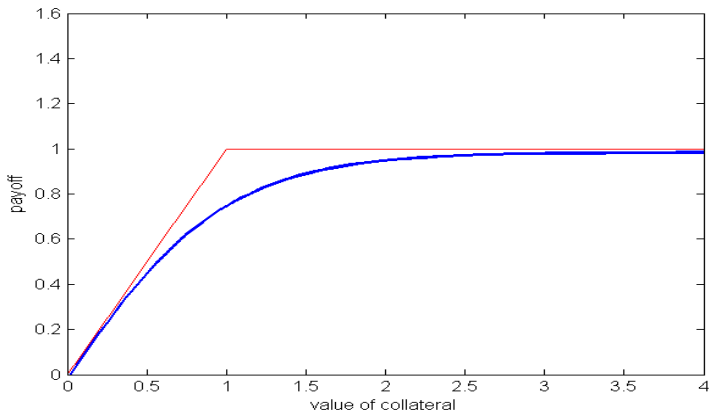

Figure 1. The (qualitative) value of collateralized debt as a put option (adapted from Holmström, 2015). The upper line represents the payoff to the writer of a put option with unit strike price and vanishing exercise price.

Consider collateralized debt with unit present value. The value of the put option on such debt is the concave curve below the 'inverted hockey stick' line. At the left end of the plot, the value of the option approximates closely the identity function, and then progressively flattens, finally approaching the horizontal asymptote as the value of collateral diverges. Thus, for collateral value significantly larger than 1, we move in the information

insensitive region, in which NQA. Then, moving in the direction of decreasing collateral value, the region neighboring 1 stages the transition to information sensitivity. Figure 1 represents the 'response function' of the value of debt to the value of collateral, and provides a canvas for painting the details of specific relations and models of collective phenomena and systemic events. In a comment to Holmström (2015), von Thadden (2015) argues that the truly fundamental degree of freedom in such a problem is not collateralized debt per se, but the security that creates fragility "because it puts the whole investment at stake every period"; a finitely lived equity security may play such a role. Even more significant, though, may be the speed at which confidence evaporates and collective reactions precipitate.

Holmström (2015) envisions urgency as a key difference between stock markets and money markets. Noticeably, urgency as a physiology of financial institutions is guest in the "cash flow approach" advocated by Hyman Minsky (1986). It is not our aim to explore the connection between the inherent instability of the financial system discussed by Minsky (1986) and Holmström's (2015) framework, a connection that is adumbrated by Holmström himself arguing that "the calamity is a consequence of the quiet." For our sharp methodological purposes, it is more interesting that Holmström (2015) invites us to balance properly the physiologic and pathologic aspects of shadow banking[5] in order to build a sound picture of the properties of current market networks. According to the Nobel laureate, among the salient features of shadow banking, one should consider the fact that it represents an efficient way to mobilize collateral. This kind of reasoning points at the relevance of augmenting Holmström's (2015) analysis with specific details of the microstructure of markets. In such respects, repurchase agreement (repo) markets provide concrete and interesting elements.

It is by now well established that problems in the roll over of short-term debt marked both the early phase (summer 2007) of the great financial crisis, and the subsequent unfolding of events (see for instance Brunnermeier, 2009; Krishnamurthy et al., 2014; Martin et al., 2014; Acharya and Mora, 2015). Still, a sharp representation of the role of repos in such a dynamics seems not easy to fix. Krishnamurthy et al. (2014) employ empirical data to shed light on the reallocation of liquidity among dealers and between dealers and hedge funds, and conjecture that repos played a crucial role in the crisis by hitting disproportionately a few systemic banks. On top of such empirically relevant considerations, though, our interest in the mechanics of repos builds on the specific nature of such transactions.

