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Contextualizing Systemic Risk*

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Abstract

I analyze the rapidly growing literature about systemic risk in financial markets and find an important commonality. Systemic risk is regarded to be an endogenous outcome of interactions by rational agents on imperfect markets. Market imperfections give rise to systemic externalities which cause an excessive level of systemic risk. This creates a scope for welfare-increasing government interventions. Current policy debates usually refer to them as ’macroprudential regulation’. I argue that efforts undertaken in this direction - most notably the incipient implementation of Basel III- are insufficient. The problem of endogenous financial instability and excessive systemic risk remains an unresolved issue which carries unpleasant implications for central bankers. In particular, monetary policy is in danger of persistently getting burdened with the difficult task to simultaneously ensure macroeconomic and financial stability.

JEL-Classification: E44, E52, G01, G18

Keywords: Systemic Risk, Systemic Externalities, Macroprudential Regulation, Basel III

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1 Introduction

The financial crisis has put the issue of systemic risk on top of the agenda of policymakers and researchers. With the benefit of hindsight, it has become clear that financial fragility in mature economies drastically increased in the 2000s. While the adverse consequences of the crisis are felt until today, the detection of potential causes and their classification within established economic theory continues to be an open issue.

Common definitions of systemic risk tend to be vague and incomplete. For example, the ECB (2009) broadly defines it as the risk 'that financial instability becomes so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially.' A similar definition is given by FSB et al. (2009), where systemic risk is defined as 'a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy.' Both these definitions focus on the consequences of a materialization of systemic risk, yet they are silent on its nature and on its potential sources.

The partial inability of the profession to explain causes and mechanisms of the crisis has led to a revival of heterodox theories of financial fragility, most notably the famous financial instability hypothesis advocated by Minsky (1986, 1992). Indeed, the onset of the crisis in August 2007 is sometimes revealingly labeled as a 'Minsky Moment'. It has to be conjectured that the majority of economists and policymakers had a limited understanding of systemic risk in the run-up to the crisis. However, this should *not* imply that well-established paradigms like the efficient market hypothesis or the assumption of rational expectations are disqualified as being illusive. Instead, existing frameworks urgently need to be extended in order to incorporate the systemic implications of market imperfections.

This paper thus aims (i) to comprehensively classify the phenomenon of systemic risk on financial markets with particular respect to its sources and (ii) to point out that systemic risk is an endogenous market phenomenon which can be explained by adequately adjusting traditional frameworks.

2 The Nature of Systemic Risk

Systemic risk was commonly assumed to emerge from fundamentally exogenous shocks which trigger an endogenous process of propagation and amplification within the financial system (De Bandt and Hartmann, 2000). Exogenous shocks were thought to be either idiosyncratic, such as the failure of an individual bank, or systematic, such as a macroeconomic recession. In both cases, financial distress endogenously diffuses within the system. The original quantity of a shock may become drastically amplified and gets propagated to indirectly exposed institutions which would have been fundamentally solvent in the absence of the shock.

An alternative and more recent approach denies that systemic risk is genuinely caused by exogenous shocks (Borio, 2003; Brunnermeier et al., 2009; Crockett, 2000). According to this view, crises emerge *within* the system due to an endogenous build-up of financial fragility. Systemic vulnerability will inevitably become revealed, yet shocks act as mere triggers instead of constituting the root cause of financial distress.[1] For example, it would be misleading to regard the meltdown of the subprime mortgage market as an exogenous shock. Financial intermediaries fueled the boom-bust cycle on US housing markets through the erosion of lending standards, extremely favorable lending conditions and accumulated large common exposures (Dell'Ariccia et al., 2012). Thus, banks themselves created the very fragility that made the seemingly unspectacular rating downgrades of some mortgage-backed securities unfold into a full-blown financial crisis.

Systemic risk is generally broken down into two categories (Caruana, 2010; Galati and Moessner, 2011). The *cross-sectional dimension* captures the distribution of risk in the financial system at a given point of time. Common exposures, institutional interconnections and the vulnerability of systematically important market participants are of major relevance in that respect. The *time dimension* captures the evolution of aggregate financial sector risk across time, which tends to be characterized by the procyclicality of lending standards, maturity mismatches and leverage dynamics.[2]

However, these categorization efforts still do not provide any satisfying answer to the fundamental question - *why is the financial system prone to excessive systemic risk?* I argue that the main reason are

[1] Borio (2011) states: '[D]rivers of risk depend on the collective behaviour of financial institutions (are "endogenous"), and are not something outside their influence ("exogenous"). Asset prices and the macro-economy are not a given, as they may appear to each individual firm; they reflect systematically its decisions along those of its peers. Financial crises are not an act of God or perfect storms; they are the outcome of systematic distortions in perceptions of risk and responses to it, including as a result of fallacies of composition.'

[2] See Borio et al. (2001), Nuño and Thomas (2013) and Panetta et al. (2009) for stylized facts.

various negative externalities which are insufficiently addressed in current policy frameworks. Excessive systemic risk may well emerge in a world with fully rational agents interacting on imperfect markets. Agents do not account for their individual contributions to systemic risk and thereby impose externalities on either their peers or on agents outside the system. Equlibria are thus characterized by excessive levels of systemic risk and socially inefficient balance sheet structures.

The view of excessive systemic risk as an unfavorable outcome of various externalities represents an important progress in the understanding of financial crises. Policymakers no longer have to ground regulatory actions on fuzzy notions of 'inherent financial fragility' but are now equipped with solid theoretical underpinnings which enable the development of adequate and well-targeted regulatory responses.[3]

3 Systemic Externalities

The following section aims to provide an overview of the literature which has emerged on the various forms of systemic externalities. According to Wagner (2010), '[a]n externality [...] is caused by a financial institution and either imposes costs on other financial institutions or on agents outside the financial system. A systemic externality is then an externality whose impact does not only depend on the institution which poses it, but also crucially depends on the state of the financial system at the time the externality is posed.' While this definition serves as a useful starting point, there are additional important features of externalities in the financial system which deserve special consideration:

- Financial market externalities are mainly pecuniary but may nevertheless exhibit adverse welfare effects.[4] For instance, one is tempted to think of fire sales as being neutral in their welfare implications. After all, there is a distressed institution which is forced to sell assets below fundamental value but also a buyer who conversely realizes excess returns. However, the associated market price depression may trigger widespread deleveraging and costly liquidations as a second-round effect. The initial price change hence induces real welfare effects.

- Private internalization is probably infeasible. Financial institutions are numerous, tend to form their decisions in an atomistic setting and usually consider their impact on market conditions to be negligi-

[3] De Nicoló et al. (2012) put it as follows: 'This approach clarifies that macroprudential policies are justified by the need to correct market failures, and not simply because the financial system is “fragile.” It also provides a justification for specific forms of regulation, and a framework to analyze the economics behind recent policy proposals.'

[4] Greenwald and Stiglitz (1986) generally demonstrate that pecuniary externalites produce non-negligible welfare effects in the presence of market failures and incompleteness.

bly small. Moreover, they may sometimes deliberately maximize their utility at the expense of agents outside the financial system. Therefore financial stability shows characteristics of a public good.

- Traditional microprudential banking supervision measures mainly fail to mitigate systemic externalities. Their focus lies on the individual soundness of specific institutions and on the mitigation of *intra*-bank externalities between shareholders and depositors.[5] However, systemic externalities are *inter*-bank externalities or externalities being imposed on agents outside the financial system such as the taxpayer and tend to operate independently from intra-bank mechanisms.

