The Foundations of Macroprudential Regulation

A Conceptual Roadmap

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Abstract

This paper examines the conceptual foundations of macroprudential policy by reviewing the literature on financial frictions from a policy perspective that systematically links state interventions to market failures. The method consists in gradually incorporating into the Arrow-Debreu world a variety of frictions and sources of aggregate volatility and combining them along three basic dimensions: purely idiosyncratic vs. aggregate volatility, full vs. bounded rationality, and internalized vs. uninternalized externalities. The analysis thereby obtains eight “domains,” four of which include aggregate volatility, hence call for macroprudential policy variants grounded on largely orthogonal rationales.

Two of them emerge even assuming that externalities are internalized: one aims at offsetting the public moral hazard implications of (efficient but time inconsistent) post-crisis policy interventions, the other at maintaining principal-agent incentives continuously aligned along the cycle. Allowing for uninternalized externalities justifies two additional types of macroprudential policy, one aimed at aligning private and social interests, the other at tempering mood swings. Choosing a proper regulatory path is complicated by the fact that the relevance of frictions is likely to be state-dependent and that different frictions motivate different (and often conflicting) policies.

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The Foundations of Macroprudential Regulation: A Conceptual Roadmap

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1. Introduction

The literature on both macroeconomics with financial frictions and prudential policy reform has exploded in the wake of the recent global financial crisis.¹ However, as was the case of the discussion of these topics in the past, the connections between theory and policy remain ill established.² Impressive progress has been made in analyzing the linkages between real and financial volatility and identifying the channels of transmission and dynamics leading to financial crises. Yet limited progress has been made so far in conducting welfare analyses to identify in a precise manner the justification for various types of policies (regulatory and otherwise) and calibrate their use accordingly.

Linking theory to policy is inherently hard, not least because it is difficult to sort out market failures leading to a constrained efficient equilibrium from those leading to a constrained inefficient equilibrium. In the first case, the state can improve the equilibrium by supplying public goods that help relax the constraints. In the second case, through regulatory interventions, the state can directly improve the efficiency of the equilibrium, given the constraints. However, to implement a sensible regulatory agenda, the state also needs to identify the nature of the market failure lying behind the constrained inefficiencies—again not an easy task. Thus, the suitable policy response to a *principal-agent (agency)* failure may be quite different from that applying to a *collective action* failure, to the point of sometimes pulling in diametrically opposite directions. At the same time, there needs to be a differentiation between *policy* failures (both of omission, where the state fails to improve the market equilibrium, and of commission, where the actions of the state worsen the equilibrium) and *market* failures. Finally, even justified state interventions can have adverse unintended consequences. In particular, they can alter the structure of market incentives and induce *public moral hazard*.

This paper contributes towards bridging some of the gap between theory and policy. By reviewing from a policy perspective the theoretical literature on financial frictions, starting from its early roots, the paper provides a roadmap that not only links more systematically theory with policy but also helps put in a proper perspective the different branches of the literature in relation to each other. It does so by using an extension of the basic conceptual framework developed in de la Torre and Ize (2010a and 2010b) that identifies three basic paradigms (or interpretative lenses), an agency paradigm, a collective action paradigm and a collective cognition paradigm.

Our method consists in introducing various types of frictions (participation, enforcement, asymmetric information gathering, asymmetric information processing, and collective bargaining) and sources of aggregate volatility (aggregate risk, irreducible uncertainty, overlapping generations, and behavioral finance-type biases) into the frictionless, atomistic world of Arrow-Debreu with infinitely-lived agents transacting under perfect competition. We

¹ Brunnermeier, Eisenbach and Sannikov (2012) provide an excellent recent technical survey of the theoretical literature on the macroeconomic impact of financial frictions. Bank of England (2009), Borio (2011) or Galati and Moessner (2012) provide broad overviews of macroprudential policy proposals. A small but growing literature, such as Hanson, Kashyap and Stein (2011), Longworth (2011) or De Nicolo, Favara and Ratnovski (2012), attempts to connect the two strands of literature.

² For a discussion of the difficulties of assessing the appropriateness of traditional prudential regulation based on micro foundations, see for example Allen and Gale (2007).

then group these frictions and sources of volatility to generate eight possible “domains” based on three basic dimensions: (i) internalized externalities vs. uninternalized externalities; (ii) idiosyncratic vs. aggregate volatility; and (iii) full vs. bounded rationality. Each domain has specific features and dynamics that call for specific policy responses. Progressively traveling across domains by adding more frictions and sources of volatility (i.e., from the simplest domain with internalized externalities, full rationality and purely idiosyncratic risk to the most complex domain with uninternalized externalities, bounded rationality and aggregate volatility) leads to an increasingly more realistic (albeit more complex) world where the role of prudential oversight expands and metamorphoses.

Taking for granted the—admittedly undemonstrated but in our view hard to disprove—assertion that the state, *as a lender*, has no comparative advantage over *rational* financial market participants in handling bilateral agency (contractual or informational) frictions, our journey and its main messages can be summarized as follows:

1. While prudential regulation—i.e., aimed at influencing the risk taking decisions of financial market participants—can be justified in a world of purely idiosyncratic risk once boundedly rational, unsophisticated depositors and/or externalities are brought into the picture, it is only of the microprudential type. Aggregate risk is the key factor separating the realms of micro and macroprudential regulation and a necessary (albeit not sufficient) condition for the latter. When interacted with agency frictions and other sources of aggregate volatility, it generates the endogenous dynamics that are at the core of systemic risk. Without aggregate risk, it is indeed very difficult to conceive how financial markets could be systemically unstable.
2. While aggregate volatility opens the door to systemic risk and “stormy finance”, the associated (pro-cyclical) financial fluctuations and crises can be constrained efficient as long as one remains strictly within the realms of rationality and agency frictions (i.e., as long as uninternalized externalities do not have first-order effects). Hence, they do not justify preventive (*ex ante*) macroprudential regulation. In contrast, the state has comparative advantages over markets in conducting *ex post interventions* (state-led recapitalizations or aggregate liquidity support) that improve social welfare by speeding up the recovery after a financial crisis. Reflecting its taxation capacity, the state can issue (risk free) debt without being restricted by agency frictions and spread risk more finely, including across generations. However, because such interventions (or the expectation thereof) beget time inconsistency and public moral hazard, they motivate the introduction of a first type of macroprudential regulation (*time consistency macroprudential*), aimed at curbing public moral hazard.
3. Adding boundedly rational, unsophisticated players to the above mix justifies a second type of macroprudential oversight (*dynamic alignment macroprudential*), as the regulator must now must represent the unsophisticated in a proactive manner, so as to continuously align the incentives of agents and principals along the cycle and in the face of aggregate shocks. The excess (constrained inefficient) financial volatility that may arise under these circumstances reflects a *policy failure* (the regulator’s failure to fulfill its assumed responsibility effectively) rather than a market failure.

4. However, when uninternalized externalities—of which we identify four basic types, pecuniary, behavioral, informational and interconnectedness—coexist with agency frictions, excess volatility and crises become the reflection of a basic *market failure* in aligning private and social interests, even if all players are fully rational. Externalities both exacerbate the scope for ex ante systemic risk buildup and strengthen the grounds for ex post interventions (yet further boosting public moral hazard). At the same time, they expose various *fallacies of composition* (in particular, that the financial system as a whole is not the same as the simple sum of its components) and erode the viability of a narrowly and sharply drawn perimeter for prudential oversight. This sets the grounds for a third type of macroprudential policy (*collective action macroprudential*), oriented at the system rather than its parts, and focused on inducing players to internalize the systemic consequences of their actions, including those induced by public moral hazard.
5. Finally, when boundedly rational momentum traders are added to the mix, the scope opens up for irrational mood swings due to the failure of rational arbitrageurs. This justifies a fourth and final role for macroprudential policy (*collective cognition macroprudential*)—whose aim is to temper mood swings rather than to align incentives—not because the state is smarter than market participants but because it can solve collective action problems where rational arbitrageurs cannot.
6. Prudential policies often conflict head-on. In particular, policies aimed at narrowing the gap between private and social interests can misalign principal-agent incentives and exacerbate public moral hazard, thereby undermining market discipline. Moreover, the relevance and impact of different types of frictions is likely to be state-dependent. Thus, financial systems may de facto behave as if they were most of the time governed by optimizing and self-stabilizing market forces, while making only occasional forays into systemically dangerous zones that are ripe with destabilizing externalities and mood swings. Regulators must therefore carefully pick the regulatory fights. A macroprudential policy option worth considering is a similarly state-dependent (bimodal) regulatory framework, one that focuses in normal times on agency frictions and market discipline but shifts its focus and degree of policy intervention in exceptional times of high aggregate volatility to collective action and cognition failures, where leveraged credit dynamics can be most destructive.
7. While agency frictions and externalities are often joined at the hip (in particular, agency frictions may beget externalities when constrained players are connected through asset markets or banks' balance sheets), separating them conceptually, as we do here, helps differentiate constrained efficient from constrained inefficient financial volatility. Since only the latter justifies prudential regulation, a clear differentiation has key practical implications as regard where to put the bar when setting prudential buffers (i.e., what is the level of tail risk against which *it is no longer socially optimal to protect the system*). Hence, clarifying in theoretical models where the frontier between the two lies should be a core research priority.

Our approach faces important caveats regarding both content and method. With respect to content, we try to stay as close as possible to the basic Arrow-Debreu assumption of perfect competition and atomistic agents.³ While this keeps the discussion manageable, *it leaves aside the potentially important analytical dimension of market power*. A broad literature, which we do not review here, analyzes the implications of imperfect competition for the systemic stability of banking systems.⁴ While this literature does not reach uniform conclusions in this regard, it obviously yields rich implications for competition policy. However, it generally does not identify clear implications for *prudential* policy. It is nonetheless fair to say that some of the messages and conclusions in the paper might need to be reviewed or qualified in a context of imperfect competition.

With respect to method, a first caveat concerns our analytical approach. While our paper is technical (and, unfortunately, often rather dense) because it is based on a very broad review of the theoretical literature on the micro and macro foundations of prudential regulation, it is not mathematical. Thus, although we cover rather similar grounds as Brunnermeier, Eisenbach and Sannikov (2012), our presentation relies more on intuition and the preponderance of reasons than on mathematical proofs. The advantage of our approach is that it covers a lot of ground with broad strokes, in a way that helps organize and conceptualize the policy discussion while hopefully remaining accessible to a larger audience (including one closer to the policy world). The downside, of course, is that grey areas remain where the more formally inclined readers might feel unsatisfied. While we plead guilty in this regard, we nonetheless feel that the paper adds value by helping build firmer foundations on which to assess macroprudential policy.

A second methodological caveat concerns the choice and classification of the papers we review. As we develop our analysis, we classify different research pieces under the conceptual “buckets” of our framework. While this helps understand the logic of the particular world that we describe in order to assess the grounds for policy, it does some violence to the papers, as the latter often belong to more than one of our conceptual categories or paradigms. At the same time, in view of the breadth and rapid growth of the literature on the subject, we cannot claim to have reviewed and cited all the relevant papers. Our particular choice of referenced papers can thus be at times arbitrary.

The rest of the paper is organized as follows. Section 2 lays out our methodological approach and briefly describes the salient financial features of the Arrow-Debreu setting. Section 3 explores the world of purely idiosyncratic risk. Sections 4, 5 and 6 bring in aggregate volatility. Section 4 does so while remaining in a world of pure agency frictions; Section 5 adds externalities but retains the assumption of full rationality; Section 6 introduces bounded

³ We cannot fully retain the perfect competition assumption because, once information asymmetries are introduced, financial intermediaries necessarily acquire some market power over their borrowers. However, we will assume this to be the only possible source of market power.

⁴ In the pure agency paradigm, some papers, including Allen and Gale (2000) or Hellman, Murdock and Stiglitz (2000) conclude that competition increases risk-taking by banks; others, including Boyd and de Nicolo (2003), reach the opposite conclusion. Once we shift to the collective paradigm, imperfect competition might sometimes improve things (for example, large banks may better internalize some externalities) and sometimes makes them worse (for example, large banks are more prone to the too-big-to-fail syndrome).

rationality. Section 7 concludes with a synopsis of the key policy trade-offs and research challenges that arise from the perspective of our framework.

2. Methodological and conceptual point of departure

a. Methodology and roadmap

Our methodological approach consists in gradually adding and interacting two types of deviations from the ideal Arrow-Debreu world. On the one hand, there are *frictions* that prevent agents from communicating, agreeing upon and enforcing financial contracts in a way that would be socially beneficial to all. On the other hand, there are *sources of aggregate volatility*—aggregate shocks magnified by behaviors linked to structural deviations from Arrow-Debreu postulates, such as irreducible uncertainty (which deviates from the assumption that the probability distribution of random shocks can be commonly known), overlapping (mortal) generations (which deviates from the assumption of infinitely-lived individuals) and behavioral finance-type cognitive biases (which deviate from the usual neoclassical postulates of conventional utility theory). These deviations complicate reactions to common factors and aggregate shocks and make financial market participants more susceptible to shifting, moody expectations, thereby amplifying aggregate volatility. We group and combine frictions and sources of volatility so as to generate eight “domains” based on three basic dimensions, which form the backbone of our conceptual framework: internalized vs. uninternalized externalities; idiosyncratic vs. aggregate volatility; and full vs. bounded rationality.

We consider two broad types of frictions, principal-agent (agency) frictions and collective action frictions. On the agency side, we adhere to convention in defining our *classic* set of frictions to include enforcement and asymmetric information *gathering* frictions. We depart from convention, however, in that we consider information *processing* frictions (which relax the Arrow-Debreu assumption of full rationality) to be one of the two key sources of bounded rationality, the other, as noted, being behavioral finance-type deviations from the postulates of neo-classical utility theory. Information processing frictions are assumed to apply asymmetrically across the population, but the asymmetry is different depending on the setting. Where principal-agent interactions are emphasized, the asymmetries divide the population into a group of more sophisticated players and another of less sophisticated players, creating room for the former to take advantage of the latter. Where collective interactions are emphasized, the asymmetries give rise to a group of rational arbitrageurs and another of boundedly rational momentum traders, creating room for the latter to undermine the welfare of the former (in addition to their own).⁵

On the collective action side, while we recognize that they are part of a continuum, we distinguish between *participation* and *bargaining* frictions, and we associate the former to *public goods*, the latter to *externalities*. Participation frictions discourage citizens from spontaneously assembling and agreeing on providing public goods, or preventing free riding (not sharing the

⁵ While the population of unsophisticated investors of the agency paradigm is likely to broadly overlap with that of the boundedly rational traders of the collective paradigm, the two do not need to fully coincide.

costs) by individual agents of public goods already provided by the state.⁶ Instead, bargaining frictions refer to the transaction costs that prevent market participants from coordinating, bargaining, agreeing on, engaging in, and enforcing collective actions geared at internalizing both negative externalities (i.e., mitigating the adverse implications of individual actions on others) and positive externalities (i.e., inducing individual participants to take actions that bring positive externalities on others). Thus, we assume that bargaining frictions (but not participation frictions) invalidate the Coase Theorem, hence are the ones setting the dividing line between the worlds of internalized versus uninternalized externalities.⁷

The policy implications of participation and bargaining frictions thus defined are conceptually distinct. In one case (public goods), public policy is focused on easing the frictions that constrain the equilibrium—thereby improving the overall market-enabling environment, a typically uncontested role of the state. In the other case (externalities), the public policy interventions may directly improve the equilibrium, *given the constraints*—a more controversial role were it not for the widely accepted idea that (provided effective political institutions) the state (unlike markets) can internalize externalities and, hence, help align private and social interests. Thus, when it comes to the financial services industry, in the case of public goods, the state aims at *completing markets*; in the case of externalities, the state aims at *correcting markets*.