2.2 Repos

Recall, a stylized repo is a two stage financial operation in which an initial exchange of collateral for cash (the "opening leg") can be reversed at expiry (the "closing leg") so that collateral can flow back in exchange for cash that pays both principal and interest (gauged by the repo rate). Conceptually, a stylized repo can be considered a prototype collateralized loan, in that the cash lender is immediately entitled the ownership of the securities that collateralize the loan (that, in fact, are at times rehypothecated); in case of default on the cash obligation, ownership is simply maintained. Furthermore, the haircut (reasonably) secures the cash lender from variations in the value of collateral, which is anyway expected to be small, since repos are short-term loans, in many cases

[5] In a metaphor coined by Adair Turner, shadow banking is like cholesterol, there is good and there is bad. It has in fact been repeatedly argued that securitization and 'originate to distribute' practices should not be taken as inherently destabilizing.

overnight. By these stylized characteristics, repos seem to embody an ideal representation of the NQA principle, i.e. a collateralized loan whose value is expected to lie stably in the information insensitive region of Figure 1.[6] Still, the size of such operations has contracted significantly at the height of the great financial crisis, with a sharp increase in margins for bi-party repos and complete breakdown for tri-party (Martin et al., 2014). One may consider such evidences as gauges of the severity of the crisis, as the impact of a 'perfect storm' on otherwise robust relations; however, a more sophisticated outlook of concrete market arrangements shows the devil in the details.

Recall, repos come in two forms. In the bi-party form the cash provider, among other things, has to keep track of the received securities and check their adequacy and valuation (Copeland et al., 2012). Such frictions, arguably, have played a role in the evolution of general collateral (GC) markets and tri-party arrangements. Today bi-party repos often deal securities that are in particular demand, like recently issued ("on-the-run") Treasuries, for which cash lenders are willing to charge lower rates and haircuts. In fact, on the collateral desk of large banks, "gem picking" occurs (Singh, 2017), and the best securities go out bilateral. Less-than-gem securities go to the GC market, in which collateral is specified in terms of equivalence classes. In the US tri-party repos are intermediated by *clearing banks* that, beyond settlement and custody, provide services like daily revaluation of assets and remargining of collateral (Copeland et al., 2012). The clearing banks intermediate an anonymous market; they are market-makers that not only match demand and supply for liquidity, but have been providing intraday credit to the dealers engaged in short-term borrowing, so as to fill the gap between the "unwind" of expiring repos and the "rewind" of new ones. One has thereby twice a day transfer of exposures from a dealer's investors to the clearing bank, and way back (ivi).

Then, like any intermediary, clearing banks are subject to the potential emergence of financial constraints. Vulnerabilities of tri-party arrangements have in fact concretely manifested during the crisis, and a rethinking of practices has been undertaken. It has been appreciated that the default of a cash borrower may not be absorbed by a clearing bank, determining an interruption of payment services for other clients. Furthermore, the discretionary nature of the clearing bank's credit extension has inherently procyclical effects (Agueci et al., 2015). Channels of instability did emerge indeed at the height of the great financial crisis, in particular, contributing to the Lehman crack (Martin et al., 2014). Such problems have motivated a reform in the US, under the supervision of the Tri-Party Repo Infrastructure Reform Task Force. An account of the positive effects of the reform is given by Agueci et al. (2015), and a theoretical analysis of the problem is given by Martin et al. (2014). According to the Authors, equilibrium in the tri-party market may break down simply because of coordination (ES) failure. On top of the analytic details of the model, it is the conceptual relevance of such an insight which seems to fit nicely our normative stance. In particular, our major concern is whether problems manifested with tri-party repos should be considered to undermine the soundness of the NQA principle. In the author's view, this is a good question.

As already pointed out, the issues raised by Holmström (2015) do not represent an absolute novelty (see for instance Andolfatto, 2010; Gorton, 2017), and still do not seem to fit common views on transparency. It is therefore important to envision both the reach and the limits of the NQA principle, in order to sharpen its

[6] Securities lending and bilateral repos are part of the bilateral collateral market (see Singh, 2017).

relevance in the larger playbook of financial stability. The aforementioned vulnerabilities may lead one to consider NQA a 'weak' principle, a characterization of 'good times' that simply breaks down under adverse circumstances. Well, from a normative standpoint it matters to recall that the reach of a principle at the same time gauges its limits, where other principles should be expected to come into play. Then, what principles should we envision at the boundaries of NQA? For sure, it is not more information that is needed to fix the aforementioned instabilities. In such respect, a remark by Copeland et al. (2012) is worth explicit quote.