- Confusion may arise from the fact that the mitigation of both intra- and inter-bank externalities should be achieved with the very same instruments of capital and liquidity requirements. It is therefore difficult to allocate a certain measure to the mitigation of a certain externality. It may even hold that tight microprudential regulation 'accidentally' mitigates inter-bank externalities and vice versa.

In line with Wagner (2010) and De Nicoló et al. (2012), I distinguish five major sources of systemic externalities: (i) interconnectedness of market participants, (ii) strategic complementarities between market participants, (iii) fire sales, (iv) liquidity externalities and (v) adverse selection (see Figure 1 for an overview). These externalities do not emerge independently but may powerfully reinforce each other, which is often embedded in the subsequently described modeling approaches.

3.1 Interconnectedness

A highly connected financial system exhibits ambiguous implications for welfare. On the one hand, interconnections produce efficiency gains as they foster the distribution of liquidity and idiosyncratic risk sharing. On the other hand, interconnections may become an important source for contagion. Interconnections may produce direct and indirect spillovers of financial distress. Direct spillovers are characterized by the immediate propagation of losses between institutions through balance sheet interlinkages. Indirect spillovers may follow from direct spillovers in a second-round effect. Importantly, only indirect spillovers constitute externalities by affecting institutions without direct exposures towards a distressed institution. Indirect spillovers may appear in the form of higher-order propagation effects, fire sales, funding contagion and informational externalities.

[5] There are two classical intra-bank externalities. Limited liability may induce risk shifting, i.e. bank owners take excessive risks as their downside is mostly borne by creditors (Jensen and Meckling, 1976). And Diamond and Dybvig (1983) show that coordination problems among depositors can cause inefficient bank runs, which can be ruled out by the implementation of a deposit insurance scheme.

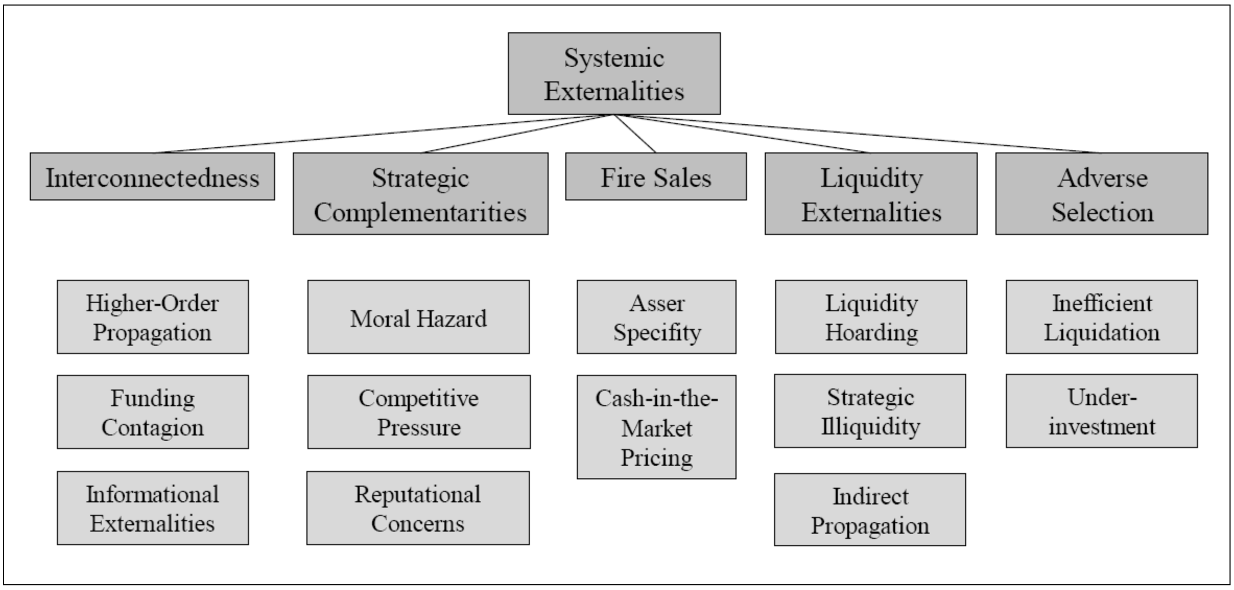

Figure 1: *Categorization of Systemic Externalities*

The trade-off between basically beneficial risk sharing and the risk of contagion is shown in the canonical model of Allen and Gale (2000).[6] Banks obtain funding from depositors with different liquidity needs across time. Interbank lending produces efficiency gains since banks thereby insure each other against asymmetric liquidity shocks. A bank facing liquidity needs unwinds its interbank claims, and its counterparty in turn is happy to reduce excess liquidity. Most importantly, the precautionary accumulation of liquidity balances at the expense of productive long-term investment is reduced considerably. However, the established network is highly fragile in the case of liquidity shocks with unexpected magnitude. Massive withdrawals cause affected banks to unwind a large chunk of their interbank claims which may force other banks into costly liquidation of long-term assets or even into bankruptcy. Liquidity shocks spill over to other banks and may produce a contagious bank run. Systemic implications depend on the size of the shock and particularly on the structure of institutional interconnections. A completely interconnected interbank market is resilient against moderate shocks since their adverse impact gets distributed to several banks (see Figure 2). A large shock, however, might cause the breakdown of the entire banking system. Conversely, an incompletely connected interbank market limits contagion under large shocks at the expense of decreasing resilience against small shocks (see Figure 4).

6 Other models analyzing the role of interbank markets are for instance Rochet and Tirole (1996), Freixas et al. (2000) and Brusco and Castiglionesi (2007). They similarly acknowledge a trade-off between ex ante efficiency gains and an increasing ex-post likelihood of contagious bank failures.

These results have been generally confirmed by Acemoglu et al. (2013). They find sparsely connected networks to be strictly less stable and resilient than densely connected networks for small shocks, while networks with a medium degree of interconnectivity are optimal in case of large shocks. Their novel contribution is to show that a *network externality* yields to an endogenous choice of socially inefficient network structures. Banks internalize the direct benefits and the direct costs of interbank lending by charging risk-sensitive interest rates on bilateral lending, but do not incorporate the costs of *higher-order propagation effects*.[7] Under limited connectivity opportunities, banks form fragile ring networks (Figure 3) and do not exploit diversification opportunities. In the case of full connectivity, a complete yet socially inefficient financial network emerges. Expected costs of contagious defaults - which are rare but devastating in a complete network - exceed gains from perfectly diversified interbank lending, but agents do not internalize the individual contribution of their bilaterally formed connections to systemic fragility. The system is characterized by robustness against small and frequent shocks but also with an inefficient degree of vulnerability against rare and large shocks. It is excessively interconnected.[8]

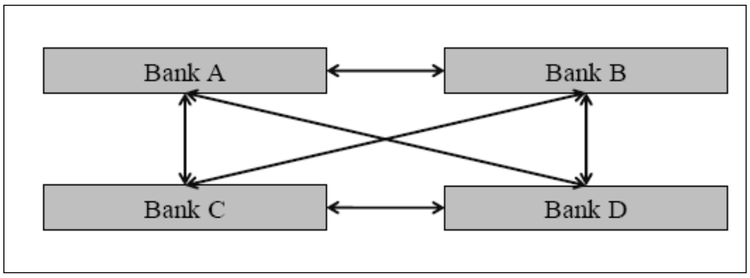

Figure 2: *Complete Network*[9]

The mechanisms of *funding contagion* are examined by Gai et al. (2011), who focus on the propagation of both idiosyncratic and aggregate liquidity shocks under various financial network configurations. If a bank is hit by a liquidity shock, it tries to obtain liquidity by winding up its interbank claims or she refuses to roll them over, respectively. In that way, liquidity shortages are spread to direct counterparties, who may react by winding up interbank claims themselves. The authors examine two network types. Poisson networks are characterized by a similar degree of interconnectivity across banks. In geometric

7 If direct creditors of a distressed institution face high losses pushing them to default, their creditors have to bear losses even though they are not directly exposed to the original source of distress.