Figure 1 serves as our main roadmap. It should hopefully assist the reader to find her way through the details of the paper and keep the larger story line in focus. Starting from the frictionless Arrow-Debreu world, we first introduce a “primordial soup” of frictions. This primordial soup includes participation frictions (to ensure a role for the state in the provision of public policy) and the classic agency frictions (to ensure a role for financial intermediaries in the provision of financial services). It sets the limits of the IFA domain (the space bounded by the outer circle in Figure 1), where idiosyncratic risk (I) coexists with full rationality (F) and agency frictions (A).

As we move towards the inner spaces in Figure 1, new frictions and sources of aggregate volatility are *added to the IFA brew*. The diagram thus displays three additional (inner) circles that define the borderlines where these new frictions or sources of volatility come into existence. Thus, the *aggregate volatility* (G) circle defines the domain where aggregate risk, irreducible uncertainty and overlapping generations (mortality), three key sources of aggregate volatility, come into being. The *bounded rationality* (B) circle sets the boundary of information processing frictions and behavioral finance-type biases. Finally, the *externalities* circle defines the perimeter within which collective bargaining frictions (C) start to exist.⁸ This additive approach should be

⁶ Constrained inefficient equilibria driven by social participation frictions can obtain where the impact of isolated individual action on the common good is negligible or, if significant, the benefits of individual action accrue mainly to others. Thus, rational individuals may not act to achieve the common good (or avoid the common bad) and free ride instead on the actions of others. Social participation frictions can also lead to constrained inefficient equilibria where the benefits of individual action are privately appropriable while the costs are borne by others.

⁷ The Coase Theorem (Coase, 1937) states that, if trade in an externality is possible and there are no transactions costs, collective bargaining can lead to an efficient outcome regardless of the initial allocation of property rights.

⁸ We group aggregate risk, irreducible uncertainty and mortality under a single label (G) in order to simplify the visual appearance of Figure 1. However, in the body of this paper and where appropriate, we discuss them separately.

kept in mind in interpreting the labels; specifically, G stands for aggregate *plus* idiosyncratic volatility (G includes I); B stands for boundedly rational *plus* fully rational players (B includes F); and C stands for agency *plus* collective bargaining frictions (C includes A). Figure 1 should thus be understood as a *density* map: when a circle lies (partially or totally) inside another circle, in the intersection of the two circles the frictions and types of volatility contained in the first circle become accumulated with those contained in the second.

Figure 1: The Frictions-Volatility Density Map

Legend

Volatility	Rationality	Frictions
I : Idiosyncratic	F : Full	A : Agency
G : Aggregate + Idiosyncratic	B : Bounded + Full	C : Collective bargaining + Agency

Eight domains of different densities are delimited, all of which contain the features of the IFA “primordial soup.” For example, in the domain labeled GFC, G denotes the coexistence of aggregate with idiosyncratic volatility, F denotes full rationality, and C denotes the coexistence of collective bargaining frictions (i.e., uninternalized externalities) with agency frictions. The densest domain at the core of the diagram is labeled GBC, where G denotes that aggregate *plus* idiosyncratic volatility, B denotes bounded *plus* full rationality, and C denotes collective

bargaining *plus* the agency frictions. Policy roles also accumulate as more frictions (or sources of volatility) are introduced and domains become denser.

The domains *without collective bargaining frictions* (IFA, GFA, GBA, and IBA) jointly form the *agency paradigm*. The domains *with collective bargaining frictions* (IFC, GFC, IBC, and GBC) jointly form the *collective paradigm*. In line with de la Torre and Ize (2010a and b), the latter can in turn be sub-divided into a *collective action paradigm* (IFC and GFC) and a *collective cognition paradigm* (IBC and GBC). The collective paradigm is denser than the agency paradigm, as the latter is embedded in the former.

b. The frictionless world: No need for regulation

The departure point for our journey is the ideal Arrow-Debreu setting (Arrow and Debreu, 1954), where atomistic market participants are rational, free to choose, and live indefinitely in a frictionless world. Because market participants have different time preferences, degrees of risk aversion, and abilities to manage assets, they engage in financial transacting as a way to enhance their welfare. The scope for finance is minimal, however. The absence of frictions implies, in particular, that there are no costs whatsoever in enforcing contracts or in acquiring and processing information. A complete set of contracts thus exists *ex ante*, which insures players against any possible contingency and spreads risk optimally. Thus, there is no role for financial intermediaries (why using an intermediary when anybody can transact at no cost with anybody else). And the structure of financing (debt or equity) does not matter—the Modigliani-Miller theorem applies, with borrowers completely indifferent between raising debt or equity to finance their projects (Hagen, 1976).

In this world, there is no need for money or liquidity (all trades are set simultaneously and all contracts can be traded at no cost and at any time); dynamics are minimal (only those associated with equilibrium growth paths); and there are no financial crises. Moreover, the distribution of assets across agents is irrelevant as far as aggregate output is concerned.⁹ All players are price takers and efficient markets (working through price signals that perfectly reflect relative scarcities and risks) ensure that assets and risks are entrusted at no cost to those best able to manage them. Idiosyncratic risk is exogenous (it does not depend on the decisions of players) and risk aversion is just a reflection of the concavity of utility functions.

This frictionless world has no need for financial regulation. Nor does it need any organization, corporation, public institution, or public good (such as the judiciary or the police) aimed at smoothing out or circumventing frictions. All such services, when needed, can be costlessly and spontaneously provided by willing market participants. Thus, other than for redistributive purposes, there is no role for the government in the provision of public goods.

3. Purely idiosyncratic risk: Financial deepening

We now leave the frictionless Arrow-Debreu setting and explore how the world of purely idiosyncratic risk mutates as one introduces a progressively richer menu of frictions. We start

⁹ The equilibrium path is one of full employment where aggregate output ultimately depends only on technology, time preferences, and risk aversion.

with the IFA domain, which, until relatively recently, was the setting of choice for most financial frictions research. In this domain, the primordial soup of frictions (participation frictions and the classic agency frictions) is now present but all players remain rational. To better understand the relative role of enforcement and information gathering frictions, we will discuss them one at a time, in Sections 3a and 3b, respectively. We will then switch, in Section 3c, to the IBA domain by introducing information gathering frictions, thereby opening the door to bounded rationality. We will conclude with Section 3d by adding collective bargaining frictions, thereby introducing un-internalized externalities and moving from the agency paradigm to the collective paradigm, into the IFC and IBC domains.

While the nature of the underlying equilibria and policy responses evolve drastically from domain to domain as additional frictions are brought in, there are two key common denominators throughout the four domains visited in this section (IFA, IBA, IFC, and IBC). A first common denominator is the absence of systemic risk (i.e., equilibria are stable), which flows from the assumption that all risks are idiosyncratic. In the absence of aggregate shocks and the compounding effects of endogenous dynamic responses and other sources of aggregate volatility, such as irreducible uncertainty and inter-generational contracting failures, it is difficult to imagine ways in which systemic collapses could occur.¹⁰ A second common denominator is that agency and collective frictions induce inefficient financial equilibria (i.e., suboptimal equilibria relative to the Arrow-Debreu idealized setting) where the scope for intermediation (in both quantity and diversity) is constrained. We will argue, however, that the specific roles for policy vary from domain to domain, even if the overall goal of policy (including of prudential regulation) is to promote financial development and financial inclusion while preserving the soundness of individual financial institutions.

a. Enforcement frictions: Market conduct regulation

The introduction of enforcement costs in bilateral contracting is a key building block of the IFA world of finance—it gives rise to a fundamental moral hazard-induced *wedge between agents and principals*. It may not be in the best interest of the agent (the one entrusted with the funds or other assets) to honor her contract with the principal.¹¹ Given enforcement costs, the agent has incentives to take risks with the assets entrusted to him by the principal in ways that are not aligned with the principal’s interests. Time inconsistency problems thus emerge. Since the agent can get away without honoring the contract in some future state of the world, she cannot fully and credibly commit today (Kehoe and Levine, 1993). At the same time,

¹⁰ Without some common shock, financial intermediaries cannot become simultaneously (and suddenly) unsound. It is of course in principle possible for one intermediary hit by an idiosyncratic shock to trigger serial collapses through domino effects. This amounts to a “house of cards” view of financial systems that was an important part of traditional supervision (indeed it probably was the only thing systemic about traditional supervision). However, both theory and recent history have largely de-emphasized its importance. As Brunnermeier and Sannikov (2012), among others, have shown, financial systems in rational worlds tend to be naturally stable as long as they are not perturbed by large aggregate shocks. And as recent history has amply demonstrated, correlated risks (stemming from common shocks amplified by endogenous dynamics) are the key to systemic collapses.

¹¹ Enforcement costs can reflect the costs of the legal proceedings to recover tangible value after a default (Krasa and Villamil, 2000) or the inalienability of human capital, as an entrepreneur may not be able to commit not to withdraw his human capital from a project (Hart and Moore, 1995). In either case, *limited liability* is a central feature of this paradigm.

enforcement costs limit the pledgeability of assets (or income flows) by introducing a wedge between the net worth of an asset and the proportion of the asset that can be pledged. By posting good collateral, an agent seeking finance puts her own resources at risk, which enhances her willingness to honor the contract in the future and mitigates the time inconsistency problem. But not all collateral is pledgeable and the range of pledgeable collateral is a function of the quality and effectiveness of the contractual environment. Given the contractual environment, players that lack “good” collateral (i.e., easily tradable collateral whose value does not vary excessively as a result of idiosyncratic shocks) can become credit constrained.

A world of incomplete contracts thus arises, where projects with a positive net present value and rates of return above the risk free interest rate may nonetheless be unable to obtain financing. Agents may be forced to cancel positive net present value projects that are “illiquid” because they lack good collateral. Liquidity (hence money) thus matters because it provides insurance against adverse idiosyncratic shocks that call for additional investment in ongoing projects (Holmström and Tirole, 1998). At the same time, contract enforcement costs imply that the distribution of wealth now also matters because players are subject to different collateral constraints that cannot be traded away. The equilibrium is thus suboptimal relative to that in a frictionless world—it impedes a re-distribution of net worth in favor of those with superior skills to manage the assets, which would enhance pledgeability and lead to significant efficiency and output gains.¹²

Given contract enforcement frictions, the Modigliani-Miller theorem ceases to apply because a premium that reflects enforcement costs has to be paid for external finance.¹³ More importantly, there is a role for the financial services industry. Financial intermediaries add value because, by being longer lived than persons, they have better incentives to enforce penalties on defaulting contracts. Moreover, by specializing and covering the necessary fixed costs, they can achieve efficiency gains and economies of scale in enforcing contracts (Eaton, 1987). They can also enhance pledgeability through asset diversification. Last but not least, financial intermediaries can fulfill individual liquidity needs through the pooling of short-term deposits and the creation of inside money in a fractional reserve system (i.e., via the credit multiplier).

Enforcement costs and the resulting time inconsistencies not only limit financial engagement (hence financial development); they also open up the possibility of financial disengagement (hence financial instability). Note, however, that in the IFA domain the option to disengage or withdraw from financial contracting promotes both development and stability. In effect, banks offer demandable deposit contracts with a sequential-servicing constraint, which makes them inherently fragile and exposed to runs. However, absent coordination failures (ruled out by construction in the IFA domain), runs must be strictly driven by fundamentals. In fact, in a purely rational world, threats of runs are a key component of market discipline because banks’ funding fragility functions as an ex ante commitment device that prevents bankers from taking

¹² By enhancing pledgeability, such redistribution would allow the skilled to borrow more and manage more assets. This link between net worth and borrowing capacity is at the core of the so-called balance sheet channel, a channel that plays a key macroeconomic role once one adds aggregate shocks, as we shall soon see.

¹³ Given that information is still symmetrically available and players are rational, the expected costs of contract enforcement will be known by all; hence, in equilibrium, the lending interest rate will incorporate such costs. By limiting enforcement costs, collateral can lower the interest rate that a borrower would otherwise face.

advantage of depositors (Diamond and Rajan, 2000). Thus, funding fragility promotes financial intermediation instead of hindering it.

The role of policy is limited in this domain because enforcement frictions lead to an equilibrium that, although suboptimal, is likely to be both stable and *constrained efficient*. Given the constraints, the state could improve this equilibrium only if it had a comparative advantage over the private sector in enforcing financial contracts. However, while the state has a clear comparative advantage on the borrowing side due to its power to tax (more on this below), it has no enduring comparative enforcement advantage on the lending side. Indeed, in a democratic society where the government itself is subject to the rule of law, any superior loan enforcement technology the state might have should respect property rights and civil liberties and should be made readily available to all lenders through improvements in the judiciary or the legal and contractual environment. Thus, the state cannot in general improve the IFA equilibrium through prudential regulation or direct intervention. Nonetheless, public policy can help financial contracting indirectly, by relaxing the constraints to which it is subject. In particular, the state can smooth out enforcement frictions through strengthening the contractual dimension of the enabling environment (a public good).¹⁴ This justifies *market integrity and conduct regulation* that can facilitate contractual relationships by standardizing behaviors and formats.

b. Asymmetric information gathering frictions: Market transparency regulation

We now add asymmetric information gathering frictions in principal-agent relationships. Specifically, the agent may have information that the principal lacks and may use this advantage to take actions with the principal's resources that are inconsistent with the interests of the principal. Alternatively, the agent may have a better capacity than the principal to acquire the information needed for selecting or managing assets. Even if both principal and agents are fully rational, such asymmetries can lead to a variety of well-known market failures, which may happen before contracting (adverse selection), during the life of the contract through various forms of moral hazard (risk shifting, shirking, or perks), or after the end of the contract (e.g., through borrower lock-in, a form of market power resulting from relationship lending).¹⁵ In particular, reflecting the risk of adverse selection, credit may be rationed at an interest rate lower than that needed to clear the market. Such information asymmetry-induced failures may take place at all levels of the financial system, including between depositors, financial intermediaries, and borrowers, and between shareholders and managers. Moreover, agency frictions can multiply and mutate as financial systems evolve and become increasingly complex (Ashcraft and Schuermann, 2008).

In these circumstances, to align principal-agent incentives, borrowers, including banks, need to meet further pledgeability and skin-in-the-game (capital) constraints.¹⁶ And banks play a

¹⁴ In practice, this may include a broad range of legal reforms such as improvements in the bankruptcy legislation and collateral registries, or an increase in the range and tradability of pledgeable assets.