"In principle, a collateral allocation process that allows for the simultaneous settlement of new and expiring repos would eliminate the gap between unwind and rewind, reducing the dealers' need for intraday credit. The clearing bank could design a collateral allocation system that achieves the various optimization objectives desired by dealers, thereby removing the incentive for them to manually intervene in the process." To the general reader, such a remark may sound like a somewhat specific suggestion concerning a specific market arrangement, without particularly significant implications. Quite on the contrary, in the author's view, such a remark does have the following far reaching implication: *it is not the relevance of new information that sets the limits of NQA, it is the contingent sustainability of the positions of market participants, that may be challenged by emerging constraints – say, liquidity or collateral constraints as in Martin et al., 2014) – perhaps generated by systemic turbulence* (compare Gorton, 2017, subsection 3E). In this sense, the previous considerations should not be considered to undermine the relevance of the NQA principle, and rather to provide hints on how to complement it with "right questions" about market design and collateral flows, that one may then model in terms of explicit ES problems. The following section pursues such a logic.

3 Market design and collateral flows

The tradition in normative finance is to address the way rational agents make markets "efficient", and the sense in which market imbalances, liquidity shortages and limits of arbitrage can be considered "anomalies". Well, over the last two decades, and in particular after the crisis, substantial research efforts have been devoted to the investigation of the 'physiology' of such anomalies (see Gromb and Vayanos, 2018, and references therein). The nature of money itself is currently subject to a profound rethinking.

The effectiveness of standard monetary aggregates as gauges of market phases has been seriously questioned – think of the 'evaporation' of the money multiplier(s) after the unprecedented increase of base money in the US since 2009. Instruments like MMMF shares – that cannot be used for settlement purposes – trade at par with deposits and possess fundamental attributes of money that can hardly be embraced by traditional schemes (like quantitative equations) that make no room for collateral. According to Singh (2017), viewed together, "money and collateral provide a more comprehensive picture of how global liquidity should be considered." In such respect, Mehrling (2012) provides an enlightening discussion that we assume as the second pillar of our conceptual framework.

3.1 A stylized market

The Author envisions a stylized market-based credit system in which the role of risk capital and collateral are given a simple representation (Figure 2 below).

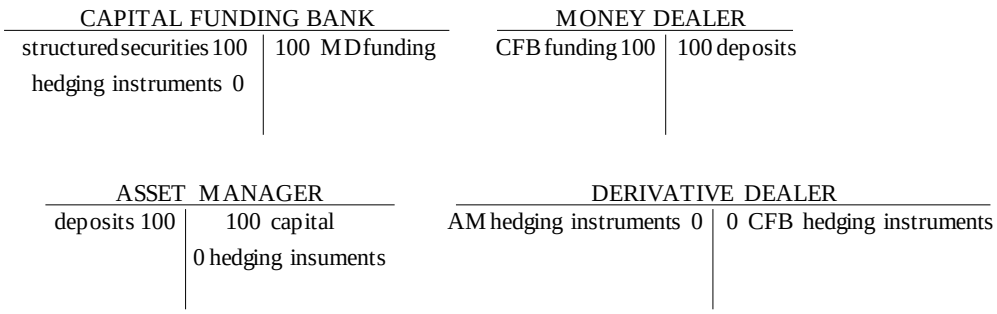

Figure 2. A stylized capital market for wholesale funding (adapted from Mehrling, 2012).