8 Stiglitz (2010a,b) and Battiston et al. (2012) similarly show that beneficial diversification effects may be outweighed by increasing contagion risks as soon as interconnectivity becomes too high. However, their network structures are imposed exogenously.

9 Directional arrows denote an interbank claim from Bank X to Bank Y. Bi-directional arrows denote reciprocal claims.

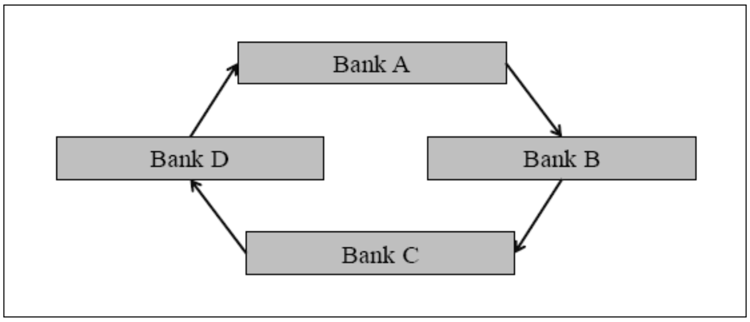

Figure 3: *Ring Network*

networks, some banks are particularly interconnected 'key players' which mimics the market structures observed in modern financial systems. The vulnerability of the Poisson network is found to be a hump-shaped function of interconnectivity. In comparison, the geometric network is more resilient if weakly connected but more vulnerable if interconnectivity increases. It is generally more prone to funding contagion for most parameter constellations, which especially holds true if liquidity shocks hit a particularly interconnected bank.

Allen et al. (2012) stress the importance of contagion due to *informational externalities*. In their model, banks are able to engage in two different interbank risk sharing schemes. It is shown that in a setup with six banks, it is equally optimal to form either two clustered sub-networks consisting of three banks which reciprocally acquire one third of each others project (asset structure C, see Figure 4) or an unclustered ring structure, where banks uniformly acquire one third of the project of their direct neighbors (asset structure U, see Figure 3 with reciprocal claims).

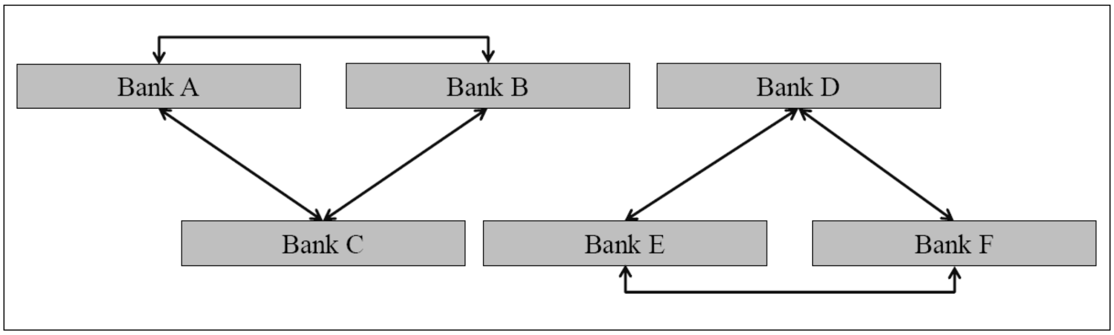

Figure 4: *Clustered Subnetworks*

These two network configurations have different informational properties in case one bank becomes insolvent. Bank portfolios under structure C are characterized by a higher degree of *asset commonality*.

A default of one bank is likely to lead to a collapse of its entire associated sub-network, while risk is more dispersed under structure U. This difference crucially matters for outside investors who finance banks through revolving short-term debt. By assumption, outside investors cannot evaluate individual solvency. They receive a signal concerning the overall solvency of the banking sector instead which either indicates that no default occurs or that at least one bank will become insolvent. The probability of default for a single bank conditional on the signal for the bad state differs between U and C and is higher in the latter case. Investors may hence refuse to roll over short-term debt under asset structure C, while they readily continue to finance banks under asset structure U. If short-term funding dries up, banks are forced into premature and costly liquidation of their projects. The default of a single bank consequently imposes an informational externality on healthy banks as they may loose access to short-term funding. This mechanism is prevalent within asset structure C for a wide range of parameter constellations, but banks cannot coordinate on the preferable structure U ex ante.[10]

3.2 Strategic Complementarities

According to De Nicoló et al. (2012), strategic complementarities are situations in which the return of pursuing a certain strategy increases with the number of its followers. They may emerge within the financial system in the context of (i) moral hazard behavior, (ii) competitive pressure and (iii) reputational concerns, and constitute systemic externalities which are usually imposed on actors outside the system, especially the taxpayer. If one of the inefficiencies mentioned above is prevalent, agents may find it optimal to jointly embark on strategies which contribute to the excessive build-up of systemic risk.

Regarding *moral hazard behavior*, Acharya and Yorulmazer (2007) show that banks have the incentive to perfectly correlate their investments such that they either succeed or fail jointly. Joint failures force the regulator into bailing out banks, since system-wide liquidations exhibit prohibitively high costs. Ex ante commitments towards a non-bailout strategy hence suffer from the problem of time inconsistency. Herding is optimal for banks since bailouts occur with certainty in the joint-failure state which drastically contains their downside risk. This strategy lowers expected output of the banking system since systemic

[10] It is notable that the result of clustered networks being inferior to ring networks contradicts the findings of Acemoglu et al. (2013), who show that clustered networks are the most resilient under a large-shock regime. The ranking of different network architectures is apparently not robust with respect to the specification of different propagation channels and parameter choices. To be fair, none of the mentioned models claims to fully incorporate all variations of financial contagion.

failures and costly bailouts or liquidations occur more frequently. Subsequent work of Acharya et al. (2010) demonstrates that internalization can be achieved through risk-adjusted deposit insurance premia.

Farhi and Tirole (2012) demonstrate that banks coordinate on excessive levels of maturity mismatch and inefficiently correlated portfolios. If a crisis occurs, banks are forced to scale back investment projects which diminishes future output. The central bank can engineer a bailout by cutting interest rates which, however, carries *fixed* distortion costs for society as it comes along with (i) an implicit subsidy from depositors to banks (ii) financing of unworthy projects and (iii) an incentive for excessive risk-taking in the future. The central bank seeks to pursue the policy which minimizes costs to society and trades off the prevention of output losses versus the costs of distortion. As in Acharya and Yorulmazer (2007), banks correlate their exposures which forces the central bank to bail them out in the joint-failure state. This minimizes their downside risk at the expense of society which consequently has to bear the costs of distortion. Put bluntly, intermediaries abuse the central bank as an insurer against credit and liquidity risks. The financial system becomes excessively prone to a systemic crisis in equilibrium while associated costs are finally borne by households. Ex ante-commitments towards a strict no-bailout-policy are equally time-inconsistent, since the minimization of social costs always requires bailouts as soon as banks become *too-correlated-too-fail*.[11]

With respect to *competitive pressure*, Dell'Ariccia and Marquez (2006) show how strategic interaction between competing banks accommodates rising credit demand and increases financial fragility.[12] Credit markets are populated by a unit mass of known borrowers, where 'known' implies that their true quality is known to one of the competing banks. There is also a mass λ of unknown borrowers whose true quality is not known to any of the competing banks. Yet lending to an unknown borrower is on average profitable. The magnitude of λ should be interpreted as the intensity of aggregate credit demand. The credit market exhibits two types of equilibria. A low level of λ gives rise to a *separating equilibrium*, where each bank only lends to its known borrowers with good quality. Extending credit is deemed as unprofitable, since most of the remaining borrowers in the market have been rejected by competing banks and are therefore of bad quality. A rise in λ induces a switch towards a *pooling equilibrium* where credit is granted to every unknown firm. The intuition is as follows: The pool of borrowers increasingly consists of completely unknowns which attenuates the problem of adverse selection and the prospect of

11 Similar models were developed by Cao (2010), Cao and Illing (2011) and Chari and Kehoe (2013) who likewise show that time inconsistent no-bailout policies represent an incentive for excessive risk-taking of various forms.