¹⁵ Starting in the 70s, the literature on all these issues has developed enormously. Foundational papers include Akerlov (1970), Stiglitz and Weiss (1981), and Mankiw (1986) on adverse selection; Townsend (1979) on costly state verification; and Innes (1990) on moral hazard.

¹⁶ The link between banks' capital and lending capacity is at the core of the lending channel, another key channel of financial transmission once aggregate shocks are added.

number of key additional roles, including that of delegated monitoring and relationship lending (thereby making financing available to a variety of borrowers for which direct participation in the securities market would be too costly).¹⁷ A number of important implications follow. First, financial intermediaries can address informational inefficiencies by splitting assets into risk-free debt claims sold to uninformed/unsophisticated players and equity claims sold to informed/sophisticated players (Gorton and Pennacchi, 1990). Second, there is a new function for collateral, that of supporting “information-free” lending (particularly through repos, as in Gorton and Metrick, 2009). Third, debt contracts can be optimal because they minimize socially wasteful monitoring costs while maximizing the agent’s effort (he gets a maximum upside when outcomes are good, and a maximum penalty when they are bad; DeMarzo and Duffie, 1999; Dang, Gorton and Holmström, 2010). Fourth, information-based bank runs may provide an efficient mechanism to close down inefficient and insolvent banks (Jacklin and Bhattacharya, 1988). Fifth, market discipline can function even when only a fraction of bank depositors are well informed (Calomiris and Khan, 1991).¹⁸ Sixth, banks’ risk aversion (and hence their intermediation spread) may no longer be exogenously given in all cases, it could now vary with the banks’ capital, typically reflecting the shadow price of a Value-at-Risk financing constraint (He and Krishnamurthy, 2010).

As in the case of the enforcement costs discussed earlier, bank failures are efficient outcomes of market discipline and absent an enduring informational advantage of the state (as a lender) over the market, financial contracting should arguably remain constrained efficient.¹⁹ Thus, the regulatory role for the state would again be circumscribed to easing the overarching constraints, by providing the public goods required to enhance the enabling environment, this time along the informational dimension. This role entails, in particular, introducing traditional (information disclosure-based) consumer protection, as well as establishing a *market transparency and corporate governance regulation* that facilitates improved market discipline through the flow, standardization, and reliability of information, thereby enabling the better informed to take better decisions. The state should also create a suitable regulatory framework for the establishment of market entities specialized in verifying and assessing information, such as accountants, auditors, and rating agencies.

However, in the IFA domain the state does not need to supervise financial intermediaries by itself (indeed, it does not have any comparative advantage in doing so). Nor should it be especially worried about the less informed. Since, by assumption, they are price takers (they live

¹⁷ On the monitoring role of banks, see Diamond (1984), Hellwig (1991), and Holmström and Tirole (1997). On the cost of direct access to the capital market, see Haliassos and Bertaut (1995).

¹⁸ In fact, market discipline is enhanced by a suitable mix of debt and equity that optimally allocates control rights on a bank (Dewatripont and Tirole, 1993).

¹⁹ Arguably, this conclusion must be subjected to at least three caveats. First, development banks that are focused on underserved sectors may develop informational advantages over private lenders. Second, the legislation in some countries may give state-owned banks some enforcement advantages over private banks in loan collection. There are no solid grounds, however, not to level the enforcement playing field across public and private banks. Third, well-targeted non-linear taxes could in principle be used to tax away the proceeds from moral hazard or any other benefit obtained by the agent at the expense of the principal, thereby helping align incentives towards an efficient equilibrium. However, such (Orwellian) use of taxation lies (and will most likely remain) much beyond the realm of the possible. It would require an enormous amount of information and would be extremely hard to implement, thereby facing huge risks of policy failure.

in an environment of perfect competition) and process information efficiently (they are rational), they will behave prudently, fend for themselves, and eventually learn their way around in the world of finance.

The crucial conclusion so far—and one that is often ignored or misunderstood, at least in policy circles—is that neither enforcement costs nor asymmetric information-gathering frictions *per se* offer compelling grounds to justify prudential regulation in competitive financial markets. If all players are rational and there are no uninternalized externalities, the coexistence of enforcement and information-gathering frictions warrants governance and market integrity and transparency regulation *but not prudential regulation* (i.e., regulation intended to influence risk taking decisions). Enforcement and information-gathering frictions and failures are best dealt with directly by self-interested principals and agents operating in contestable markets. To enter into financial contracts, rational principals will require that rational agents meet sufficient skin-in-the-game and other conditions. Rational agents, for their part, will find it advantageous to oblige and will in fact offer of their own volition incentive-aligning undertakings, including pledges of collateral, provision of information through accounting and auditing arrangements, willingness to obtain finance via short-term debt, etc. Thus, the invisible hand can still obtain in the IFA domain, as all feasible win-wins could be achieved through financial contracting such that a constrained efficient equilibrium is reached. The beneficial role of the state is thus limited to keeping markets open and easing the constraints to financial activity by improving the contractual and informational dimensions of the enabling environment.

c. Information processing frictions: Consumer protection microprudential regulation

We now switch to the IBA domain by adding asymmetric information processing frictions. The financial world now has some agents that are less sophisticated than others, i.e., are “boundedly rational.”²⁰ Even if the information were available at no cost, the unsophisticated could not make efficient use of it due to cognitive limitations. Hence, their understanding of complicated financial contracts is imperfect or frankly flawed. This opens up a world ripe with potential consumer abuse, which now justifies a role for prudential regulation.²¹ In this world, no matter how much information is available, some (the sophisticated) are able to systematically exploit and fool others (the unsophisticated), leading the latter to eventually disengage from financial transacting.

²⁰ The assumption of bounded rationality based on information processing frictions connects with the world of behavioral finance without fully overlapping with it. The behavioral finance literature provides growing evidence that human beings tend, on average, to behave on the basis of systematic cognitive biases (see Kahneman, 2011, for a broad recent overview). Such biases—which include “framing,” “hyperbolic discounting,” “loss and ambiguity aversion,” “endowment effect,” “overconfidence,” “anchoring effect,” and “hindsight bias,” among others—are of course more likely to emerge the more exposed individuals are to information processing frictions. Thus, they can be implicitly attributed to the unsophisticated, rather than to the population at large. Yet, it is also conceivable for boundedly rational individuals to be free of biases and for fully rational individuals to be “wired” in a way that is not fully consistent with the traditional postulates underlying the Arrow-Debreu world.

²¹ It is rather remarkable that the distinction between information *gathering* and information *processing* frictions is rarely made in the theoretical literature, which, by and large, simply distinguishes between “informed” and “uninformed” agents. Yet, the policy implications are radically different. While making information available, including through transparency-oriented regulation, does the trick when agents are rational, it becomes clearly insufficient in a world of asymmetric bounded rationality.

The resulting equilibrium is inefficient, as a vast amount of private financial transactions that represent win-wins may fail to take place. In the absence of participation frictions, the unsophisticated could organize themselves as a club and appoint a (presumably fully rational) representative who could monitor the banks and negotiate with them the conditions under which the members of the club would agree to have contractual relationships with the banks. Given participation frictions, however, the state is better able to provide this service *as a public good*. The official supervisor can thus “represent” the small and unsophisticated depositors (or borrowers) by issuing prudential and consumer protection regulations that exactly mimic what the large and sophisticated depositors (or borrowers) would require from their financial service providers (Dewatripont and Tirole, 1994). This is the core of the rationale for a “delegated regulation” performed by an official agency.

Yet, strong counterattacks have been launched against this IBA-based (traditional) rationale for prudential regulation, in favor of “free banking.”²² The criticisms have been launched on at least three grounds: (i) the high costs of good prudential oversight may more than offset its benefits (i.e., when all is said and done, the state’s comparative advantage may not be sufficient to justify intervention); (ii) failures of the regulators to regulate efficiently, due in particular to regulatory capture, whereby the regulator fails to appropriately represent the best interests of those it is meant to represent, a clear case of public failure (Boot and Thakor, 1993); and (iii) public moral hazard arising from a deposit insurance that is either underpriced or whose incentive distortions are not adequately offset by prudential regulations, particularly by capital (skin-in-the-game) requirements (an adverse unintended consequence).²³ Thus, some (for example Allen and Gale, 2007) have argued that “one bad policy (deposit insurance) might not justify another (capital adequacy requirements)”. These criticisms have accentuated the calls for sharply limiting the deposit insurance coverage to small deposits and drawing the regulatory perimeter as narrowly as possible, so as to ensure that financial innovation can thrive in the presumably market discipline-driven world of the sophisticated.²⁴

Be it as it may, the logic of the IBA domain provides the basic ingredients for the *traditional (pre-subprime crisis) regulatory architecture*, which focused on the small depositors as the main unsophisticated players of the financial world. Accordingly, a *consumer protection oriented microprudential regulation* for deposit-taking intermediaries and an explicit *deposit insurance* limited in coverage to small deposits constituted the two pillars of this pre-subprime architecture. Deposit insurance was justified not just because unsophisticated depositors needed to be protected from banks’ potential exploitative behaviors, but also because unsophisticated depositors needed to be protected from themselves—by preventing them from running out of unjustified nervousness—as well as from the state—whose own regulatory failures (malpractice) could lead to unforeseen bank failures.

²² The case for free banking has been made in particular by Calomiris and Kahn (1996), Herring and Santomero (2000), and Allen and Gale (2003). Countervailing views can be found in Matutes and Vives (1996, 2000).

²³ On the impossibility of fully internalizing public moral hazard in the deposit insurance premia, see Chan, Greenbaum and Thakor (1992) and Freixas and Rochet (1995).

²⁴ Support for the line-in-the-sand approach is well synthesized by the now famous quote from Alan Greenspan (1998): “*Regulation of [financial] transactions that are privately negotiated by professionals is unnecessary*”.

Moreover, given the public moral hazard implications of the deposit insurance, both microprudential regulation and the deposit insurance were designed to be coterminous,²⁵ with the *regulatory perimeter* narrowly and clearly drawn so as to ring fence *only* the unsophisticated small depositors. Indeed, this is fully consistent with the inner logic of the IBA domain. Absent uninternalized externalities, sophisticated (rational) investors and financial service providers are expected to discipline each other. Hence, it is privately and socially efficient for the sophisticated to be allowed to operate and innovate freely outside the regulatory perimeter, without the intrusive burdens of prudential oversight or the public moral hazard-promoting protection of the deposit insurance. At the same time, again absent externalities, regulation does not need to incorporate Pigouvian taxes or any other prudential surcharge aimed at aligning social and private interests. Therefore, since there is no pricing wedge between the regulated and unregulated financial sectors, the unsophisticated have no incentive to venture into the wild unregulated world. Instead, they are better off remaining within the safe waters of the regulated sector, where they can be adequately protected (more on this below).

d. Collective bargaining frictions: Market correction microprudential regulation

In this subsection we explore the IFC domain in detail and only briefly discuss (at the end) the effects of cognition frictions in the IBC domain. The IFC domain retains the assumptions of purely idiosyncratic risk (I) and full rationality (F) but adds collective bargaining frictions (C) to the primordial soup. Collective bargaining frictions hinder the spontaneous internalization of externalities, thereby introducing a wedge between social and private interests. There are at least four main channels through which wedges between private and social interest can arise: (i) pecuniary externalities (price spillovers); (ii) behavioral externalities (herds); (iii) interconnectedness externalities (balance sheet or market spillovers); and (iv) informational externalities (information free riding).²⁶ In the absence of aggregate volatility and, hence, of externalities-boosted aggregate dynamics, we will only focus here on the externalities that are relevant in a static environment and leave the others for Section 5. In particular, we leave for Section 5 externalities-driven herds, which are intrinsically dynamic in nature, as well as pecuniary externalities, which only seem to matter in a context of aggregate dynamics.²⁷ We are thus left here with interconnectedness and informational externalities.

Let us start with *informational externalities*. Rating agencies or other market analysts may fail to invest sufficiently in data gathering and produce a socially suboptimal level of analysis and monitoring because they cannot internalize the full social value of the information they produce. Instead, other market players can free ride on the information they produce. Similarly, large (wholesale) institutional investors may free ride on imperfect but easily available

²⁵ That is, deposit insurance is to be offered only to prudentially regulated banks and, conversely, prudential regulation is to apply only to insured banks.

²⁶ De Nicolo, Favara and Ratnovski (2012) propose a rather similar typology, albeit with a somewhat different terminology and without including informational externalities.

²⁷ As argued by Arnott, Greenwald and Stiglitz (1993), agency frictions can give rise to welfare relevant pecuniary externalities even in a static context, thereby justifying taxes and subsidies aimed at influencing consumption patterns in ways that limit the impact of these externalities. In a finance context, however, we do not see (nor are we aware of any literature exploring) pecuniary externalities as a material justification for microprudential regulation in a static context with purely idiosyncratic risk.

public information, investing short-term and counting on exiting early (at the first sign of trouble) rather than increasing their monitoring effort. This can lead to inefficient runs on solvent institutions (Huang and Ratnovski, 2011).

Consider now *interconnectedness externalities*. The interconnectedness between financial market participants can take place through at least two different channels. The first is the balance sheets of financial institutions. Different financial intermediaries can become interconnected through their balance sheets because of direct or indirect cross-exposures. The failure of one institution can thus affect the soundness of all other institutions to which it is connected, thereby exacerbating the vulnerability of financial systems to contagion and domino effects. However, in the absence of common shocks, it is hard to make the case for *systemic fragility* arising from purely idiosyncratic shocks that propagate throughout the financial system.²⁸ Instead, because aggregate volatility plays a key role in magnifying such effects and making them systemically lethal, we will leave this case for later.

Interconnectedness externalities can also be at work through the balance sheet of a single financial institution whose creditors become interconnected because the actions of one creditor affect others. For example, an early withdrawal by one creditor can undermine the capacity of the financial institution to honor its commitments to its remaining creditors. Given fractional reserve banking, an individual depositor may shorten the maturity of his deposit because this allows him to pull out before other depositors. However, iterating this reasoning over all depositors may lead to a “maturity rat race” where all depositors shorten the maturity of their deposits in order not to be left behind in the event of a run. The end result is therefore a funding structure that is both socially inefficient (excessively short-term) and raises the vulnerability of financial institutions to rollover risk (Brunnermeier and Oehmke, 2010).

Markets (or networks) constitute the second channel for interconnectedness externalities. Financial institutions can become interconnected through markets because they have similar portfolio compositions, participate in a service jointly offered to the public (such as the payments system), or engage in markets where they share liquidity (such as the interbank liquidity market) or risk (the derivatives markets). In all such cases, interconnectedness triggers network effects where the actions of one participant spill over on everybody else in the network. In particular, because participating in a given market or network enhances market liquidity, interconnectedness can exert positive externalities on all other participants, thereby helping this market develop. At the same time, by enhancing market and institutional liquidity, it can facilitate the dispersion and diversification of risk and, hence, reduces risk premia. Moreover, the development of one market can exert positive externalities on the development of other interconnected markets. Thus, unless such externalities are internalized, financial development can be slowed down due to lack of participation, or else take a wrong turn when market forces promote the development of alternative, socially inferior instruments or markets.