The assets in the market (say, structured securities resulting from tranching pools of illiquid loans) enter the LHS of the balance sheet of a (representative) "Capital Funding Bank" (CFB), together with suitable hedging instruments (say, credit default swaps). Such a position is financed by a (representative) "Money Dealer" (MD). In turn, the MD is financed by deposits that represent the assets of an "Asset Manager" (AM), whose liabilities represent the risk capital in the system. In addition, a "Derivative Dealer" (DD) provides the counterparties for the hedging positions in the system. One may argue that such a stylized market can hardly compare with empirical market arrangements (see Pozsar, 2014, for a detailed account), and therefore question the relevance of such a stylization. However, *simplification* is exactly the point of the argument. The complexity of a system is an obstacle for both understanding what's going on (the positive) and arguing about restructuring patterns (the normative) that may enhance the resilience of the system. In both attempts, one is invited to look for simplification. In fact, Mehrling's picture has the merit of suggesting a simple pattern of collateral flows that may support a smooth contraction of the system.

Suppose a negative shock affects the price of the assets in the model (say, the value of structured securities falls from 100 to 90). A corresponding increase (from 0 to 10) of the value of the hedging instruments must compensate such a loss, if the shock is not to compromise the sustainability of the positions of the CFB, but the truly interesting point is that *the system as a whole* must react properly for such a transition not to ignite dangerous instabilities. In particular, both sides of the balance sheet of the DD must respond identically, in order to maintain the solvability of the centralized derivative counterparty. Well, it turns out that suitable collateral flows support such a (perhaps temporary) transition. Suppose a mechanism exist for shifting the AM deposit collateral to the credit of the CFB, so as to secure (perhaps, temporarily) its positions; such a collateral

reallocation can support the expansion of the balance sheet of the DD, so as to have the counterparties suitably hedged. If the price shock is temporary, after the price recovery collateral can flow back to the AM, so that the values of positions can be reestablished as in Figure 2. If the price change is permanent, collateral flows enable the system to adjust to a new equilibrium in which risk capital absorbs the losses, preventing the onset of destabilizing mechanisms. In this sense, Mehrling (2012) solves an ES problem that prevents destabilizing phenomena.

Such a simple picture enables Mehrling to argue about first principles for the regulation of market-based credit. According to the Author, policymakers should trigger markets, not "too big to fail" institutions,[7] and in particular central banks should be primarily concerned with market liquidity and DOLR, and not with funding liquidity as in the traditional LOLR approach. However, from the sharp methodological perspective we are pursuing, the key result is the 'stability theorem' that demonstrates *the existence of suitable collateral flows that can trigger a smooth response of the system: suitable collateral flows support the extension of "credit", in the generalized sense of expansion of some key balance sheets in response to the contraction of counterparties*. One may feel somewhat unimpressed by such a simple observation, which, notice, depends crucially on the accounting convention of treating AM derivatives as liabilities. Still, in the light of the remarks at the end of the previous section, one can envision the relevance of this stability theorem as a natural complement to the NQA principle.

In subsection 2.2 we reproduced a remark by Copeland et al. (2012) emphasizing the relevance of collateral reallocations. Well, Mehrling's picture provides a simple intelligent market design that facilitates the representation of stabilizing collateral flows, and seems to provide a sound complement (at the boundaries) of the NQA principle. The stylized market represented in Figure 2 emphasizes the relevance of centralization. On the one hand, risk capital is concentrated in the RHS of the balance sheet of the AM, that can therefore command collateral flows without having to solve coordination problems with other investors. On the other hand, the DD provides a central counterparty for derivative positions, so that the expansion of its balance sheet is not inhibited by coordination problems. Such a benchmark market arrangement, then, helps us envision a simple pattern of collateral flows that enable the system to contract smoothly, and, possibly, restore a state of NQA.