12 A similar result for procyclical lending standards is derived by Ruckes (2004).

increasing market shares and additional profits motivates banks to relax their lending standards. While aggregate credit in the pooling equilibrium is considerably higher, bank profits and the average quality of bank portfolios erode. Financial fragility increases and the banking system becomes increasingly vulnerable towards adverse shocks. The probability of a banking crisis increases with λ, implying that a severe credit boom is likely to end in a severe crisis.

Gorton and He (2008) demonstrate that revisions of lending standards may arise as an entirely endogenous outcome and can act as a driving force of the business cycle instead of merely responding to economic conditions. Under limited competition, banks coordinate on a collusive strategy of charging high interest rates from potential borrowers while the intensity of (costly) screening and the corresponding lending standards are quite low. However, this strategy exhibits an incentive for deviation. A bank could secretly increase screening intensity and attract more borrowers of the good type which leaves the other banks worse off with an adversely selected pool of remaining borrowers. The deviating bank increases the quality of her portfolio - or lowers default rates, respectively - at the expense of its competitors. Deviations become apparent as soon as different performances of banks' loan portfolios become public information. Other banks react by similar increases of screening intensity in order to counteract the problem of attracting bad-quality borrowers which have been rejected by other banks (winner's curse effect). Subsequently, lending standards will become tighter and credit availability for firms and households decreases sharply.

Rajan (1994) shows that *reputational concerns* may betray banks into lending policies which exhibit an expansionary bias. Crucially, bank managers' utility depends on their relative performance compared to other banks which is assumed to be important for future reputation on capital markets and job prospects. Banks thus face the incentive to hide losses from the market by prolonging credit relations with non-performing borrowers. The hiding strategy avoids visible short-term losses but typically yields higher losses in the long run. If a bank believes that her peers embark on hiding, she will hide losses as well. Admitting them would lead to a decrease in reputation, since bad relative performance is attributed to a lack of manager ability. Conversely, if a bank believes that her competitors will recognize losses, she likewise embarks on loss recognition. If every bank displays losses, the market attributes them to adverse economic conditions instead of lacking management ability. Thus, the model displays multiple equilibria and banks either coordinate on hiding losses or on tight credit policy. Inefficiency arises since hiding exhibits a negative net present value and enhances systemic risk. Interestingly, a supply-driven credit cycle endogenously emerges if economic conditions are dependent on the choice of credit policies. Specifically, the likelihood of an adverse state increases plausibly with the number of banks pursuing the hiding strategy. Low crisis probabilities indicate a coordination on liberal credit policies and the crisis probability consequently increases up to the threshold were banks jointly switch to tight credit policies and the cycle reverts.

3.3 Fire Sales

A compelling definition of fire sales is given by Shleifer and Vishny (2011: p. 30):

> '[A] fire sale is essentially a forced sale of an asset at a dislocated price. The asset sale is forced in the sense that the seller cannot pay creditors without selling assets. The price is dislocated because the highest potential bidders are typically involved in a similar activity as the seller, and are therefore themselves indebted and cannot borrow more to buy the asset. Indeed, rather than bidding for the asset, they might be selling similar assets themselves. Assets are then bought by nonspecialists who, knowing that they have less expertise with the assets in question, are only willing to buy at valuations that are much lower.'

It is not self-evident in the first place why financial institutions should prefer fire-selling instead of raising new debt or issuing additional equity. Hanson et al. (2011) argue that explanations can be deduced from well-known approaches in corporate finance theory. One potential reason is that aggressively leveraged banks suffer from a debt overhang problem as described by Myers (1977). Debt overhang makes it impossible to issue new debt claims, since potential investors anticipate that future payoffs will be primarily channeled to existing creditors. Equity issuance may be infeasible for similar reasons. Under asymmetric information about banks' asset quality, equity issuance might signal that the management of a firm believes it is overvalued and the stock price falls. This harms existing shareholders and the management hence refrains from increases in capital (Myers and Majluf, 1984). Both phenomena cause (i) underinvestment in NPV-positive projects and (ii) give rise to an adverse feedback loop between the need for deleveraging and falling asset prices.

A canonical contribution to the understanding of fire sales was provided by Shleifer and Vishny (1992). They regard *asset specificity* as being the most important determinant for asset liquidity and liquidation values. If an asset can be used for many different purposes, its set of potential buyers is likely to be large. Hence, liquidation value and liquidity should be high. If an asset can be utilized only for specific purposes which require specific and scarce skills, liquidity is likely to be low.[13] They distinguish between three groups of potential buyers: (i) Specialized industry insiders who are able to extract an asset's full value. (ii) Industry outsiders, who are only able to extract a fraction of the asset's value in best use. (iii) Financial investors, who are indirectly capable to extract full value by hiring specialized (and costly) employees. Clearly, the latter two groups are not willing to pay the fundamental asset price under best use. If financial health of industry insiders is highly correlated, they tend to be simultaneously finance-constrained in bad states and assets have to be sold to outsiders with considerable discounts, which is inefficient for two reasons: First, outside investors generate lower output due to their inferior asset management ability. Second, original investment by outside investors may be crowded out.

An equally important contribution was made by Allen and Gale (1994), who stress that asset prices are not a mere function of fundamentals, but also of available liquidity. Their model describes the mechanisms of *cash-in-the-market pricing*. If aggregate liquidity is lower than the total supply of assets, i.e. if cash in the market is scarce, prices may drop significantly below fundamental value. Available liquidity is modeled as being related to costs of market participation. If theses costs are low, aggregate liquidity is high and forced asset sales by agents who find themselves to be suddenly liquidity-constrained have negligible price impacts. If participation costs are high, only agents with low liquidity preference enter the market. Aggregate liquidity is thus very scarce, and forced asset sales may have a dramatic impact on prices, causing heightened volatility and deviations from fundamental values.[14] Importantly, the model may exhibit multiple equilibria. If agents expect low participation, most of them will not enter the market and vice versa. Hence, the full participation equilibrium may not be reached due to coordination failures despite of being welfare-superior.

The described concepts are a crucial building block of a class of models which focus on the intertemporal dynamics of liquidity transformation and exposure to the risk of fire sales. A common finding is that agents do not internalize their individual contribution to fire sale dynamics in adverse states and therefore excessively engage in the issuance of short-term debt. In Giavazzi and Giovannini (2010), for example, banks undertake investments in risky projects with a duration of two periods. Banks can

[13] In the case of financial assets, it may be necessary to have specific skills in monitoring and valuation to extract an asset's full value, i.e. an exotic derivative is more specific than comparatively simple government bonds. Respective examples of real assets with high specificity are airplanes and oil rigs.