Absent systemic risk, the state’s policy roles are confined as follows. Markets can be induced to internalize informational externalities through transparency and disclosure regulation

²⁸ Take for example the case of a run on an individual bank motivated by expectations of unsoundness. Such a run could trigger similar runs in other banks if depositors expected other banks to be facing similar vulnerabilities. By construction, however, this cannot be the case in a world without common shocks.

(say, by setting information-intensive credit underwriting standards), by subsidizing information gathering, or by complementing private information with publicly produced information. The latter may include official supervision and monitoring of individual financial intermediaries, both of which are likely to be under-produced by the private sector (auditors, rating agencies or private analysts).²⁹ Market interconnectedness externalities call for *developmental policies* (market regulations or public initiatives such as development banks) aimed at internalizing the benefits of coordinating market participants around developmental options that better align their individual interest with those of society. Finally, balance sheet interconnectedness externalities call for prudential regulations that correct the associated market distortions (which arise despite full rationality), for example a bias towards excessively short funding. We will define this new type of microprudential regulation as *market correction microprudential regulation*. Because this regulation should focus on correcting specific market distortions, its scope should be both more limited and more focused than that of the consumer protection oriented microprudential regulation discussed in the previous subsection.

Before moving on to Section 4, we touch briefly here upon the IBC domain, which makes room for unsophisticated depositors while staying in a world of purely idiosyncratic risk. Among all domains, the IBC is the one that probably comes closest to representing the state of prudential policy thinking prior to the recent financial crisis. At that time, prudential norms aimed at *both* protecting the unsophisticated from the impact of individual bank failures *and* making the financial system more robust against possible systemic events. Thus, capital adequacy norms were designed to include a *systemic add-on buffer* on top of the minimum requirements needed to align incentives from a pure agency perspective and ensure the soundness of individual institutions. The latter was justified in view of the perceived negative externalities of individual bank failures, including in particular via the operation of the payments system and contagion on other banks through domino effects. For this reason, we will define the regulatory framework best associated with this new domain as *Basel II microprudential regulation*. However, as argued above, in the absence of significant aggregate risks, financial systems are unlikely to be houses of cards. Hence, because it failed to emphasize aggregate volatility, Basel II essentially amounted to Hamlet without the Prince.

4. Aggregate volatility: Policy-induced systemic instability

This section adds aggregate volatility while assuming a world without collective bargaining frictions, i.e., without uninternalized externalities. We see aggregate (common or correlated) shocks as the fountainhead of aggregate risk, amplified by endogenous dynamics and behaviors linked to irreducible uncertainty and overlapping (mortal) generations. Aggregate risk stresses shocks derived from an objective, *commonly shared and understood* probability distribution. The endogenous market responses to such aggregate shocks provide the basic persistence and amplification dynamics. Such dynamics are further amplified by irreducible (Knightian) uncertainty and overlapping generations (mortality). The former stresses adjustments in expectations that result from updating *individual subjective priors* derived from past

²⁹ In addition, when private information gathering and monitoring is carried out through a pyramidal structure (where rating agencies sit at the top of a monitoring pyramid that includes auditors, boards of directors, and risk managers), the state can help close the pyramid through official oversight of rating agencies. Alternatively, the state can seek to flatten the pyramid by limiting the use of ratings by banks and other financial intermediaries.

observations and personal beliefs in a context in which probability distributions are not commonly knowable; the latter stress (rational) *collective mood shifts* derived from inherent failures in inter-generational contracting that lead to self-fulfilling dynamics. Thus, while aggregate risk directly focuses on the shocks coming from the environment, irreducible uncertainty and overlapping generations provide key expectational amplification mechanisms. The interplay of all three sources of volatility is in turn magnified by endogenous market dynamics.

We explore the world of full rationality (the GFA domain) in subsections 4a through 4c. Aggregate volatility brings about a world of persistence, financial amplification, and crises where equilibria nonetheless remain *constrained efficient*. Thus, while aggregate volatility goes a long way towards making the GFA domain more real and life-like than the IFA domain, *it does not provide, of itself, compelling grounds to justify prudential regulation*. However, because of the state's power to tax and, hence, spread risk across generations, the GFA domain can justify an array of ex post efficient policy responses (such as aggregate liquidity provision and risk absorption of last resort) that reduce the severity and duration of financial crises once they occur. In turn, the anticipation of ex post policy responses (whose bailout component cannot be fully eliminated) can induce ex ante incentive distortions in the form of public moral hazard (an adverse unintended consequence). Thus, in the absence of a credible policy commitment not to engage in such ex post interventions, the introduction of an ex ante macroprudential regulation aimed at containing public moral hazard may be justified. Reflecting the importance of post-crisis policy intervention, we devote to it a separate subsection (Subsection 4c). We also devote separate subsections to aggregate risk and the sources of shock-amplification because they have different implications for the nature of financial dynamics.

In Subsection 4d we enter the GBA domain by introducing bounded rationality. As discussed in Section 3, the coexistence of sophisticated (rational) players with unsophisticated (boundedly rational) ones opens up a role for microprudential regulation, that of representing the unsophisticated by acting on their behalf vis-à-vis financial service providers. This role acquires a macroprudential character in the context of aggregate volatility, however, because to adequately represent the unsophisticated, the regulator must now adapt and modulate prudential regulation over time by taking into account aggregate shocks and fluctuations while keeping public moral hazard in check. The failure to do so efficiently (a policy failure) can amplify aggregate volatility and alter its nature, turning it from constrained efficient to constrained inefficient volatility.

a. Aggregate risk: Persistence and amplification

The interaction of aggregate risk with the classic agency frictions can give rise to aggregate endogenous risk and lead to persistent, amplified, and unstable macro-financial dynamics with major output effects. In particular, leverage now has a major potential downside, as adverse shocks that reduce borrowers' net worth limit their future borrowing capacity. While leveraged credit had no relevant macroeconomic implications in the IFA domain (where idiosyncratic risks could be fully diversified and idiosyncratic shocks washed out in the aggregate), it acquires major importance in the GFA domain.

The earlier literature that, during the 1990s, examined the real macroeconomic impact of financial frictions led to two main findings. First, adverse aggregate shocks (i.e., the materialization of aggregate risks) have *persistent effects* on real economic activity and employment because the borrowing firms that have suffered a loss of capital (hence of collateral value) must reduce their spending in order to rebuild their net worth over time through retained earnings. The across-the-board reduction in spending has a lasting impact on aggregate output and the business cycle (Bernanke and Gertler, 1989; Carlstrom and Fuerst, 1997). Second, there can be *amplification effects* when the decrease in capital reduces the price of capital and collateral due to convex (nonlinear) adjustment costs that magnify the original shock (Bernanke, Gertler and Gilchrist, 1999). Further amplification effects occur when the leveraged borrowers fire-sell their assets to players that are less skilled at managing them, leading to a loss spiral in asset prices that further erodes their borrowing capacity (Kiyotaki and Moore, 1997).

A more recent strand of literature (Adrian and Shin, 2009; Adrian, Colla and Shin, 2012) focuses on financial accelerator effects whereby increases in asset prices boost financial intermediaries' capital through valuation adjustments. In turn, the procyclical increase in capital raises financial intermediaries' leveraging capacity, thereby allowing lending to increase and further boosting the rise in asset prices. In the downward phase of the cycle, falling asset prices erode banks' capital, forcing deleveraging and adding to the spiraling down of asset prices.³⁰ By raising the profitability of financial intermediation (hence risk appetite), low short-term interest rates are powerful contributors to the booms.

Another recent strand of literature analyzes the role of precautionary liquidity and liquidity spirals (He and Krishnamurthy, 2012; Brunnermeier and Sannikov, 2012a). It finds that financial equilibria can become bi-modal. Small shocks have no macro-financial impact because they are absorbed through the liquidity buffers voluntarily built by individual intermediaries and market players; hence, in normal times, risk remains largely exogenous and the economy exhibits low volatility. By contrast and reflecting the strong nonlinearities resulting from financing constraints that suddenly become binding, larger aggregate shocks can throw the economy into a crisis mode where risk becomes mostly endogenous. The fire sales of assets by leveraged intermediaries and borrowers can trigger amplification loops and abruptly raise volatility.³¹ In turn, the rise in volatility can induce haircut and margin call spirals that induce further fire sales and higher price volatility (Brunnermeier and Pedersen, 2009).

In these models, there is typically an exogenous aggregate risk component—which exacerbates the agency frictions-driven financing constraints that shaped the financial equilibrium during normal times—and an *endogenous risk component*—which arises out of the market responses to the large shocks and plays the key magnifying role during crisis episodes.³²

³⁰ Adrian and Shin (2013) show that such leveraging procyclicality can be consistent with optimal contracting under moral hazard and may justify the commonly used Value-at-Risk rule.

³¹ Brunnermeier and Sannikov (2012a) and He and Krishnamurthy (2011) present very similar models along these lines, with the former being based on debt finance by final borrowers, the latter on equity finance by financial intermediaries. In both cases, the nonlinearities play out in full force by avoiding to solve the models through linearization, as used to be the case in the older literature on the macroeconomic impact of financial frictions.

³² For an empirical examination of the distinction between exogenous and endogenous risk, see Majnoni and Powell (2011)

The interplay of exogenous and endogenous risks can lead to *volatility paradoxes*. Less exogenous risk can lead to more endogenous volatility because it induces borrowers to lever up and hold lower precautionary buffers, thereby making the financial system more vulnerable to large shocks. Finally, there is a further evolution of risk aversion: even when everyone is risk neutral, borrowers exhibit risk-averse behavior because their investment opportunities are state-dependent and time-varying.³³

Regardless of the source of amplification (persistence, financial or real accelerator effects, liquidity spirals, etc.), these dynamics can give rise to pro-cyclical changes in risk-taking by financial intermediaries, particularly the levered ones. During credit booms, banks may relax their credit standards, leading to more intense competition for market shares (Dell’Ariccia and Marquez, 2004; Gorton and He, 2008).³⁴ These dynamics are congenial with the “risk taking channel” of monetary policy, first identified by Borio and Zhu (2008), whereby low monetary policy rates augment risk appetite by, for instance, boosting asset values, incomes, and profits.

What is most remarkable, however, is that the complex aggregate dynamics described above may occur in a basic agency world of full rationality and devoid of externalities. To be sure, pecuniary externalities are bound to automatically arise when principal-agent frictions become binding in a setting where agents interact through asset markets (more on this in Section 5). Indeed, this is the case in many of the above-cited models. Yet, we cite these models here in the GFA domain, rather than in the GFC domain where externalities drive the show, because we conjecture that the non-linear dynamics found in these models are not only (and not even mainly) the reflection of uninternalized externalities. Instead, our conjecture is that sufficiently large and low-probability shocks (akin to one hundred year floods) may overwhelm the buffering capacity of the system, *even when buffers are set to be socially optimal*—i.e., when they internalize externalities. These buffers may not suffice to cushion the (perhaps less extreme but still virulent) downward spirals that ensue when binding agency (collateral, information asymmetry) constraints, compounded by asset market interlinkages, trigger fire sales. If so, at least part of the volatility in these models should be constrained-efficient, which is equivalent to saying that occasional crises are bound to happen as long as the distribution of shocks is sufficiently fat-tailed.³⁵ In this case, a central planner would not set prudential buffers high enough to totally eliminate systemic risk because it would be socially too costly to do so.

³³ Taking on greater risk leads borrowers to suffer greater losses when they value funds the most, after negative shocks lower asset prices and open up profitable investment opportunities.

³⁴ Dell’Ariccia and Marquez’s model is an interesting illustration of the difficulties involved in pinning down the policy implications of theoretical models. In their model, lending booms are associated with a deterioration of lending standards due to a reduction of information asymmetries that limit adverse selection and, hence, induce banks to lend more broadly. While their model is often interpreted as a clear justification for regulation to control the deterioration of lending standards during lending booms, the authors in fact show that such deterioration is generally constrained-efficient (it maximizes aggregate surplus). Thus, the case for regulation can only be made based on a possible trade-off between efficiency and stability. It is only warranted if risk taking, by reducing profitability, raises the banking system’s vulnerability to a *socially costly* banking crisis (i.e., to un-internalized negative externalities) sufficiently to more than offset the increase in social surplus resulting from the lending boom.

³⁵ This is indeed what Bianchi (2011) finds. In his model, the probability of crises is seven times larger and the maximum drop in consumption is 70 percent higher when externalities are not internalized than when they are. Efficient crises (with fully internalized externalities) occur when negative shocks exceed two standard deviations. The author therefore concludes that “*it is still socially optimal to experience a crisis in some unfortunate states of nature*”. Allen and Gale (2007) present views along broadly similar lines.

How to sort out purely agency frictions-driven crisis dynamics (that do not justify prudential regulation) from externalities-driven crisis dynamics (that do justify prudential regulation) is therefore a central issue that requires further research and calibration. Where to set the bar in terms of required prudential buffers is precisely what regulators need to know to do their job well. This is a key theme of this paper, to which we will return.

b. Compounding aggregate volatility: Irreducible uncertainty and overlapping generations

Irreducible (Knightian) uncertainty about the stochastic nature of the aggregate shocks is likely to amplify the scope for such constrained-efficient volatility. It naturally gives rise to heterogeneous beliefs despite the assumption of full rationality. Being rational, players do learn but their beliefs need not fully converge overtime because residual uncertainty makes it impossible to falsify all but one set of beliefs. Thus, heterogeneous beliefs are akin to preferences.³⁶ Some are born optimists, others pessimists.

In an Arrow-Debreu environment, this would be of no consequence, as the optimists would naturally take more risks while selling the pessimists insurance against bad outcomes. However, with agency frictions-induced credit constraints and incomplete markets, the distribution of wealth between optimists and pessimists matters for determining asset prices. For example the optimists may temporarily dominate the market and push asset prices up, because they have access to an instrument (say, repurchase agreements) that increases their leverage. However, asset prices can abruptly fall when bad news impose losses on the optimists, washing them out of the market and triggering a redistribution of wealth towards the pessimists. Alternatively, asset prices may fall when new financial instruments (for example, credit default swaps) emerge, allowing the pessimists to better insure against bad outcomes and giving them in this way more weight in asset price determination (Geanakoplos, 2010). Thus, irreducible uncertainty and heterogeneous beliefs can lead to an “anxious” (albeit fully rational) world where news can, by themselves, have a large impact on asset prices (Geanakoplos and Fostel, 2010). Along somewhat similar lines, Bianchi, Boz and Mendoza (2012) find that financial innovations can lead to waves of optimism and pessimism as agents learn in a Bayesian fashion about the ultimate impact of these innovations. In either case, the important takeaway is that volatility can be magnified even without externalities.