To the author's knowledge, the generality of such a collateral shift mechanism for the logic of financial stability and its connection with the NQA principle have not yet been explored in depth. Evidently, analogous mechanisms have been discussed and implemented in the history of financial theory and practice. For instance, Gorton (2017) notices that, for the economy to "get back to insensitive debt" (ivi, subsection 3E), it is not more information about the quality and allocation of collateral that matters; the Author recalls in fact the traditional emergency role of clearinghouses of *pooling* the assets in the banking system as a systemic guarantee, against which to issue clearinghouse notes ("loan certificates"). Furthermore, one may notice a recent proposal of manufacturing synthetic "European Safe Bonds" (ESBies: Brunnermeier et al., 2017) by means of a securitization design in which pools of Eurozone government bonds are tranched into junior ("EJB") and senior ("ESB") claims. Such an operation, according to the Authors, should result not only in a larger share of safe assets, but, importantly, in a stabilizing mechanism for sovereign risk. Well, both such mechanisms are somewhat close to our logic; still, the difference stands out between pooling assets as systemic collateral (which, in game-theoretic jargon, is a

[7] Dacorogna and Busse (2017) advocate a method for gauging the "price" of being a systemically important financial institution.

cooperative solution), and *shifting* collateral (which is a *non-cooperative* solution) to reestablish NQA locally, i.e. for individual balance sheets or primitive claims. Furthermore, our logic aims at a more general normative foundation of first principles of financial stability.

Our picture seems to complement properly the representation of the coordination failure at the root of the asset liquidation and liquidity spirals discussed by Krishnamurthy (2010). In line with the relevant literature, the Author notices (ivi, section IE) that definite central bank policy commitments – asset purchase and discount window lending – can work effectively as ES devices ruling out bad liquidation equilibria. Well, the 'centralized' collateral flow design envisioned by Mehrling (2012) can be considered a benchmark 'coordinated solution' of one such ES problem – perhaps useful for comparative welfare analysis – in which the explicit representation of the interaction of balance sheets displays explicitly the potential channels of stabilization. We seem thereby to envision lines of progress for the complementarity between the "balance sheet mechanisms" and "information mechanisms" discussed by Krishnamurthy (2010), pointing at a more fine grained representation of the microstructure of markets.

Along such a perspective, Pozsar (2014) provides explicit 'maps' of the balance sheet interactions in the contemporary financial system. A "hierarchy" of balance sheets, with the Central Bank at the top, is conjectured to represent properly the monetary interactions in the system and the various forms of liquidity therein. Explicit maps enable one to trace the sources and uses of money instruments that represent sort of "working capital" for market participants. In particular, explicit maps depict the public and private backstop (LOLR) arrangements that pivot the stability of the system, as well as the systemic reverberations of the strategies of cash pools, looking for safety (NQA), and leveraged portfolio managers looking for yield. A key point is that derivatives separate the flow of risks from the flow of funds, and their explicit role in definite balance sheet networks can hardly be accounted for by Flow of Funds accounts. In addition, the complexity of the phenomenology of financial networks represents a major challenge to a comprehensive analysis of stability.

3.2 Networks

On theoretical grounds, Acemoglu et al. (2015) address seemingly incompatible and yet apparently sound insights on the resilience of markets that the extant literature has been debating. On the one hand, increasing the number of counterparties of a financial firm may enhance its resilience by diversifying counterparty risk. On the other hand, increasing the connectivity of the network may increase the number and effectiveness of potential channels of contagion. It has even been conjectured that such apparently conflicting insights may represent different "phases" of a "robust-yet-fragile" system (ivi, references therein). It is precisely this conjecture that Acemoglu et al. (2015) aim at giving an analytic foundation. One may notice at the start, however, that the previous insights should not be taken as necessarily incompatible, since the first concerns local properties, whereas the second targets global properties.