[14] Allen and Carletti (2008) argue that the adverse amplification of illiquidity-driven asset price volatility can be prevented if accounting rules are based on historical costs rather than market values. However, this comes at the cost of decreasing transparency of balance sheets which may enhance uncertainty about counterparty risks and give rise to other unfavorable outcomes such as liquidity hoarding and adverse selection.

finance themselves with long-term deposits or cheaper short-term deposits and need to trade off lower funding costs and the risk of liquidity shortages. In the intermediate period $t+1$, either a good or a bad state of the world is revealed. Project payoffs are delayed in the latter and banks need to sell parts of their projects to outside investors in order to be able to pay off short-term depositors. Market clearing on the secondary market takes place with a considerable fire sale discount and investment in new projects is crowded out. It is shown that the privately optimal amount of short-term funding is excessive and a social planner can improve welfare by containing liquidity transformation. Excessive short-term funding is especially prevalent if the spread between short-term and long-term funding costs is large.[15] If it becomes sufficiently small, the private and the social optimum coincide. This finding assigns a potentially important role to monetary policy in limiting systemic risk via its particular influence on the term structure.

In a similar fashion, Korinek (2011) demonstrates that banks undertake socially inefficient refinancing decisions which gives rise to fire-sale equilibria in adverse states. Banks can share risk with households by selling them sate-contingent claims ('equity'). Since households are risk averse by assumption, this source of financing is particularly costly. Banks can obtain cheaper funding by making the claims non-contingent ('debt-like'). However, the associated repayment obligations may trigger the need of asset liquidations in bad states. Crucially, banks act as atomistic price-takers on the secondary market and do not internalize the price-impact of their own asset sales, their contribution to the deterioration of market prices and the additional pressure on balance sheets of other banks. They consequently undervalue the benefits of liquidity in bad states and engage in excessive systemic risk-taking, i.e. they inefficiently trade off the minimization of financing costs against the robustness of balance sheets. By contrast, a social planner would rely on aggregate risk sharing more strongly by choosing a higher amount of equity. An equally superior equilibrium can be established through Pigouvian taxation of debt issuance.

[15] A similar result is derived by Stein (2011) within a closely related setup while he proposes a different mechanism for internalization. The social planner creates permits to issue single units of short-term debt which are traded among banks - very much akin to carbon emission certificates. Their market price corresponds to the marginal value of the additional issuance of short-term debt. Importantly, the regulator is able to calculate the socially optimal permit price and sets the quantity accordingly.

3.4 Liquidity Externalities

Liquidity externalities arise if banks' individually rational liquidity management exacerbates a systemic crisis. According to Gale and Yorulmazer (2011), two motives for *liquidity hoarding* stand out:

- *Precautionary motives*: If counterparty risks in the interbank market are perceived to be high, banks may stop lending to their peers. Thus, every bank faces the danger of losing access to interbank funding which provides an incentive for hoarding. However, this very behavior creates an adverse feedback loop between diminishing liquidity and fire sale behavior and the associated depression of market prices heightens perceived counterparty risks further.

- *Speculative motives*: Banks may anticipate that other institutions facing liquidity shortages may be forced to fire-sell assets in the near future. This creates the possibility to acquire them at large discounts, which provides an additional incentive for hoarding.

Indeed, Gale and Yorulmazer (2011) provide a model where the market equilibrium is characterized by an inefficiently low volume of interbank lending. Some banks hoard cash balances in line with the mentioned motives, while others who are subject to random liquidity shocks cannot obtain additional funding and eventually default. A social planner is able to improve welfare through adequate liquidity redistribution.[16] Banks choose an inefficiently low level of liquidity and welfare can be increased through ex ante liquidity requirements.

Diamond and Rajan (2005) demonstrate that the behavior of banks subject to a liquidity shock carries adverse systemic effects even if direct interbank connections are absent. Banks attract deposits and invest them into projects whose payoff may be randomly delayed by one period. In order to pay off depositors, distressed banks are forced into costly project restructuring, i.e. they obtain immediate liquidity while sacrificing returns on maturity. Troubled banks spread liquidity stress through various channels: (i) Premature restructuring leaves project entrepreneurs with zero income which diminishes incoming deposits for the entire banking sector. (ii) Troubled banks sell claims on delayed revenues of restructured projects in exchange for liquid assets which further diminishes aggregate liquidity. (iii) Excess demand for liquidity increases the interest rate which lowers the net worth of originally surviving banks and may

[16] Formally, this result arises from the wedge between marginal private utility of liquidity hoarding and marginal social utility of avoiding costly liquidations. The latter one is arguably larger, which however is not internalized by atomistic banks.

even trigger their insolvency.[17] In the worst case, every bank will be subject to a run and the banking system finally melts down. Distressed banks do not internalize the spillovers which are associated with their desperate search for liquidity. Thus, an externality is imposed on healthy banks, the initial liquidity shock gets drastically amplified and inefficient restructuring greatly reduces aggregate output.

More recent work of Diamond and Rajan (2009) shows that banks may strategically prefer illiquidity over insurance against liquidity shocks. Banks can initially sell assets to outside investors. However, outside investors can alternatively choose to embark on speculative hoarding and to buy assets from banks facing a shock later on. The existence of this alternative lowers their bid price already for the initial period. Thus, banks' ask price in the initial period is higher than the bid price of outside investors and no trade occurs. Even though banks have the possibility to sell assets in the initial period for insurance, they are reluctant to do so due to risk-shifting motives. Without a liquidity shock, assets pay off regularly and shareholders make an enormous profit. If the shock hits the bank, she is forced to conduct fire sales and finally becomes insolvent. However, depositors are bearing the lion's share of the associated losses. After all, banks find it favorable to remain exposed to the liquidity shock since, in expectation, this represents the return-maximizing strategy for shareholders. Banks shift their liquidity risk to depositors and choose to remain 'strategically illiquid'. This equilibrium is inefficient for two reasons. First, banks do not internalize that their endogenous choice of illiquidity is the very source for depressed asset prices and heightened financial fragility at every point in time. They impose an externality on their peers and also on their depositors. Second, financial fragility creates special return opportunities for outside investors and investment in new projects is crowded out. Public intervention could be conducted by enforcing asset sales to outside investors in the initial period. Alternatively, government subsidies could ensure that banks receive their desired ask price.

A further important contribution is made by Brunnermeier and Pedersen (2009), who introduce the concepts of market liquidity and funding liquidity and show that they are interdependent and may act in a mutually reinforcing and destabilizing way. *Market liquidity* is defined as the property of an asset and reflects 'the ease with which it is traded'. *Funding liquidity* refers to situations of market participants, namely 'the ease with which they can obtain funding'. Agents engage in trading risky assets and finance themselves via capital and collateralized debt. Specifically, they pledge risky assets as collateral to

[17] While a drastic increase of the interest rate would provide an incentive for healthy banks to restructure in order to lend to their peers, it may trigger defaults and additional liquidity shortages on the other hand . Thus, the market for liquidity is stuck in an excess demand constellation and cannot be cleared by respective movements of the interest rate.

outside financiers and receive funding in turn. In order to protect themselves against losses, financiers require a wedge between the current asset price and its collateral value. They demand a *haircut* $h \in (0,1)$ which positively depends on the volatility of the asset subject to collateralization. The prevailing haircut determines the feasible balance sheet structure of market participants. It determines the minimum capital ratio - and equivalently the maximum feasible leverage ratio - as well as the maximum balance sheet capacity given an initial capital endowment.[18]

Prudent financiers vary the required haircut positively with the riskiness of the collateralized asset, i.e. with its volatility. This point is of utmost importance in triggering a feedback loop between market and funding liquidity. In the model, market liquidity is subject to stochastic disturbances. If market liquidity decreases, asset prices temporarily decreases as in Allen and Gale (1994). Price declines boost observed volatility, while it is assumed that financiers cannot distinguish whether the price decline is due to fundamental reason or due to stochastic variations in market liquidity. Financiers will consequently tighten haircuts which decreases funding liquidity. Decreasing funding liquidity then triggers a massive need for deleveraging, since feasible capital ratios shoot up and maximum trading volume is lowered (*margin spiral*). The need for deleveraging causes further declines in asset prices, market liquidity is further impaired and market participants suffer from additional losses (*loss spiral*). Financiers respond again by rising haircuts and two adverse and mutually reinforcing feedback loops occur.