Overlapping generations (OLG), which imply a relaxation of the Arrow-Debreu assumption of infinitely lived players, provide yet another possible source of amplification of aggregate volatility. In an overlapping generations setting, the equilibrium path is anchored on expectations of what will happen tomorrow, which in turn depends on what will happen the day after tomorrow, and so on until the infinite future. If trust in future generations abruptly falls, the economy can all of a sudden switch from an efficient trading equilibrium to an inefficient zero

³⁶ In a world of learning frictions, such as the one explored later in the paper, heterogeneous beliefs can also exist and persist because the additional learning needed to smooth out such discrepancies is too expensive. See Savage (1954), Aumann (1976), Kurz (1994) and Acemoglu, Chernozhukov and Wold (2009).

trade equilibrium.³⁷ Thus “moods” matter and inefficient mood swings occur not because market participants are irrational and form their expectations looking backward, but rather because they are perfectly rational and form their expectations looking forward.³⁸

While both irreducible uncertainty and overlapping generations exacerbate aggregate volatility, neither provides by itself a strong case for prudential regulation. In the case of irreducible uncertainty, absent externalities or bounded rationality, volatility should continue to be constrained efficient, hence not amenable to improvement through preventive (micro or macro) prudential policy. In the case of an OLG setting, however, the inefficiency of mood swings should in principle call for state intervention. However, while moody growth paths in OLG models may be accompanied by different rates of credit expansions, it is not clear why, in the absence of externalities or bounded rationality, such paths should give rise to *prudential concerns* (e.g., why real inefficiencies affecting employment, output or investment should be accompanied by financial inefficiencies affecting risk-taking).³⁹ Hence, although the OLG approach is another frontier area where more research is clearly needed, it does not seem to provide a strong case for prudential regulation either.

c. Post-crisis policy responses: Time inconsistency

So far we have therefore argued that the interaction of aggregate volatility (no matter its source) with agency frictions in a world of rationality (the GFA domain) does not provide a strong case for (preventive) micro or macro prudential policy. Even if crisis can be calamitous, they are a fact of life not worth preventing all the time and at all costs. There is nothing enduring that prudential regulation could achieve that is socially justified and that rational market players are not already doing. However, as we will now argue, the GFA domain may justify ex post interventions aimed at speeding up the recovery of financial and real activity after a crisis. Such interventions include the provision of aggregate liquidity via a lender of last resort (LOLR) or the issuance of risk-free debt; the redistribution of assets towards financial intermediaries via a countercyclical monetary policy; and risk absorption of last resort (RALR) operations by the state.⁴⁰

³⁷ This is the basic intuition underlying Allais (1947) and Samuelson (1958), who provide the points of departure for the OLG literature.

³⁸ The OLG literature emphasizes two different types of market failures. The first strand explains the sub-optimality of the equilibrium with reference to the “indefinite” nature of generational overlaps, which leaves the economy with a “lack of market clearing at infinity” (Geanakoplos, 2008). This opens up the scope for self-fulfilling “rational bubbles”. The second strand emphasizes the problem of incomplete markets that is at the heart of an OLG setting, namely, that the current generation cannot contract with future generations. Thus, the living cannot insure themselves against generation-specific shocks. This failure can again give rise to suboptimal multiple equilibria because, in the absence of full cross-generations insurance, the living become vulnerable to exogenous shocks and self-generated waves of pessimism (Cass and Shell, 1983; Farmer, Nourry and Venditti, 2012).

³⁹ In addition, the lack of intergenerational insurance should generally trigger conservatism and pessimism. If so, the OLG world should be generally biased towards low (rather than high) credit expansions. Yet, it is high (not low) credit expansions that are generally at the root of systemic crises.

⁴⁰ The risk-absorption role of the state (RALR) is arguably more fiscal than monetary. It has traditionally been strongly resisted by orthodox central bankers. In the aftermath of the sub-prime and Eurozone crises, however, major central banks have been compelled to adopt it.

Consider first the case of aggregate liquidity management. As already noted in Section 3, contract enforcement frictions between principals and agents induce a demand for precautionary liquidity as self-insurance against adverse shocks. However, aggregate liquidity shortages may arise if firms with excess liquidity cannot lend to firms with liquidity gaps in times of stress (as in Woodford, 1990); or if, as a result of a large aggregate shock, all firms find themselves on the demand side of the market, i.e., in need of liquidity (as in Holmström and Tirole, 1998). In the first case, *public debt* securities can provide a bridge asset that can be used as risk-free collateral by firms with liquidity shortages to borrow from firms with excess liquidity. In the second case, the state can resolve the aggregate liquidity shortage by providing LOLR liquidity support to individual institutions or the markets more generally.⁴¹ In either case, the state can improve the post-crisis equilibrium because of its advantage over the market in *enforcing* taxation, which is what ultimately gives the state a comparative advantage in issuing (risk free) debt.⁴² Indeed, as noted by Calvo (2002), the state’s capacity to be an effective “lender of last resort” ultimately hinges on its capacity to be a “borrower of last resort.”⁴³

Consider next the ex post asset redistribution-oriented interventions. By boosting financial intermediation (hence economic activity) in times of crisis, these interventions might be welfare improving (Brunnermeier and Sannikov, 2012a).⁴⁴ Specifically, countercyclical monetary policy in the midst of a financial crisis (*redistributive monetary policy*) can perform what Brunnermeier and Sannikov call “stealth recapitalization”—i.e., looser monetary policy gives windfall capital gains to financial intermediaries because their assets are usually of longer duration than their liabilities. Thus, such operations effectively redistribute capital from the rest of the economy to financial intermediaries, thereby alleviating the impact of principal-agent frictions and helping sustain financial intermediation in turbulent times (Brunnermeier and Sannikov, 2012b).

Consider finally RALR operations (“qualitative easing” operations in Farmer’s nomenclature; Farmer, 2012). They can take the form of government-led asset purchases or

⁴¹ As an alternative to setting up a LOLR liquidity facility, the government could issue bonds that make payments to the holder under bad states of the world.

⁴² Note that the basic underlying driver of market inefficiency is not a free-riding problem. As shown by Holmstrom and Tirole (1998), market participants can address the free-riding problem by issuing multiple securities that discriminate between investors depending on how much they value liquidity. Moreover, the logic of the GFA domain, which assumes away bargaining frictions, implies that market participants could coordinate to carry larger liquidity buffers if this was socially optimal. However, reflecting the state’s comparative advantage in issuing debt and enforcing taxation, Holmstrom and Tirole show that such an equilibrium would still be dominated by one in which the state would provide aggregate liquidity. Of course, however, this assumes lack of fiscal dominance (i.e., no questioning by markets of the solvency of the state). This in turn implies that the state can only issue debt *within* the limits imposed by public solvency constraints and the political process.

⁴³ Note that in either case, the state complements the endogenously created inside money with exogenously provided outside money, be it in the form of claims on the treasury (as liquid public debt, a form of “quasi-money”) or direct money issuance (e.g., via central bank reserves).

⁴⁴ Brunnermeier and Sannikov (2012a) recognize however that such a redistributive monetary policy might not necessarily lead to Pareto superior outcomes (some agents may be left worse off). Bernanke and Gertler (1987) present an earlier and somewhat more skeptical discussion of the scope for asset transfers when these transfers are between individuals rather than financial institutions and are based on comparative advantages in managing assets. They argue that they are likely to require information on individual abilities that the state generally does not have.

targeted recapitalization programs. By transferring public resources to where they are most needed (financial intermediaries' balance sheets), RALR can help bring financial activity back to life after large shocks have de-capitalized the financial system. Such recapitalizations are unlikely to occur spontaneously in the private sector, reflecting two problems. On the one hand, investors face participation frictions (such that the investment costs incurred by individual investors exceed the returns from isolated investments; Bianchi, 2013). On the other hand, the risk exposure per investor (hence the risk premium) rises as the number of investors declines, a problem that becomes exacerbated during crises, when private risk aversion shoots up. Both factors lead to a public good-type collective action problem: should everybody pitch in and invest, collective returns would exceed collective costs. Thus, the state can improve the equilibrium because of its ability to provide public goods and its comparative advantage in absorbing and spreading risk, both across all agents in a given generation and across generations (Arrow and Lind, 1970).⁴⁵ The state's risk spreading capacity hinges again on its power to tax (both current and future generations) with an enforcement capacity that markets do not have.⁴⁶ Such policies depend on fiscal capacity, however.⁴⁷

If these ex post interventions were strictly targeted to solvent institutions and would not bailout bank shareholders or creditors, they would not distort ex ante risk taking behavior and would validate, rather than undermine, market discipline.⁴⁸ However, the scope for such targeted interventions is limited, as the state may have difficulties in assessing solvency problems and distinguishing them from liquidity problems, particularly in the midst of a crisis, where information asymmetries intensify. A countercyclical monetary policy (based on interest rate adjustments) can be preferable because it may improve targeting—by benefitting the most the intermediaries with the better (quality of) assets, hence the most solvent ones (Farhi and Tirole, 2011b). However, when anticipated, such a supportive ex post monetary policy is equivalent to a put option provided free of charge. Yet, reflecting the ex-ante incentive distortions introduced by the ex-post loosening of monetary policy (it leads to sub-optimal asset allocations), this option has a social cost that is not being paid for by intermediaries. As a result, the latter take more risk and hold less liquidity than would be socially desirable, thereby increasing the likelihood of a crisis and a monetary policy that is ex post optimal (given the crisis) but ex ante undesirable. Thus, the state may be induced to follow time inconsistent policies.

That financial intermediaries benefit from a publicly provided facility (monetary policy) without paying for it amounts to free riding on a public good. In turn, the associated public moral

⁴⁵ Anginer, de la Torre and Ize (2013) expand on Arrow and Lind (1970) by exploring the conditions under which the State can pool atomistic agents that would not otherwise organize themselves to solve monitoring or commitment problems.

⁴⁶ Thus, such RALR operations can be particularly effective in an OLG setting (Farmer, 2012). By contrast, in a world of infinitely lived players, the risk absorbed by the public sector would be borne by existing taxpayers and, hence, would not alter their overall risk burden (Woodford, 2012).

⁴⁷ Economies that are near their fiscal limits can be instead exposed to severely destabilizing (“diabolic”) feedback loops between financial instability and public debt unsustainability (Brunnermeier and Sannikov, 2012; Caballero and Farhi, 2013).

⁴⁸ If rational players do not expect to be bailed out, market discipline will ensure that solvency and liquidity problems are sorted out in pre-crisis times. Anticipated bailouts of insolvent institutions undermine market discipline because depositors or debt holders no longer have incentives to monitor and require adequate skin-in-the-game from intermediaries as a precondition for funding them (in effect, they replace private capital by public capital).

hazard is made possible by participation frictions (which permeate the GFA domain just as much as all other domains in our frictions density map). Just as they inhibit the spontaneous supply of public goods, participation frictions inhibit the ability of taxpayers to participate in a common action to prevent such ex ante inefficient equilibria. As we will see later below, introducing additional frictions (information processing or collective bargaining) will significantly boost the scope for (and impact of) such time inconsistencies.

There can thus be an important policy dilemma at the heart of the GFA domain. A state that could credibly commit not to bail out insolvent institutions or conduct (redistributive) countercyclical monetary policy, no matter how painful the crisis, could go for “free banking” (i.e., prudentially unregulated banking) and limit its policy focus to relaxing through institutional and legal reforms the constraints that hinder market functioning. In particular, to reinforce market discipline, the state can put special emphasis on establishing *systemically efficient bank resolution arrangements*, whereby private capital can be quickly brought into the financial system or reshuffled amongst financial intermediaries and disciplining haircuts applied efficiently and as needed to creditors.

However, because ex post interventions are likely to have first order benefits (they relax binding financial constraints), states may not be able to credibly commit not to intervene in the event of a crisis (Jeanne and Korinek, 2013). If so, states need to introduce a first type of macroprudential policy (*time consistency macroprudential policy*) aimed at offsetting the moral hazard created by (the expectation of) ex post interventions. Indeed, the optimal policy mix requires, in general, some combination of ex post intervention and ex ante macroprudential policy (Bianchi, 2013). The latter should be focused on pricing the financial safety net—including through liquidity requirements that prevent market participants from holding less liquidity than what is socially optimal, as in Farhi and Tirole (2011b)—or on limiting ex ante indebtedness so as to reduce the ex post benefits of bailouts, as in Chari and Kehoe (2013).

d. Information processing frictions: Dynamic alignment macroprudential policy

Bringing in bounded rationality, in the form of information processing frictions, moves us to the GBA domain. As an aggregate shock can, on impact, jolt principal-agent incentives out of alignment, a supervisor that continuously and effectively acts on behalf of the unsophisticated (and of the deposit insurer) has to *dynamically calibrate and recalibrate its policies as required by circumstances*. He should adapt prudential regulation so as to mimic what sophisticated investors and borrowers would require from financial service providers to restore principal-agent incentive alignment and continue transacting following an aggregate shock. The failure by the regulator to conduct such adjustments can give rise to a constrained inefficient equilibrium with *excessive volatility* and inefficient banking crises. The latter occurs because all banks, being subject to similar incentives, follow similar dynamics that, in the absence of a proper regulatory response, lead them to fail at the same time.⁴⁹

⁴⁹ An early discussion of the role of macroeconomic factors in banking crises can be found in Gavin and Hausmann (1996). Focusing on Latin America’s macro-financial volatility, they find that banking crisis are more often than not preceded by credit booms and argue that the excessive lending in good times is a reflection information asymmetry problems, whereby “good times are bad for learning.” Indeed, Calderon and Servén’s (2013) recent empirical analysis of the links between credit booms and crises confirms that the propensity of the latter to follow the former

Consider three illustrative examples. First, the regulator may fail to raise prudential requirements on banks in response to a credit boom fueled by a financial innovation. By widening the upside relative to the downside, such a positive aggregate shock can create conditions where banks may have *too much to gain* in taking risk (too much of an upside relative to the possible downsides).⁵⁰ Second, the regulator may grant regulatory forbearance after an adverse aggregate shock that destroys much of the banks' capital. This may result in banks having *nothing to lose* and, hence, becoming all too willing to gamble for resurrection. Third, an economic downturn can seriously weaken debtors' capacity to pay but the regulator may not permit capital requirements to decline temporarily (hence allowing buffers to have a true buffering function). This may induce a situation where banks have *too much to lose* given the adverse implications of failing to meet their prudential requirements. Thus, a credit crunch can emerge, with banks reducing credit exposure and foreclosing on loans too aggressively. Such a credit crunch may also result in the closure of banks whose locked-in borrowers become inefficiently cut off from credit.⁵¹

In turn, the GBA domain gives public moral hazard (which had already arisen in the GFA domain, contingent on ex post interventions) a further boost. In this domain, inefficient dynamics are allowed to develop because of a lack of market discipline. This occurs despite the presence of sophisticated short-term bank creditors. Instead of monitoring and leaving in droves as soon as the intermediary takes excessive risk following the regulator's failure to adjust regulation optimally over time, the sophisticated are better off staying put and taking one-sided bets. As long as the going remains good, they benefit from the upside. But when the bad times come, they can walk away with their profits by exiting early. In turn, they can do this because the smaller depositors, being covered by the deposit insurance, have no reason to run (Huang and Ratnovski, 2011). Thus, the sophisticated investors get the upside and leave the downside to the deposit insurance (hence the state) in a classic case of privatization of the gains and socialization of the losses. Although they are not directly covered by the deposit insurance, they can appropriate it to their benefit if it is not properly priced. Investors can thus free ride on the liquidity and information provided by markets while eschewing their monitoring duties.⁵² Thus, participation frictions (free riding), intensified agency failures (investors' reliance on "exiting" at the expense of "monitoring"), and public moral hazard (risk shifting to the deposit insurer) can create a particularly explosive mix.

has historically been the highest in Latin America. Allen and Gale (1999) present an early model of moral hazard-induced asset bubbles that derive from aggregate risk in a pure agency world. Borio (2003) provides a first integrated discussion contrasting the micro and macro prudential perspectives to regulation.