The Authors consider a fixed number of financial firms (stylized banks) linked by bilateral unsecured debt contracts in a "regular" network, i.e. a network in which banks have identical interbank claims and liabilities. Such an assumption is meant to focus the role of the network as *interaction channel*, even in the absence of

significant market imbalances. The topology of the financial network is framed with respect to the extreme cases of the ring and the complete network; a general network can then be defined as a convex combination of the polar cases. The aggregate measure of excess liquidity in the system turns out to represent a crucial systemic variable. The response of the network to shocks (default of a single bank or multiple banks) is pivoted by a threshold value of such a variable: below the threshold, increasing the number of connections in the network has stabilizing effects, and the complete network is the more resilient; above the threshold, instead, the system undergoes a phase transition, and the complete network becomes the least stable, together with the ring. The two "shock absorbers" in the system make the argument intuitively plausible. On the one hand, the excess liquidity of the non-distressed banks is more effective as shock absorber for more connected networks; on the other hand, the claims of senior creditors, that are forced to bear some of the losses, are more effective for less connected networks. In the author's view, such insights should feature among the drivers of progress of financial stability analysis; for instance, one may investigate whether networks for secured (collateralized) market-based credit may display a different phenomenology, given enough 'fluidity' of collateral flows.

On empirical grounds as well the phenomenology of networks has been investigated. For instance, Li and Schürhoff (2019) elaborate on the behavior of networks of dealers in municipal bonds. The available data enable the Authors to test a number of hypotheses, among which the role of LOLR of central dealers in times of stress. On top of the soundness of such an hypothesis, though, the generality of such a phenomenology in more sophisticated dealer networks may deserve further analysis. The insight that investors do trade primarily for liquidity reasons, and not because of private information about fundamentals, seems to be more general.

3.3 Coordination and money

Sketchy as they are, the previous remarks convey the sense of the challenge that financial networks pose to the normative analysis of stability. First principles are meant to distill right and *simple* questions, but it is hard to ask simple (right) questions about *complex* phenomena. It is in such respects that we envision the relevance of the stylized market depicted in Figure 2 and the simple pattern of stabilizing collateral flows discussed by Mehrling (2012): the very identification of the pivotal degrees of freedom is what first principles should be primarily concerned with. The first principles we have been addressing seem to be well suited for the aim. One may then consider the question whether policymakers, generalizing the remark by Copeland et al. (2012) quoted in subsection 2.2 above, should target *a gigantic coordination problem of complete contingent plans of collateral flows in case of adverse systemic events, and its connection with a package of LOLR facilities*.

In the author's view, such a question may be useful if only as an intellectual exercise, a "gedanken experiment" meant to deepen the logic of financial stability. Nowadays, the availability of computational power poses no obstacle to the feasibility of numerical approaches to such a question. Significant challenges, though, may concern the generality of the results of simulations, the availability of empirical data to confront with, and the extent to which basic principles of financial stability may have a grip on such phenomenology. These challenges seem to broaden the sense in which, according to Holmström (2015), the logic of financial stability should not be taken for granted. Krishnamurthy et al. (2014) provide an explicit representation of the market microstructure that channels the funding liquidity that supports positions in asset-backed securities of special purpose vehicles

(ivi, Figure 1). In such a picture, repos and asset-backed commercial paper (ABCP) represent alternative routes for collateralized liquidity provision from MMMFs and securities lenders to dealers and ABCP conduits. The 'substitutability' of such routes as a stabilization mechanism may represent a sharp playground for (part of) the aforementioned "gedanken experiment".

As stated in the Introduction, the current debate on safe assets provides a natural background for our considerations. Brunnermeier et al. (2017) notice that a crucial problem with the Euro area is that it does not supply a union-wide safe asset. According to the Authors, engineering and marketing union-wide safe ESBies would ensure that flight to quality occur across assets rather than countries. As already pointed out, such a logic is somewhat close to our conceptual framework, in particular concerning the ex-ante approach of anticipating and 'programming' the transition from information insensitivity to sensitivity, and (hopefully) way back. In fact, beyond issues of financial stability, the role of money itself may be at stake in our approach.