3.5 Adverse Selection

The concept of adverse selection has been pioneered by Akerlof (1970) and is applied to interbank markets by Heider et al. (2009). In their model, heterogeneous banks are subject to both idiosyncratic liquidity shocks and shocks to credit quality. Idiosyncratic liquidity shocks lead to the emergence of an interbank market, however, its functioning is impaired by adverse selection. Adverse selection occurs since shocks to credit quality are private information. Lenders will consequently charge an interest rate which compensates for *average* credit risk. In that way, risky banks impose an externality on less risky ones, since the latter have to pay higher interest compared to the full information case. For low levels of the interest rate, the interbank market is characterized by full participation despite of the occurrence of information asymmetries. If the interest rate reaches a specific threshold, safer banks exit the market as

[18] A certain haircut h implies that an asset amount X can be used to obtain collateralized funding of $X(1-h)$. With a capital endowment of C, it is thus possible to acquire (and simultaneously collateralize) an asset amount C/h. The feasible capital ratio equals h and the feasible leverage ration its inverse.

the interest rate exceeds their opportunity costs of liquidating long-term assets. This may subsequently give rise to liquidity hoarding, if surplus banks regard lending to risky banks as unprofitable. For very high interest rates, both safe and risky banks with a liquidity shortage strictly prefer (costly) liquidation anyway. The level of the prevailing interest rate is governed by the underlying parameter constellation. Most prominently, the interbank interest rate is positively related to the average level of counterparty risk (the average success probability of bank-financed projects) and the dispersion of counterparty risk (the difference between the success probabilities of safe and risky banks). If one (or both) parameters increase, the interest rate rises and market functioning will be impaired.

Importantly, the model may feature multiple equilibria. If banks expect full participation and choose a relatively liquid portfolio in the initial period, the interbank rate remains moderate and safe banks stay in the market. If, however, banks expect adverse selection, they choose a less liquid portfolio and the volume of the interbank market shrinks, interest rates and the risk premium rise and safe banks leave the market and rely on liquidation instead. It is shown that ex ante liquidity requirements can act as an extrinsic coordination device towards full participation. Moreover, the central bank can intervene by lending at subsidized rates, which is possible due to its ability of producing liquidity without any costs. A similar analysis is carried ot by Bolton et al. (2011). Their model features short-term investors (SRs) and long-term investors (LRs) and involves four points in time, i.e. $t \in [0,3]$.[19] LRs can either invest in riskless long-term assets or they can hold cash. While returns on holding cash are zero, its implicit value consists of the possibility to acquire assets from struggling SRs at favorable prices. LR cash balances are referred to as *outside liquidity*. In turn, SRs can hold cash themselves (*inside liquidity*) or invest in assets which are subject to the risk of delayed and/or absent payoffs. Since only SRs have access to the superior investment technology of the risky asset, it is principally desirable that SRs maximize their respective positions. Hence, contingent liquidity needs are most efficiently satisfied by the provision of outside liquidity.

There are two possible equilibria. Under the *immediate trading equilibrium*, SRs immediately sell assets with delayed payoffs in $t = 1$. Adverse selection is a minor issue here and assets will be traded close to fair value. Hence, LRs decide to hold less liquidity since there are no excess returns to be gained from buying risky assets. SRs respond by relying on inside liquidity which implies fewer investment in risky assets. The market is characterized by a low trading volume with no dislocated prices. In contrast,

[19] Formally, the assumption of different time horizons is implemented via different utility functions. While LR-utility is simply additive, the utility function of SRs discounts consumption in the last period of the model.

the *delayed trading equilibrium* is superior. SRs choose to hold more of the risky asset and refrain from immediate trading in the case of delayed payoffs, i.e. they gamble on the possibility that payoffs will occur in $t = 2$. If further delay occurs, they sell them to LRs with a considerable discount.[20] LRs respond by holding more outside liquidity since buying assets at distressed prices implies excess returns. While this equilibrium exhibits higher fragility, it is nevertheless more efficient since aggregate investment in risky assets is higher and liquidity is efficiently provided by LRs. If, however, the adverse selection problem becomes too severe, obtaining outside liquidity carries prohibitively high costs for SRs and the equilibrium is no longer feasible. As in Heider et al. (2009), severe adverse selection leads to a collapse of the market for liquidity. SRs hence choose more cautious balance sheet structures with less risky and more liquid assets, which lowers the aggregate output of the banking system. Regulators can establish the delayed trading equilibrium for instance by supporting secondary market prices through adequate subsidies.

4 Policy Implications

The previous section highlighted the development of theoretical foundations for macroprudential regulation within the recent years. While 'Minskyian' economists intuitively suggest that imperfect rationality and swings of optimism and pessimism play a non-negligible role within the financial cycle, their issued policy recommendations do not differ much from the ones implied by the concept of systemic externalities. Consensus about policy implications between different schools of thought arguably even strengthens the case for macroprudential regulation. Nevertheless, I believe that the presented approach is the most promising one since it relies on a particularly well-established, disciplined set of assumptions and on stronger analytical foundations.

4.1 Conceptual Foundation of Macroprudential Regulation

Fuzzy notions of an inherent fragility of financial markets are continuously being replaced by the analytically precise description of market failures giving rise to excessive systemic risk. Table 1 relates these failures to theoretically feasible internalization strategies. Two general points are worth mentioning: First, policymakers are seemingly equipped with a rich toolkit of complementary internalization

[20] The discount stems from an adverse selection problem which arises from the fact that SRs asymmetrically learn about true payoffs. LRs hence face uncertainty whether offered assets finally pay off in $t = 3$ or whether they are worthless 'lemons'.

Type of Externality	*Internalization Strategies*				
	Capital Require-ments	Liquidity Require-ments	Restrictions on activities, assets, or liabilities	Taxation	Others
Interconnectedness	X		X	X	
Strategic Complemetarities	X		X		
Fire Sales	X	X		X	X
Liquidity Externalities		X	X	X	
Adverse Selection	X				X

Table 1: *Internalization Strategies*[22]

schemes. Secondly, capital requirements are of particular importance, since they are capable of mitigating every market failure except the ones related to liquidity issues. However, given their highly stylized nature, these approaches are still of limited use for actual policymaking. While being theoretically appealing, they are far too simplistic to be matched with real-world data and to provide helpful guidance for the difficult task of calibrating macroprudential instruments properly.[21] Nevertheless, they convey a clear message: traditional banking regulation fails to account for individual contributions to systemic risk and leaves the financial system with an inefficient degree of vulnerability.