⁵⁰ Such excessive risk-taking incentives can be boosted further when the risk measurement underlying prudential norms is procyclical, as was the case with Basel II.

⁵¹ Arguably, banks may fail to lend during downturns also because risks of failure increase and market overreaction penalizes the banks which raise their risk exposure, and not just because they are constrained by regulation (Fernandez de Lis and Garcia Herrero, 2012).

⁵² Note that a remarkable metamorphosis of the nature of inside money takes place as one shifts from the IFA to GFA domains. In the IFA domain, inside money (short-term bank deposits) allowed depositors to pool liquidity in a socially optimal way. Instead, in the GBA domain, inside money (wholesale funding) gives uninsured players the option to shift risk to the deposit insurance and walk away at the expense of the taxpayer.

As financial crises correlate with economic cycles and other key macro variables, prudential regulation—in its role of representing the unsophisticated—needs to be responsive to macro shocks and must try to reduce unnecessary pro-cyclicality. This provides grounds for a second type of macroprudential policy, *dynamic alignment macroprudential*. While it takes into account aggregate shocks and macroeconomic cycles, it is still focused on principal-agent incentives alignment and on the health of individual financial intermediaries.⁵³ A mix of *rules-based, countercyclical (or through-the-cycle) prudential regulation* (e.g., dynamic provisioning)—which deals with predictable dynamics—and macro-focused, state-contingent or even discretionary oversight (*regulatory activism*)—which deals with large, unpredictable shocks—may be called for.⁵⁴ This mix, which would need to be supported by systematic *mark-to-market accounting* and *forward-looking provisioning* (to better enable the monitoring of the agents by their principals), may include cycle-oriented macro-prudential tools such as a *countercyclical capital buffer, contingent capital, mandatory capital insurance, and managerial compensation reforms*. Such a broad regulatory agenda is indeed at the core of Basel III.

The role of preventive prudential regulation in offsetting public moral hazard is arguably a harder nut to crack. It can be in principle addressed through *risk-based capital surcharges, risk-based insurance premia, or mandatory capital insurance*. However, doing this right is not likely to be easy (Kahsyap, Rajan and Stein, 2008). The bar is raised even higher because the regulatory requirements (for example capital requirements) that optimally align the interests of the principals with those of their agents (i.e., that eliminate *private* moral hazard) have no reason to necessarily coincide with those that optimally align the interests of market participants with those of the state (i.e., that eliminate *public* moral hazard).⁵⁵

In addition, in the GBA domain, as prudential policy acquires a macroeconomic dimension that may be partly subject to discretion, it needs to be *coordinated with monetary policy*.⁵⁶ In particular, unless offset by increased prudential requirements, low and stable interest rates can exacerbate agency wedges—a version of the risk-taking channel of monetary policy. In the presence of a maturity gap, for example, the steeper yield curve resulting from a looser monetary policy raises the profitability of financial intermediation, hence tilting the balance of risk-taking toward the upside. As a result, to ensure that financial intermediaries do not take

⁵³ Even though it focuses on principal-agent relations and the soundness of individual financial intermediaries, we define this *dynamic alignment* policy as macroprudential because it takes into account common macro shocks that simultaneously affect the soundness of all individual institutions, hence the soundness of the system as a whole. However, unlike in the GFC domain explored below, there are no fallacies of composition (the soundness of the system is just the sum of the soundness of individual institutions) in the GBA domain. Defining the *dynamic alignment* policy as macroprudential may be at variance with the terminology used by some other authors, who call microprudential any policy that focuses on the soundness of individual institutions, regardless of whether it takes into account aggregate risks (e.g., Claessens, Gosh and Mihet, 2012).

⁵⁴ Repullo and Suarez (2012), for instance, argue that there can be scope for a countercyclical buffer (that can be used up during downturns) as long as banks are sufficiently capitalized through a preservation buffer, which is the basic design followed under Basel III.

⁵⁵ Interestingly enough, we have not found any paper that discusses this issue.

⁵⁶ Linkages between monetary and macro-prudential policies along the business cycle in a world dominated by agency frictions have been the object of an important strand of literature, which includes Borio and Zhu (2008), Dell’Ariccia, Laeven and Marquez (2010), Adrian and Shin (2011), Angelini, Neri and Panetta (2011), Repullo and Suarez (2012), De Nicolo, Gamba and Lucchetta (2012), and Cordella and Pienknagura (2012), among others.

excessive risks, prudential policy must be made cycle dependent, hence become a function of monetary policy. As the latter has its own objectives to fulfill, if macro-prudential policy did not any face any limitation, one would expect macro-prudential policy to be set in light of monetary policy. However, where macro-prudential policy is itself constrained, the linkages between monetary policy and risk-taking (e.g., the risk-taking channel) may call for monetary policy to be also formulated as a function of financial soundness. Hence, a preventive monetary policy that seeks to defuse financial stress early on may also be called for.⁵⁷

5. Externalities: Market-induced systemic instability

This section explores the GFC domain. It expands the discussion of the GFA domain in Section 4 by adding collective bargaining frictions leading to uninternalized externalities (alternatively, it expands the discussion of the IFC domain in Section 3 by adding aggregate volatility). We deal in separate subsections with each of the four externalities identified in Section 3: pecuniary, behavioral, interconnectedness, and informational. In all cases, the externalities transform the agency wedges of the GFA domain (between the interests of the principals and those of the agents) into collective action wedges between the interests of individual agents and those of society. This opens a whole new world in which un-internalized externalities and aggregate volatility can combine to produce systemic instability. Because the state has a comparative advantage over the private sector in resolving collective action failures, a macroprudential approach that aims at aligning the incentives of the individuals with those of society (i.e., at internalizing externalities) is called for. We label this new type of regulation as *collective action macroprudential*. However, because externalities also increase the potential social benefits, hence the likelihood, of post-crises interventions, they also deeply *broaden the ground for public moral hazard*. Thus, collective action macroprudential oversight also needs to focus on correcting the unintended ex ante market distortions brought about by (the expectation of) ex post interventions.

At the same time, the GFC domain brings to life various *fallacies of composition*. One such fallacy is the erroneous reasoning that individually healthy institutions imply a healthy financial system; another that every individual institution can draw at the same time on a collectively supplied source of liquidity; and a third, that every institution can insure itself against aggregate volatility by contracting insurance with other market participants. In all cases, the whole is much more than (or not consistent with) the sum of the components. In effect, the system has properties that the individual parts do not possess. Hence, a regulatory policy that does not recognize externalities and systemic constraints, and that is focused solely on the individual health of financial intermediaries, falls significantly short of the mark. A systemically-oriented prudential oversight becomes essential.

Uninternalized externalities also *erode the efficacy of the regulatory perimeter* (i.e., the sharply drawn boundary beyond which prudential regulation ceases to apply). This is because uninternalized externalities span over the sophisticated financial market players. Market discipline outside the regulatory perimeter can take care of principal-agent failures but not of collective action failures. Thus, rational agents that contract outside the perimeter and do not

⁵⁷ However, if monetary policy is constrained (e.g., by concerns about the exchange rate), macroprudential policy may have to carry more of the burden.

internalize the systemic implications of their actions affect social welfare. As prudential regulation within the perimeter may induce at least a partial internalization of externalities, this can create a large wedge in returns between the regulated and unregulated spheres. In turn, such a wedge can spur the expansion of “shadow banking” and encourage even the unsophisticated investors to abandon in droves the regulated world, thereby undermining consumer protection at its very core (de la Torre and Ize, 2010a).

a. Pecuniary externalities

Pecuniary externalities take the form of *price spillovers*, where players do not internalize the impact that their own trading has on others through market prices. In the presence of perfect competition, pecuniary externalities have no significant welfare impact as long as there are no trading constraints. If a consumer demands more apples, the increase in the price of apples makes other apple consumers worse off but makes the apple producers better off. Buyers and sellers are price-takers and, through unconstrained trading, they all equate their marginal utilities to the price. Hence, the welfare effects on both sides of the market cancel out. With a trading constraint, however, and even if markets remain contestable, this is no longer the case because constrained players may have higher marginal utilities than unconstrained players.⁵⁸ When, in addition, there is an aggregate shock such that many individuals alter their preferences simultaneously, pecuniary externalities can have first-order welfare effects.

In the case of financial transacting, the trading constraints take the form of collateral constraints and credit rationing, reflecting the agency frictions reviewed above.⁵⁹ Take first the case of a pure endowment economy where consumers borrow to smooth out their intertemporal consumption and credit constraints are generated endogenously, as in Jeanne and Korinek (2010) or Bianchi (2011). Borrowing is limited by a collateral constraint and the price of collateral is linked to borrowers’ spending. Thus, credit booms can follow a feedback loop similar to that described in Section 4, where more borrowing leads to more consumption, higher asset prices, and hence a further increase in leverage. Crises can occur when the financial constraint becomes binding across the board, following an aggregate shock that throws the feedback loop into reverse and causes a credit crunch accompanied by deleveraging and asset price deflation spirals.

Under such conditions, borrowers, who face the same aggregate shocks and respond to similar incentives, do not internalize the system-wide implication of their individual actions and thus do not behave prudently enough *ex ante*, borrowing (and consuming) too much during the boom. Since the sophisticated do realize that over-borrowing increases the risk of a crisis, they maintain the precautionary liquidity that matches perceived risks from their own individual perspective. However, they do not internalize the fact that conserving even more liquidity would make everyone better off because it would help relax everybody else’s borrowing constraint during a bust. A wedge between individual and social values of liquidity is thus created. This leads banks to fund themselves too short because they undervalue the impact on systemic risk of

⁵⁸ The non-existence of complete markets has similar welfare implications (constrained pareto inefficiency) as for pecuniary externalities; see Hart (1975), Stiglitz (1982), Greenwald and Stiglitz (1986), and Geanakoplos and Polemarchakis (1986).

⁵⁹ Gromb and Vayanos (2002) present the earliest analysis of pecuniary externalities as applied to finance, but do not endogenize the financial constraints.

such funding (Perotti and Suarez, 2009; Segura and Suarez, 2010). Instead, they free-ride on the liquidity provided by the market (Cao and Illing, 2010; Berentsen, Huber and Marchesiani, 2011). In times of systemic stress, the resulting gap between the aggregate demand and aggregate supply of liquidity exacerbates the vulnerability of financial systems to the firesale-induced liquidity and asset price spirals already documented in the earlier analysis of the GFA domain.

Consider now the case of a production economy where some players are more capable than others at undertaking productive projects and managing assets. In this case, coordination failures have an additional, significant cost because financial constraints force fire sales during the bust. The latter in turn result in assets becoming less productive as they change hands to the less skilled.⁶⁰ Hence, there is not only a problem of inefficient consumption volatility across the cycle but also a fall in aggregate output as assets fall into the wrong (less skilled) hands. Thus welfare-relevant pecuniary externalities can occur not only because of wedges in the marginal utilities of borrowers but also because of wedges between the marginal productivities of assets.⁶¹

The analysis of the welfare implications of pecuniary externalities can be extended yet further, by including financial intermediaries and arbitrageurs. In this case, the liquidation of one arbitrageur's position may affect other arbitrageurs because it lowers the price at which they can liquidate and, more generally, reduce market liquidity for all market participants.⁶²

In all cases, the coexistence of pecuniary externalities, agency frictions, and aggregate volatility gives rise to constrained inefficient equilibria that can be improved upon by a state that mobilizes its comparative advantage in resolving collective action problems in order to induce private players to internalize externalities. This widens considerably the grounds for macro-prudential regulation. In particular, a mix of *Pigouvian taxation* (such as a tax on borrowing) and/or *quantitative regulations*, such as higher capital requirements or systemically oriented liquidity requirements that penalize short-term wholesale funding, are typically called for (Farhi, Golosov and Tsyvinski, 2009; and Perotti and Suarez, 2011). In many cases, however, first best solutions may not be available due to informational or implementation constraints. Moreover, conflicts may arise between micro and macro prudential objectives, a topic to which we will come back in the concluding section of the paper.

Here, a conventional countercyclical monetary policy also can have a preventive role but for a different reason than discussed earlier. A loose monetary policy in the midst of a credit boom not only boosts risk appetite but also exacerbates pecuniary externalities—for it inflates the value of collateral, thereby loosening credit constraints. Inversely, a tight monetary policy during the bust reduces the value of collateral, thereby tightening credit constraints and further encouraging fire sales. This may justify a tighter monetary policy than that warranted to keep

⁶⁰ See Lorenzoni (2008) and Korinek (2011) for specific models along these lines, or Shleifer and Vishny (2011) for a more general discussion of the economics of fire-sales.

⁶¹ Along similar lines, excess borrowing in foreign markets may also occur because borrowers do not internalize the impact on the exchange rate and the subsequent risks of currency crises; see Caballero and Krishnamurthy (2003) and Korinek (2010). At the same time, the socially desirable level of international collateral may be under-produced; see Caballero and Krishnamurthy (2001).

⁶² See Gromb and Vayanos (2010) for a recent survey of the reasons underlying the limits to arbitrage and their welfare implications.

inflationary expectations in check during a credit boom, and a looser monetary policy than that warranted to stimulate real economic activity during the bust (Benigno et al, 2012a). By affecting the maturity composition of financial intermediaries' funding, a heterodox monetary policy (one based on reserve requirements) may also have a role to play. For example, a tightening of reserve requirements, which induces banks to lengthen the maturity of their funding, may help internalize the adverse systemic implications of short-term wholesale funding (Stein, 2012).⁶³

b. Behavioral externalities

Behavioral externalities are associated with *herding dynamics*. They arise when a group of agents obtains a joint pay-off that depends on the actions of everyone else in the group. Behavioral externalities naturally lead to coordination failures—whereby everybody in the group is induced through peer pressure to follow individually harmful behavior yet nobody is better off acting differently unless others also do so—as well as to coordination successes—where players act as a group and everybody in the group wins but at the expense of a broader group (and, ultimately, of society).