Singh (2017) argues that progresses in the theory of money should provide a deeper account of the role of collateral in contemporary markets. Our logic seems to fit such a conceptual stance. Recall, in a renowned formula, *money is a substitute for trust* (Shubik, 1999). Not as well renowned may be the insight that, with respect to a Walrasian general equilibrium framework, money represents an extra degree of freedom that provides leeway for disequilibrium (ivi, Preface). Then, along analogous lines, one may rephrase NQA as *collateral is a substitute for questions*, and complement it with the insight that collateral represents the extra degree of freedom that provides leeway for the design of stabilizing collateral flows. Much like the acceptability of money is a coordination (ES) problem of mutually sustaining beliefs (Kiyotaki and Moore, 2001), one may envision our conceptual framework as revolving around the coordination (ES) problems of mobilizing suitably designed collateral flows that may support states of NQA.

Interestingly, our logic seem to be broadly consistent with current advances in the rationalization of large value payment systems. On empirical grounds, interbank payments mobilize reserves backed by liquid collateral. On the theoretical grounds depicted by Tomura (2018), the central bank performs a central mechanism that *coordinates* the interbank market with liquidity-saving effects. According to the Author, interbank payments can be represented as the outcome of a bargaining process which is potentially subject to a hold-up problem generated by the outside option of depositors to withdraw their funds. The central bank solves such a problem in terms of an "implicit contract" with banks; the central bank as the custodian of the collateral that backs the payment instrument enables banks to economize on liquid assets, and then circumvent the hold-up problem (one is clearly reminded of the rationale for the emergence of clearinghouses; the Author in fact notices that the custodian of collateral for interbank payments is a natural monopoly). It may not be straightforward to rephrase such a mechanism in terms of the game-theoretic "choreographer" that provides solutions to ES problems (see Gintis, 2009, and references therein); still, the strategic role of coordinators played by major central banks over the last decade stands out in unprecedented terms.

In the light of these seemingly profound analogies between the foundations of the theory of money and the principles of financial stability, one may dream of a 'perfect symmetry' between the two subjects, if only as a tentative scheme for framing specific insights and general lines of reasoning. In a concluding remark, Gorton (2017) notices that the global banking system has undergone an irreversible transition from a system based on

insured deposits to a phase driven by the strategies of wholesale investors, and that new regulations have not solved the problem of the vulnerability to runs of the current system. In the author's view, the aforementioned symmetry provides a sharp logic for framing, at least in a preliminary way, the implications of such evolutionary dynamics. However, less daringly, one may simply envision the present contribution as pointing at potential lines of progress for the (currently evolving) theory of money, which do not seem at odds with well established insights like the emergence of liquid claims out of suitable collateralization arrangements – see the engaging Clarendon Lecture by N. Kiyotaki and J. Moore (2001). It may not be inappropriate to argue that the problem of financial stability has risen to the status of key problem in political economy, on both methodological (e.g. He et al., 2019) and empirical grounds (think of the macroeconomic consequences of the great financial crisis). With that said, it is on more established grounds that we take stock of our considerations in the concluding section.

4 Conclusions

As already pointed out, it was not the aim of this short paper to provide a comprehensive scrutiny of the first principles of financial stability. Rather, the sharp methodological stance we have been addressing was meant to emphasize the relevance and the complementarity of the problems of market design, collateral flows and information insensitivity of collateralized debt. After the great financial crisis, the transition from information insensitivity to sensitivity of positions as the spark of self-reinforcing destabilizing phenomena has been the subject of substantial research efforts (e.g. Brunnermeier and Pedersen, 2009; Krishnamurthy, 2010). The principles of no questions asked (Holmström, 2015) and of the potential existence of stabilizing collateral flows (Mehrling, 2012) seem to provide "right questions" for reshaping the normative perspective on such truly relevant equilibrium selection problems, and, hopefully, on a larger panorama. It has been argued by Ben Bernanke that "the problem with quantitative easing is it works in practice, but it doesn't work in theory" (Brookings Institution, 2014), and, more generally, that the unconventional monetary policy response to the great financial crisis has projected the advanced economies into uncharted territory. Research efforts to provide charts, necessarily partial, of the new territory are under way, in which the "scarcity" of collateral, among other things, is at stake (see Williamson, 2016). The first principles we have been discussing seem to tread comparable grounds. True, we seem to envision the following more narrowly defined problems as natural playfields for our considerations.