Additionally, there is increasing empirical evidence which confirms the occurrence of systemic externalities. This is especially true for liquidity externalities and fire sales which are relatively easy to observe. Acharya and Merrouche (2012), Berrospide (2013) and Heider et al. (2009) find evidence for precautionary liquidity hoarding on interbank markets in the UK, US and Europe during the financial crisis. Acharya et al. (2007) show that corporate defaults in case of industry-wide distress cause higher losses among creditors due to aggravating fire sale effects. Coval and Stafford (2007) document fire sale behavior among distressed mutual funds leading to abnormal stock market returns. Campbell et al. (2009) demonstrate that the default of Lehman Brothers in September 2008 triggered massive fire sales of inflation-protected treasuries, since they were heavily used as collateral in Lehman's refinancing operations. Finally, Ivashina and Scharfstein (2010) report that bank lending considerably declined in the financial crisis, which can not least be attributed to fire-sale related crowding-out effects.

21 For example, Derviz (2013) strongly states that 'financial intermediation theory [...] relies on toy models which provide only very indirect, if any, empirical guidance.'

22 The table design closely follows De Nicoló et al. (2012).

The ultimate goal of macroprudential regulation is thus the mitigation of systemic externalities in order to achieve a socially optimal level of systemic risk. Clearly, this theoretical (and somewhat tautological) definition needs to be operationalized in practice.

4.2 Operationalization and Current Drawbacks

Practical macroprudential policymaking boils down to measuring and containing systemic risk. Given the ongoing absence of an empirically applicable model, the *measurement* of systemic risk is primarily based on econometric, rather non-structural techniques. The build-up of systemic risk in the time dimension is usually analyzed with early warning models, which try to find indicators of future financial distress based on historical calibration.[23] A common and robust finding is that upward trend deviations of aggregate credit serve as the most reliable predictor of future financial distress. Systemic risk in the cross-section is measured by processing data on financial interconnections, which aims to capture the distribution of risk within the system as well as the individual contributions of single institutions. For instance, contagion models aim to quantify expected spillovers of bank defaults whereas stress testing models assess the resilience of the financial sector in the wake of a predefined shock scenario.[24]

While the development of measurement tools proceeds in a promising fashion, regulatory reforms regarding *containment* of systemic risk fall short of the recommendations being issued by academics and central bankers. The most important reform is the now revised regulatory framework of *Basel III* (BCBS, 2011a). Specifically, Basel III introduces tighter capital and liquidity requirements and their phase-in is projected to occur gradually until the year of 2019. Most importantly, both level and quality of required capital are improved. Banks will be obliged to hold core capital (common equity and retained earnings) amounting to 7% of risk-weighted assets, where 4,5% are required as *minimum capital* and 2,5% serve as a *capital conservation buffer*. Additonally, national authorities can impose an additional *countercyclical capital buffer* of up to 2,5% of risk-weighted assets if credit growth is considered 'excessive'. These stricter requirements are complemented by a maximum *leverage ratio*, which stipulates that the ratio of *total* assets to capital must not exceed 33. Put differently, this amounts to a minimum capital ratio of about 3%. Two newly introduced liquidity requirements shall reduce short-term funding risk and put a limit on the excessive reliance on short-term refinancing: The *liquidity coverage ratio* demands that

23 See inter alia Alessi and Detken (2009), Drehmann (2013), Gerdesmeier et al. (2010), Jordà et al. (2011a), Lo Duca and Peltonen (2011) and Schularick and Taylor (2012).

24 See Adrian and Brunnermeier (2011), Acharya et al. (2012), Borio and Drehmann (2009), Brunnermeier et al. (2011), Sorge (2004) and Tarashev and Drehmann (2011) among others.

banks hold enough liquid assets to be able to withstand a predefined stress scenario. The *net stable funding ratio* dictates that available stable funding shall continously exceed required stable funding. Basel III is generally appreciated as a step in the right direction (Hanson et al., 2011). The now tighter and more countercyclical configuration of capital requirements is generally viewed as a beneficial step towards the mitigation of externalities, and the same holds for the modification of liquidity requirements. However, the majority of economists dealing with financial regulation issues regards the undertaken steps as insufficient for several good reasons.

Most importantly, Basel III capital requirements are still regarded to be drastically undersized (Admati and Hellwig, 2013). Especially the practice of risk-weighting is heavily criticized (Bair, 2013). Within the risk-weighting approach, capital requirements should reflect the riskiness of bank assets.[25] The standard approach defines risk weights according to publicly available ratings while the internal approach allows banks to compute adequate risk weights using their own credit risk models. Both approaches suffer from serious problems: The standard approach tends to stipulate artificially low risk weights particularly for government debt, thereby creating incentives for the fateful intertwining of bank balance sheets and government finances as currently witnessed in the Eurozone (Weidmann, 2012). The internal approach allows banks to embark on strategic risk modeling such that they seem to end up with unreasonably low risk weights thereby minimizing regulatory capital requirements (Mariathasan and Merrouche, 2013). In any case, banks are able to accumulate too much assets with too little capital. Risk-weighted capital measures create an illusion of safety, however, actually available capital - as measured by the leverage ratio - might become prohibitively low. Indeed, Haldane and Madouros (2012) show that risk-weighted capital ratios have no power in explaining bank failures while the leverage ratio turns out to be a very reliable indicator. Clearly, this is the very reason for the introduction of a leverage ratio in order to put a backstop on the potiential abuse of risk-weighting practices. However, the leverage ratios of banks which failed during the financial crisis were mostly well below the new backstop of 33. Hence, it is highly doubtful whether the incipient implementation of Basel III really leads to a material

[25] Risk weighting is achieved by multiplying every credit exposure with an appropriate percentage risk weight, ranging usually between zero to hundred percent. The aggregated sum of risk-weighted assets is the denominator of the risk-weighted capital ratio within the Basel framework.

improvement of financial sector resilience. It is thus no surprise that economists continue to urgently call for a further tightening of capital requirements.[26]

Additionally, the problem of banks being too-big-too-fail remains unresolved and continues to be a pressing concern (Haldane, 2013). The crisis triggered several bank mergers in both the US and in Europe, thereby increasing concentration and systemic importance of the remaining institutions. If an institution becomes too big (or too interconnected) too fail, its bankruptcy is effectively ruled out which clearly represents both an effective subsidy on funding costs and an enormous incentive for risk taking. The IMF (2012) estimated the funding cost advantage of systemically important institutions to be in the range of 60 to 80 basis points until the end of 2009. Policymakers started to address this problem by implementing additional capital surcharges for institutions deemed as systemically relevant (BCBS, 2011b), accompanied by various efforts to strengthen resolution procedures. However, Schäfer et al. (2013) document that even after reforms have been announced, effective subsidies remain substantial in magnitude.

Moreover, even an adequately capitalized financial sector is subject to inherent procyclicality which is due to the active balance sheet management of financial intermediaries (Adrian and Shin, 2010a,b). Under mark-to-market accounting, rising asset prices immediately translate into higher capital which triggers additional debt-financed demand for assets in order to restore optimal leverage.[27] A two-directional feedback loop may arise, inducing procyclical fluctuations of balance sheet aggregates as well as of risk premia. While tougher capital requirements potentially dampen the amplification process, it is still prevalent as long as assets valued at market prices meet nominally fixed liabilities. It is thus at the very heart of market-based financial intermediation (Shin, 2011), and its mitigation can only be achieved with taxation of potentially unstable non-core funding sources (Shin and Shin, 2011).