Take first the case of coordination failures. A first example is a run where every player withdraws because others do so or are expected to do so. Bank runs are of course the most familiar case of a run (Azariadis, 1981; Cass and Shell, 1983; Diamond and Dybvig, 1983; Allen and Gale, 1994; Rochet and Vives, 2004). But many other forms of runs are analyzed in the literature (see for example Morris and Shin, 2003). There is also the converse case (the Chuck Prince case), where every player stays in the game and feeds the bubble because others do so.⁶⁴ In both cases, market participants would act differently if they could coordinate. However, they fail to do so because bargaining frictions prevent coordination and failing to follow the crowd would lead to worse outcomes from an individual point of view.

Take now the case of coordination successes. A first example involves herding dynamics induced by reputational concerns. An asset manager may take excessive risk when all other asset managers behave similarly. If things turn out well, the manager makes a windfall gain; if he incurs losses but the losses are systemic and affect everybody, he will be evaluated leniently by the market or by his bosses (Rajan, 1994 and 2004). The herding managers can clearly gain as a group, but at the expense of the larger society.

A second (and most worrisome) example is that of public moral hazard. We have previously discussed its agency paradigm incarnations. Thus, in the GFA domain, public moral hazard arose when rational agents anticipated distortionary ex post interventions without paying

⁶³ While the countercyclical use of reserve requirements has mostly vanished from the tool kit of central banks in the developed world, developing countries continue to provide a valuable laboratory to test their effectiveness as a macroprudential tool that can substitute for countercyclical (interest rate-based) monetary policy because the latter is constrained by concerns with the exchange rate; see Federico, Vegh, and Vuletin (2012a and 2012b). See Canuto and Cavallari (2013) for a review of empirical efforts in integrating monetary and macroprudential concerns.

⁶⁴ Charles Prince, head of Citigroup, famously declared that “...as long as the music is playing you’ve got to get up and dance” (Financial Times, 1987). In the Chuck Prince case it would not pay for an individual to leave if others stay, although it would be better for all to coordinate if they could and collectively stop the madness and unwind the frenzy. Remarkably, we are unaware of any formal modeling of the Chuck Prince dynamics.

for their costs. In the IBA domain, public moral hazard arose because the sophisticated took advantage of the deposit insurance offered to the unsophisticated. In the GFC domain, public moral hazard gets a further boost, for at least two reasons. First, the negative externalities associated with bank failures can significantly increase the *social benefits* of bailing out insolvent institutions (more on this below). Second, herding effects can raise the *odds* that the state will conduct such bailouts or be induced to follow a post-crisis accommodative monetary policy. This tightens the link between market actions and policy responses. Thus, herders engaging in risky behavior may expect to be bailed out by the state under a safety net expressly created for the purpose of responding to the materialization of systemic risk. In view of the systemic costs of policy inaction, the state would tend to validate the market's expectations. The key here is that the expected payoff for market participants (the probability of a bailout) increases when they herd. In particular, banks have an incentive to correlate their investment choices (Acharya and Yorulmazer, 2008; Farhi and Tirole, 2011b) and become “too many to fail” (TMTF) and to grow bigger and become “too big to fail” (TBTF).⁶⁵

As with the other types of externalities reviewed in this section, behavioral externalities introduce a wedge between private and social interests that justifies a macroprudential policy aimed at inducing the internalization of externalities. Here, however, the best tools may be those that facilitate crowd control under unruly situations. Thus, rather than pre-set, fine tuning instruments such as Pigouvian taxes, rougher instruments may be required to dampen credit booms fueled by herding dynamics. This may include *discretionary adjustments in macroprudential buffers*, such as capital requirements, or *transactions-oriented norms*, such as reserve requirements on bank credit, caps on debt-to-income ratios (DTI), or caps on loan-to-value ratios (LTV). Ex post, *unlimited deposit insurance*, or some form of massive *lender of last resort support*, may be needed to contain bank runs (Bryant, 1980).

By heightening the tensions between ex ante market discipline and ex post LOLR and RALR support, behavioral externalities clearly broaden the ground for policies aimed at containing public moral hazard. To limit the too-big-to-fail syndrome, regulatory authorities could consider capital surcharges on the *systemically important financial institutions* (SIFIs) or *size limits* on intermediaries. However, how to induce the internalization of externalities that lead to the too-many-to-fail (TMTF) syndrome is a question that remains largely unanswered so far. Ex post, public moral hazard concerns can be attenuated by improved crisis management and resolution schemes that *punish the worst performers* (Farhi and Tirole, 2011b), including via requirements on SIFIs to hold minimum levels of debt that can be subject to some form of haircutting (e.g., “bailin-able debt” or “contingent convertible bonds”), at the option of the supervisor, in the event of failure.

⁶⁵ Remarkably, all of these externalities-driven failures can be linked with some underlying agency friction. For example, Diamond-Dybvig bank runs could be avoided with a market for state-dependent contingent bonds whose returns are linked to the occurrence of individual liquidity shocks. The latter do not exist because of verifiability constraints, which are akin to an informational agency friction. Similarly, in a world devoid of agency frictions, the free riding and opportunism underlying the other collective action failures, including public moral hazard, would not occur because full transparency and full enforceability would allow the state to easily internalize through taxation or insurance premia the social costs of individual actions.

c. Interconnectedness externalities

As noted in Section 3, interconnectedness externalities between financial intermediaries can be channeled through cross balance sheet exposures or common participation in markets or networks.⁶⁶ With aggregate risk, these externalities can now lead to a gradual build-up of systemic risk. During booms, interconnectedness externalities are positive. As asset prices rise, risk appetite and leverage (typically based on non-core funding) increase, cross-hedging rises, intermediation chains lengthen, and funding maturities decline (Adrian and Shin, 2008; Shin, 2010). During busts, interconnectedness externalities turn negative. As asset prices decline, the impact of one intermediary's withdrawal (whether defaulting on commitments coming due, or just failing to rollover existing commitments) is transmitted to others through common exposures, cross-exposures or other network effects.⁶⁷ The associated flights to safety and liquidity are exacerbated by *contagion and domino effects* that can cause financial gridlock and trigger serial institutional failures; at the same time, risk-bearing becomes more concentrated, liquidity sharply contracts, and hedging markets may cease to operate.

As shown by a rich recent strand of literature, the vulnerability of networks to contagion effects depends on their geometry and complexity, as well as on the degree of systemic stress. Interconnectedness can dramatically exacerbate the nonlinearities resulting from the interaction of aggregate shocks with principal-agent frictions. While interconnectedness can dampen the impact of idiosyncratic or small aggregate shocks in normal times, it may amplify the impact of large aggregate shocks in turbulent times (Gai, Haldane and Kapadia, 2011; Acemoglu, Ozdaglar and Tahbaz-Salehi, 2012).

As was the case with the previous types of externalities, interconnectedness externalities justify an expanded policy role for the state, both *ex ante* (to prevent systemic risk buildup) and *ex post* (if and when a crisis erupts). *Ex ante*, the threats of contagion-triggered systemic failures have historically been an important source of concern for supervisors. However, until recently, this concern had only influenced traditional regulation by strengthening the case for larger prudential buffers (capital or liquidity). The global crisis, however, has brought home the realization that interconnectedness might have to be dealt with in more targeted ways than just requiring intermediaries to hold larger buffers.

For starters, there is a need to assess each intermediary's behavior and risk management policies not only in terms of the intermediary's own soundness but also of their impact on the

⁶⁶ Note that interconnectedness externalities can also take the form of price spillovers, for example when financial institutions are jointly affected by common asset price fluctuations because they have similar asset portfolios. Such externalities differ however from pecuniary externalities because they affect *solvency constraints* instead of *borrowing constraints*. Hence, the inefficiency results in this case from the social costs of bankruptcies, rather than from marginal utility (or productivity) wedges, as was the case of pecuniary externalities.

⁶⁷ An early discussion of the externalities and systemic costs associated with bank failures can be found in Santomero and Watson (1977). Contagion through the payment system is discussed in Freixas and Parigi (1998). For contagion through liquidity and the interbank markets, see Allen and Gale (2000). Kodres and Pritsker (2002) discuss international financial contagion. Cifuentes, Ferrucci and Shin (2005) discuss contagion effects through intermediaries' exposure to similar assets. Wagner (2011) analyzes the interconnectedness and contagion effects that result from mutual hedging and diversification. Bechuk and Goldstein (2011) show that self-fulfilling lending freezes by financial intermediaries can occur when the firms they lend to are interconnected.

soundness of the system as a whole. This implies policies that can induce players to internalize the systemic impact of their actions. To this end, it seems crucial to develop *systemically oriented ways of measuring risk*, such as the CoVar proposed by Adrian and Brunnermeier (2011) or the systemic risk measure (expected capital shortfall of intermediaries in a crisis) proposed by Acharya, Engle and Richardson (2012). Such tools could enable the application of *systemic capital surcharges* that are proportional to the institution’s contribution to systemic risk (hence that regulate systemically important financial institutions—SIFIs—more tightly). There is also room to consider liquidity norms that *encourage holding systemically liquid assets* (such as public bonds) or *penalize short-term wholesale funding*. At the same time, the state needs to strengthen the *failure resolution legislation* (through living wills or other means) so as to reduce the cost—hence the systemic impact—of SIFI failures. And for certain classes of market transactions, such as derivatives, *central counterparty clearing* (CCC) arrangements backed by large prudential buffers may also help reduce the vulnerability of traditional over-the-counter markets (Duffie and Zhu, 2011).

In addition, a significant *rewiring* may be needed to reduce the vulnerability of financial networks. This may involve regulatory adjustments or a wholesale architectural redesign. In particular, it may be desirable to have smaller, more diverse, less interconnected institutions (Haldane, 2009). At the extreme, interconnectedness externalities can be seen as a reason for the re-introduction of functional segmentations in the financial services industry, as is the case, for example, of the so-called Volcker Rule, which calls for a strict separation between commercial and investment banking. However, given that financial market participants are likely to rapidly adapt and find ways around barriers, especially in an environment of internationally open financial systems, rewiring might not end up reducing systemic risk as much as expected and may instead sacrifice efficiency more than expected.

d. Informational externalities

Informational externalities typically take the form of *free riding*. They reflect the fact that information is under-produced because it is largely a public good: the value of information production is not properly internalized because it cannot be privately appropriated. At the same time, the information gathered by one agent has clear spillover effects on other agents. Such informational externalities can take place either sequentially or non-sequentially. We have already discussed the latter in Section 3 (in the IFC domain). We will thus concentrate here on the former because they are the ones that are the most directly linked to aggregate volatility and have more direct implications on systemic dynamics.

Rational players learn (through Bayesian updating) from observing others. They do not internalize the fact that their behavior has information externalities (e.g., has a signaling value). Hence, when information gathering is costly, it may be privately optimal for players to stop gathering information early (“too early” from a social viewpoint) and free ride by setting their behavior purely on the basis of what they infer from the behavior of other agents confronted with similar choices. As a result, collective behavior can be characterized by cascades (when the learning process stops altogether, as players ignore their private learning and simply replicate what others are doing) or herds (when players repeat what others do while still taking into account their private learning).

Both cascades and herds can result in socially inefficient and/or fragile equilibria, where a small piece of new information can lead to a radically different equilibrium (Banerjee, 1992; Chari and Kehoe, 2000; Chamley, 2004). For example, risk managers may use the same risk management model simply because it has become the norm in the industry. Since all react similarly to news, unexpected news can all of a sudden lead to system-wide readjustments that unhinge markets. New signals can also lead to inefficient contagion (Gorton, 1988; Kodres and Pristker, 2002; Rochet and Vives, 2004). For example, the failure of one bank can boost expectations of failure for other banks with similar characteristics, even though the latter are perfectly solvent. Thus, one isolated failure (for example Lehman Brothers) can have devastating systemic consequences.

The policy response to such market failures may involve official supervision and monitoring of individual financial intermediaries as well as systemically oriented information, both of which are likely to be under-produced by the private sector (auditors, rating agencies or private analysts). In the case of central banks, well-funded and well-researched *financial stability reports* (a public good) acquire a heightened importance. In the case of rating agencies, altering compensation schemes (i.e., whether bond issuers or investors pay for the ratings) can have important implications for the quality of the ratings (Kashyap and Kovrijnykh, 2013).

6. Animal spirits: Tempering mood swings

We conclude our journey with an exploration of the GBC domain, which lies at the core of our density map and features the interactions between all the frictions and sources of aggregate volatility that we have been examining so far. In this domain, bounded rationality manifests itself in two ways: (i) as a limited ability to process information due to information processing frictions, or (ii) as a deviation from the classical behavioral postulates of traditional economic theory, much along the biases identified by behavioral finance.⁶⁸ While both routes can lead to similarly looking deviations from rational, welfare maximizing paths, there are basic conceptual differences between the two. In the first case, the problem is “processing capacity”. Being unable to process information optimally, the boundedly rational agent takes short-cuts (heuristic approximations) that lead to systematic behavioral biases.⁶⁹ In the second case, the problem is “preference wiring”. A boundedly rational agent may correctly assess the pay-offs and implications of risk-taking behavior but may not value the pay-offs based on conventional expected utility maximization. Thus, he may follow seemingly reckless risk-taking behavior not because he is unable to calculate the odds but simply because he is mesmerized by the gamble. Alternatively, he may become excessively risk averse when his behavior becomes guided solely by the wish to avoid at all costs the worse possible outcome.

⁶⁸ For comprehensive surveys on behavioral finance and sentiment-based asset pricing see Hirshleifer (2001) and Barberis and Thaler (2003). Kahneman (2011) presents an excellent compendium on the state of the art in behavioral economics. Pesendorfer (2013) argues that many (if not all) of the biases documented by behavioral economics can be explained by traditional economics once additional constraints are introduced. Pesendorfer’s view is more congenial to the characterization of bounded rationality as cognition frictions-induced.

⁶⁹ While in the agency paradigm, the emphasis was on *bilateral*, contract-specific information and rationality, the emphasis here is on the limits of *aggregate* information and rationality that can get in the way of players’ ability to ascertain whether asset prices are shaped by fundamentals or following a bubble.

In either case, the population in the GBC domain is composed of a mix of rational players—who shape their asset supply and demand based on a prudent and sound understanding of economic fundamentals—and boundedly rational players—who formulate their demands based on a biased valuation or understanding of reality, which can take the form of momentum trading and irrational “mood swings”.⁷⁰ The boundedly rational players can thus impose *perceptual externalities* that undermine the welfare of the rational players and the soundness of the system.

In principle, information processing errors by the less rational players should promote trading and arbitrage opportunities by the more rational (Milgrom and Stokey, 1982; Geanakoplos, 1992). However, rational arbitrageurs may not be able to arbitrage in practice due to the presence of agency frictions that limit their leveraging capacity (Shleifer and Vishny, 1997), or because they cannot coordinate due to lack of common knowledge (Abreu and Brunnermeier, 2003). Thus, the less rational players (the “noise traders”) may dominate the markets through the momentum they impose on prices and lead to a massive swing in market sentiment. By pushing prices away from fundamentals, noise traders impose a negative perceptual externality (a noise-trader trading risk) on everyone else (De Long, Shleifer, Summers and Woldman, 1990), thereby adversely affecting social welfare. Noise traders can drive the economy into the ditch without anybody being able to do anything about it.