First, a sharp game-theoretic approach to the "determination" of safe assets is conceived by He et al. (2019). According to the Authors, the safety of government debt can be addressed an equilibrium selection problem in which the economic size of the country (as measured for instance by GDP) represents a plus, since a large supply of bonds makes a deeper and more liquid market. The Authors envision "global games" as a natural setting for the analytical representation of such a problem. Our twofold perspective on stability may provide avenues for analytical advances on the safety of government debt. Among other things, one may represent explicit positions in government bonds in a stylized market resembling the one depicted in Figure 2.

Second, a challenging playfield for our considerations seems to be represented by the debate on the development of markets for longevity risk transfer (LRT). Over the last decades, people in the developed economies have persistently lived longer than longevity projections. This is for sure good news. Still, a subtle downside pertains to the challenge of allocating properly the longevity risks associated with benefit plans already in place and prospect; the very sustainability of plans is at stake. As a consequence, the social relevance of the development of markets for LRT has been advocated by major institutions (e.g. BIS, 2013), as well as the requirement that such markets be "safe, both on a prudential and a systemic level" (ivi). Well, in the author's view, not only the soundness of the design of LTR markets may be pivotal for the satisfaction of safety requirements, but as well a kind of "forward guidance" of market participants towards sustainable paths, for which suitable collateralization practices play a role (see Biffis et al., 2016). In such respects, the present contribution may provide a few insights.

Third, recent financial regulations have stimulated a reconsideration of the desirability of separating banking resolution and bankruptcy. On top of country-specific historical origins, the rationale for separation may be the desirability that bank resolution be quickly performed administratively by specialized agencies (like the Federal Deposit Insurance Corporation in the US) rather than by non-specialized courts that take time to accommodate the rights of different stakeholders. Well, in the US, the Dodd-Frank Act enacted in 2010 establishes a new synthesis of the two approaches. The reach of administratively oriented solutions is considerably enlarged; still, before invoking Title II–Orderly Liquidation Authority, regulators are required to testify the inefficiency of resolving in bankruptcy. Bankruptcy is the focus of the Dodd-Frank synthesis, not resolution (see Skeel, 2015/2016).

The new synthesis, unavoidably, has strategic implications. A traditional view is that some form of reorganization yields more value to creditors than liquidation; still, as already pointed out, beyond issues of efficiency, stability does matter in the current scenario. The contemporary financial system poses unprecedented challenges to well established principles. Dodd-Frank is meant to face the challenge; one can consider the Dodd-Frank synthesis as an equilibrium selection device concerning the timely initiation of insolvency proceedings, the allocation of losses, the maximization of the value of assets, and the minimization of externalities – first and foremost, the prevention of systemic reverberations. These are truly concrete and relevant matters, with respect to which the relevance of credible resolution options has been repeatedly pointed out (see for instance Tarullo, 2017). On theoretical grounds as well the nuances that percolate through such problems have been long appreciated; for instance, Diamond and Dybvig (1983; section IV) notice that, not only for financial firms, the protection from creditors provided by bankruptcy laws serves a function similar to the suspension of convertibility for banks. Well, Holmström's (2015) interpretation of collateralized debt as a put option represents basic features of resolution options, and, in connection with the stabilization properties of collateral flows, provides a sharp background logic for debating possible syntheses of banking regulation and bankruptcy laws.

As a concluding remark, recall that in a celebrated address to the American Finance Association, Fischer Black (1986) advocated the logic of "noise" as a relevant point of view on the properties of financial markets. We have devoted little attention to the 'other side' of Holmström's (2015) framework, namely, the information sensitivity of securities like stocks. According to Black (1986), the prices of stocks reflect both the information that

information traders trade on and the noise that noise traders trade on, but noise traders think they are trading on information. Such insights may define intriguing lines of progress for Holmström's (2015) logic.

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