Furthermore, regulation of the shadow banking system is still in its infancy (FSB, 2013). The crisis drastically exposed its inherent fragility and its potential to produce adverse spillovers to both the commercial banking system and the real economy (Gorton and Metrick, 2010, 2012). Shadow banking and commercial banking are closely interconnected. Commercial banks rely on funding from and are often

[26] See inter alia Miles et al. (2013), Ratnovski (2013) and Tarullo (2013). Concerns about an associated tightening of lending conditions are rejected by Admati et al. (2010) as well as Hanson et al. (2011), who argue that a tightening of lending conditions will be of negligible magnitude, especially when being traded off against the sizable gains of better crisis prevention.

[27] Optimal leverage is assumed to coincide with the regulatory permitted maximum, i.e. banks try to minimize capital. A theoretical argument for this behavior is that the Modigliani-Miller theorem does not hold for banks since their debt issuance is structurally cheaper due to its substitutability with narrow money and due to potential too-big-too-fail subsidies.

directly exposed to shadow bank entities, either by running them as off-balance-sheet vehicles or by backing them up with implicit credit and liquidity support (Claessens et al., 2012). These developments were mostly motivated by regulatory arbitrage, which is being increasingly addressed by regulatory authorities.[28] However, given the enormous size of the shadow banking system, its future regulation is important in its own right.

4.3 Implications for Monetary Policy

In summary, the ability of current regulatory efforts to mitigate systemic externalities has to be questioned. This essentially leaves central banks as the only remaining authorities being capable to consistently pursue financial stability objectives. The debate on whether monetary policy should tackle financial imbalances is an old one, and this question has already been lively discussed in the aftermath of the dotcom-bubble.[29] The proponents of the leaning-against-the-wind-approach (LATW) advocated preemptive interest rate increases as soon as financial imbalances become apparent. Conversely, apologists of the mopping-up-approach opposed preemptive actions but emphasized the need for decisive interest rate cuts as soon as the unwinding of financial imbalances threatens macroeconomic stability. The pre-crisis consensus of monetary policy clearly favored the mopping-up approach for several reasons. First, it was argued that financial imbalances are difficult to detect and the interest rate is too blunt a tool to address exuberance in narrow financial market segments. In particular, it was assumed that preemptive action turning out as unnecessary ex post might considerably impair economic activity. Secondly, the macroeconomic fallout of the bursting dotcom-bubble was rather moderate, thereby lending support to mopping-up strategies.

However, today's crisis is utterly different. While the dotcom-crisis has been mostly contained to the stock market, the current crisis has its roots in credit market exuberance and entails much more severe strains for the real economy. In fact, empirical evidence confirms that boom-bust-cycles on credit markets exhibit a much more adverse macroeconomic impact than stock market bubbles, and recessions are deeper as well as significantly longer if they were preceded by a credit boom (Jordà et al., 2011b). The experience of the current crisis - in conjunction with a growing body of empirical evidence - seems to make the pendulum swing towards LATW-policy. The emerging new consensus on monetary policy

[28] For example, the enumerator of the leverage ratio in the Basel III framework explicitly accounts for off-balance sheet exposures.

[29] See Bernanke and Gertler (1999) and Cecchetti et al. (2002) as examples for opposing views.

and its handling of financial imbalances is for instance summarized in a remarkable statement within an influential report by Eichengreen et al. (2011):

> "[C]entral bankers should then lean against the wind using a combination of the tools at their disposal, turning first to nonmonetary micro- and macroprudential tools, but also to monetary policy tools when necessary. If this results in periods when, in the interests of financial stability, the central bank sets policies that could result in deviations from its inflation target, then so be it.'"

Thus, a central bank should be willing to deliberately accept temporary deviations from its inflation target for the sake of long-run financial stability. Given the drastic macro impact of financial crises, this claim is not necessarily inconsistent with a longer-term price stability goal. However, it is likely to come at the expense of heightened short-term volatility of macroeconomic aggregates.[30] Somewhat ironically, the objection that central banks' interest rate instruments are too blunt has undergone a complete reconsideration. It now seems to be an argument *in favor* of LATW-policy, given the inability of macroprudential policy to regulate risk-taking in every segment of the financial market. Stein (2013) argues that since the key interest rate inevitably pins down short-term funding costs for the entire economy, it is by nature immune against regulatory arbitrage activities and profoundly impacts both commercial and shadow banking operations. Moreover, the use of quantitative and qualitative easing or tightening, respectively, could be engineered in a way to foster financial stability objectives without too much need for short-term interest rate moves, thereby partly alleviating the well-known Tinbergen problem.

In any case, it should be clarified that LATW-policy is a second-best policy response whose necessity emerges from the drawbacks of current financial market regulation. Monetary policy is burdened with the additional assignment of an intertemporal trade off between short-term and long-term macro volatility in the wake of financial imbalances, which impairs her menu of choice.[31] A first-best solution would imply that the latter one does not represent a concern for central bankers, since regulatory authorities adequately mitigate systemic risk. Unfortunately, the current regulation landscape makes the achievement of this constellation more or less elusive and the comparably simple stabilization tasks within the

[30] For instance, Scheffknecht and Geiger (2011) and Spahn (2013) show within different model setups that dampening financial market boom-bust cycles with appropriate macroprudential measures 'at the source' yields lower macroeconomic volatility than LATW-policy and may therefore be welfare-superior. In general, embedding and analyzing LATW-policy within macroeconomic workhorse models is a promising avenue for further research but is beyond the scope of this paper. See inter alia Curdia and Woodford (2010), Woodford (2012) and Gambacorta and Signoretti (2013).

[31] King (2012) points out that the task of mitigating boom-bust cycles causes an adverse shift of the Taylor frontier, i.e. the same degree of inflation variability now needs to be traded off against an increased volatility of output.

inflation targeting framework à la Svensson (2010) seem to be a lost paradise for central banks in mature economies. I believe that these observations reflect a deeper problem in the coordination of economic policy. Monetary policy is often (conveniently) regarded as a 'Macro-Stabilisator of Last Resort', which lowers the perceived need of painful and politically costly reforms in other policy fields, be it financial supervision, fiscal policy or labor market regulation.

5 Conclusion

Recent years have brought enormous progress in the theory of systemic risk and financial crises. By putting frictions associated with market incompleteness on center stage, the theory of systemic externalities is able to reconcile premises of rational behavior with the emergence of endogenous financial crises. While crisis phenomena were often used as an empirical argument against rationality paradigms, this apparent puzzle vanishes as soon as it is reconsidered with a focus on market failures instead of seemingly irrational investor preferences. Besides, it ensures a solid analytical foundation for policymaking.

I have outlined five sources of systemic externalities, namely institutional interconnections, strategic complementarities, fire sales, liquidity externalities and adverse selection. Each category is covered by an increasing amount of theoretical foundations and empirical evidence. However, policy prescriptions can so far only be made in a qualitative fashion, since models are still too simplistic to be empirically applicable. In any case, they deliver a sharp result: Decentralized financial market equilibria may be inefficient in terms of crisis vulnerability, since agents to not account for their individual contribution to systemic risk. With regard to internalization schemes, restrictive capital requirements are likely to be most promising.

However, the actual international regulation framework is very likely to turn out to be unsuccessful, especially due to its reliance on undersized capital requirements. This holds even after the implementation of various macroprudentially motivated measures via Basel III. Endogenous financial instability remains an unresolved issue, whose management now naturally comes to central banks as the only institutions being capable to exert both ex-ante control and ex-post support. This is not a beneficial outcome since ensuring financial stability forces central banks to partly neglect their macroeconomic stabilization task.

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