If rational arbitrage cannot dominate market outcomes, then credit or asset price booms tend to fuel irrational exuberance and optimistic collective perceptions of predictability. The associated decline in volatility and deepening of market liquidity can further feed risk appetites and pro-cyclical leveraging. As the boom reaches its peak, any significant dissonance may be enough to initiate an abrupt, 180-degree change in mood where, driven by fear of the unknown, risk aversion swells and panic ensues.⁷¹ The amplitude of mood swings is typically exacerbated by the presence of irreducible (Knightian) uncertainty.⁷² As surprises boost uncertainty, market participants may shift defensively from expected utility maximization to maximum loss minimization, triggering abrupt flights into cash and a collapse of market prices (Caballero and Krishnamurthy, 2008; Caballero and Kurlat, 2009). Alternatively, liquidity and margin/loss spirals can be accentuated when utility maximizing market makers misinterpret mood swings-driven price volatility as fundamentals-driven volatility (Brunnermeier and Pedersen, 2009), or noise as fundamental signals (Mendel and Shleifer, 2012).

⁷⁰ Minsky (1974), Kindleberger (1978), and Shiller (2000) present broad-based perspectives consistent with fairly extreme versions of mood swings (irrational exuberance, manias and panics). De Grauwe (2008) analyzes milder varieties of mood swings and expectational biases within a traditional macro model.

⁷¹ Arguably, the key dissonances in the 2007-2008 sub-prime crisis turned global were the rising wedge between the high ratings of structured obligations and the falling market values of credit default swaps, and the unexpected crash (absence of bailout) of Lehman Brothers.

⁷² Keynes (1936) offered a classic rendition of the mood swings syndrome, emphasizing the interaction between bounded rationality and uncertainty: “the market will be subject to waves of optimistic and pessimistic sentiment, which are unreasoning, yet in a sense legitimate ... [because of uncertainty] ... no solid basis exists for a reasonable calculation” (Keynes, 1936). Multiple self-fulfilling equilibria (of the type modeled in Farmer et al., 2012) provide another foundation (i.e., an alternative to bounded rationality) on which to base Keynesian animal spirits.

In this world, equilibria are again clearly constrained inefficient and the state has a potentially important ex ante role to play, except of course if everybody (including the state) is equally confused (in which case it no longer makes sense to refer to externalities imposed by some on others). However, if the irrationality does not affect everybody equally (e.g., if there is a mix of fully rational and boundedly rational agents), the state (presumably also a rational agent) can also help steer markets in the right direction, away from irrational bubbles. This the state can do not because it is any “smarter” than the rational arbitrageurs but because it can help solve collective frictions which arbitrageurs cannot. Moreover, the state is arguably less exposed to reckless risk-taking frenzies and can thus behave more prudently, in a way that maximizes expected welfare. Crucially, the aim of policy is no longer to correct and align incentives, as in previous sections, but instead to *temper irrational expectations and the associated mood swings*.

The set of tools needed to fulfill this new goal correspond therefore to a new (fourth) type of prudential policy framework, which we will define as *collective cognition macroprudential*. It is likely to involve a “kitchen sink” approach that relies largely on judgment and rough, can-do, second-best instruments. Thus, the state may use *discretionarily adjusted macro-prudential regulation and tools* (e.g., increases in reserve requirements or adjustments to maximum debt-to-income—DTI—or loan-to-value—LTV—ratios) so as to maintain financial activity within a path that is deemed to be reasonably safe and that will not contribute to feed the frenzy. By restraining exuberance, a *countercyclical monetary policy* also has an essential role to play. Finally, controls on financial innovation may also be needed to limit adverse cognitive spillovers.

Ex post (i.e., during crisis episodes), *public guarantees* can also play an important role, this time by helping eliminate irrational worst-case scenarios. As agents switch from maximizing utility to minimizing maximum loss exposure, they behave based on their own worst-case scenario, which is worse than the average, hence collectively irrational. State guarantees can therefore improve the collective choice because the state can act based on the true average (Caballero and Krishnamurthy, 2008).

7. Policy challenges ahead

While much progress has been (or is on the verge of being) achieved in incorporating into prudential oversight the main lessons of the recent global financial crisis, many gaps remain.⁷³ To a good extent, this uneven state of affairs reflects the fact that most progress to date was

⁷³ Ranked by order of where the most progress has been achieved, dynamic alignment macroprudential oversight should probably be listed first. Basel III has made important contributions to making prudential norms less procyclical and introducing more forward-looking regulations, particularly as regard provisioning (where perhaps less has been achieved thus far is as regard cyclically adjusted compensation). As regard collective action oversight, Basel III has made some progress on systemic liquidity requirements, the US authorities on SIFI regulation. However, much remains to be done on issues related to the regulatory perimeter. And as for Pigouvian taxation, it remains for the most part “terra incognita”. As regard collective cognition, significant progress has been made on institutional matters (financial stability councils and the like), which should help set the grounds for a more proactive, judgment-based style of oversight. However, there are as yet no tested macroprudential tools to dampen moods in deep financial systems. Finally, as regard time consistency macroprudential oversight, nothing of substance has yet been achieved. Even on the seemingly most straightforward matter of revisiting deposit insurance, all remains to be done.

achieved where there was the least radical departure from the pre-crisis state of regulation.⁷⁴ The more it incurs into less charted territories—say the internalization of externalities through Pigouvian taxes—the more strenuous further progress is likely to become. And the more likely it is that progress will be conditioned to satisfactorily bridging the gap between theory and practice through better identification of the main frictions and failures at work. In our view, the theoretical literature on financial frictions needs therefore to push the envelope as regard attributing and quantifying the relative contribution to financial volatility of the various frictions (or sources of volatility) embedded in the models.⁷⁵ By providing a broad roadmap of how frictions and sources of volatility combine to produce alternative dynamics and motivate different types of policy interventions, the conceptual framework explored in the previous sections should be of help. Identifying a proper regulatory agenda of reforms faces two major challenges, however. First, there are inherent tensions and conflicts across paradigms that greatly complicate finding an adequate balance. Second, there are many remaining knowledge gaps as regard regulatory needs and impacts. To each of these issues we now turn.

a. The policy roadmap

Table 1 provides a summary view of the *marginal regulatory responses* (both micro and macro) that become justified as frictions and types of volatility accumulate. Table 2 focuses on macroprudential policies and identifies four largely orthogonal dimensions associated with each of the aggregate volatility domains of Figure 1. The first three dimensions have to do with correcting incentive misalignments between agents and principals (dynamic alignment), intermediaries and policy makers (time consistency), or individuals and society (collective action). Instead, the last dimension (collective cognition) has to do with correcting moods (a conflict between more rational and less rational traders) rather than incentives. Each dimension has its own dynamics. In the GFA domain, crises are tail events triggered by large exogenous shocks magnified by imbedded nonlinearities. By contrast, crises result from the gradual buildup of policy-induced incentive misalignments in the GFA domain; un-internalized externalities in the GFC domain; and seemingly self-fulfilling perceptual biases in the GBC domain.

The above variety of policy responses is accompanied by a similar variety of *policy tools and designs*. Options span over a number of dimensions, including scope (specific vs. broad); modality (rules vs. discretion); transmission channels (prices vs. quantitative ceilings); and structure (market-determined vs. restricted). By and large, the more frictions one adds, the more unavoidable it becomes to use second-best, discretionary, specific, can-do instruments. Furthermore, within the collective action dimension, the various types of externalities we have identified have fairly different policy implications. Pecuniary and herding externalities have a

⁷⁴ In addition, in the advanced economies, financial systems are still in the deleveraging process and the unwinding of massive post-crisis interventions (particularly, quantitative easing) is still pending. This reduces the incentives to introduce deeper reforms in macroprudential policies that are, by definition, of a preventive nature.

⁷⁵ The same effort of attribution can of course also be usefully applied to the history of financial crises. For example, the S&L 1982 crisis was a clear case of dynamic alignment policy failure. The bank panics of the 19th century can be similarly attributed to pure agency frictions, albeit the evidence there is somewhat less clear-cut (Calomiris and Gorton, 1991). On the other hand, as argued in de la Torre and Ize (2010a), it is difficult to understand the recent global financial crisis in all its manifestations and complexity without recurring to a mix of all four macroprudential dimensions.

mostly dynamic orientation that naturally calls for policies that affect the path leading to a crisis. Instead, interconnectedness externalities are mostly associated with structural or architectural reforms, while information externalities naturally call for information-based reforms.

Table 1: Marginal Regulatory Responses as Frictions and Volatility Accumulate

		Frictions			
		Agency		Agency + Collective Action	
		<i>Full Rationality</i>	<i>Bounded Rationality</i>	<i>Full Rationality</i>	<i>Bounded Rationality</i>
Aggregate Volatility	<i>No</i>	IFA Market Integrity and Transparency	IBA Consumer Protection Microprudential	IFC Market Correction Microprudential	IBC Basel II Microprudential
	<i>Yes</i>	GFA Time Consistency Macroprudential	GBA Dynamic Alignment Macroprudential	GFC Collective Action Macroprudential	GBC Collective Cognition Macroprudential

Table 2: Macroprudential Policy Map
(Aggregate volatility (G) permeates all cells)

	Agency Frictions (A)	Agency + Collective Action Frictions (C)
Full Rationality (F) Private Sector - Public Sector Wedge <i>Time Consistency Macroprudential</i> Correcting incentive distortions due to expectation of post-crisis interventions	GFA Private Sector - Public Sector Wedge <i>Time Consistency Macroprudential</i> Correcting incentive distortions due to expectation of post-crisis interventions	GFC Individual - Social Wedge <i>Collective Action Macroprudential</i> Internalizing externalities (controlling crowds and crowding risks)
Full + Bounded Rationality (B)	GBA Sophisticated - Unsophisticated Wedge <i>Dynamic Alignment Macroprudential</i> Aligning principal-agent incentives on behalf of the unsophisticated	GBC Collective Perception - Reality Wedge <i>Collective Cognition Macroprudential</i> Tempering mood swings where rational arbitrageurs fail

b. Finding the balance

Finding the balance is complicated by important *trade-offs in policy impacts across paradigms*, particularly between the agency and collective action paradigms. A few examples suffice to drive the point home (Table 3). Take first the case of short-term wholesale funding. Penalizing it is good in the collective paradigm because it helps internalize the negative externalities associated with systemic runs and liquidity risk. However, in the agency paradigm, this can seriously compromise market discipline. Similarly, Pigouvian taxes on credit or countercyclical capital or liquidity requirements may be appropriate in the collective action paradigm because they can help internalize the negative externalities associated with credit booms. However, unless banks are sufficiently capitalized, these macroprudential actions may be harmful in the agency paradigm because they may induce individual banks to take excessive risk (Cordella and Pienknagura, 2012). Or take the case of mark-to-market accounting. It is unequivocally good in the agency paradigm (it helps principals monitor and discipline agents) but may be bad in the collective action paradigm (it can boost fire sales and, thus, boost inefficient amplifications, contagion or mood swings; Plantin, Sapra and Shin, 2008).

Moreover, macroprudential policies aimed at addressing systemic risks in a collective action domain can act as a common factor (or as an aggregate shock) inasmuch as they affect financial intermediaries and financial contracts across the board. Hence, they may require countervailing macroprudential policies under an agency domain, to offset the incentives distortions that the former can produce. For example, a Pigouvian tax or liquidity requirement that penalizes short-term funding under a collective-action rationale of macroprudential policy may undermine market discipline, thereby requiring an offsetting boost in capital requirements under a dynamic-alignment rationale of macroprudential policy.

Policy design is made even more difficult by the fact that the relevance of the various frictions and sources of volatility is likely to vary across time and place (i.e., the impact of frictions on the financial system is *dynamic and state-dependent*). For example, enforcement frictions are likely to acquire more relevance during downturns when collateral values drop and become acutely binding. Similarly, information frictions become more central during periods of rapid informational change (for example periods of rapid financial innovation) or during downturns (when uncertainty peaks). Or collective action frictions are likely to be more relevant when a rapid coordinated response is called for, typically during the build-up to a crisis or right at the onset. Real-life financial systems wander from domain to domain depending on the stage of the credit cycle, the process of financial innovation or any other aggregate shock. Identifying where the financial system finds itself at a given time is, hence, of the essence for macroprudential policy. The identification is all the more difficult considering that similar symptoms (i.e., boom-bust dynamics) may be driven by different combinations of underlying frictions, thus calling for different policy responses.

Setting a proper policy pitch should therefore depend on the frequency with which financial systems are expected to travel into the various domains. The policy framework for a system that is expected to remain most of the time within the IFA domain is unlikely to be the same as that prescribed for a system that is expected to make frequent incursions into the GFC or GBC domains. It will also depend on the type of error (type I or type II) one wishes to minimize.

Policy makers might prefer to minimize type I error—i.e., avoid over-regulating markets or undermining market discipline, even if that implies an occasional systemic crisis—rather than type II error—allowing devastating systemic crises, even if that implies sacrificing financial market discipline and efficiency. Of course, policy makers also need to assess whether it is preferable to intervene ex post rather than ex ante, and what ex post interventions, if unavoidable, imply for ex ante prudential policies.

Table 3: Some Examples of Cross-Paradigm Policy Tensions

Policies	Paradigm		
	Agency	Collective Action (Full Rationality)	Collective Cognition (Bounded Rationality)
<i>Short-run wholesale funding regulation</i>	<i>Undesirable</i> Undermines market discipline	<i>Desirable</i> Internalizes pecuniary externalities	<i>Desirable</i> Dampens mood swings
<i>Systemic liquidity requirements</i>	<i>Undesirable</i> Undermines individual soundness	<i>Desirable</i> Internalizes pecuniary and interconnectedness extern.	<i>Desirable</i> Enhances financial system resiliency
<i>Mark-to-market accounting</i>	<i>Desirable</i> Strengthens market discipline	<i>Undesirable</i> Promotes contagion	<i>Undesirable</i> Amplifies mood swings
<i>Pigouvian taxation</i>	<i>Undesirable</i> Promotes risk taking	<i>Desirable</i> Internalizes pecuniary externalities	<i>Ineffective</i> Not well suited to dampening mood swings
<i>Transactions norms (DTI, LTV ratios)</i>	<i>Undesirable</i> Limits scope for sound finance	<i>Desirable</i> Internalizes behavioral externalities	<i>Desirable</i> Dampens mood swings
<i>SIFI/TBTF regulation</i>	<i>Undesirable</i> Limits scope for sound finance	<i>Desirable</i> Internalizes behavioral and interconnectedness extern.	<i>Ineffective</i> Not well suited to dampening mood swings

Given the above constraints, there are at least four broad macroprudential policy options. The first two options cover the extremes. The first seeks to minimize the type I error mentioned above and focuses on market discipline and efficient ex post intervention. The second is the opposite of the first (i.e., it minimizes type II error). It restricts the scope for financial intermediation through tight ex ante prudential regulation, an emphasis on structural resiliency (size limits, functional segmentation, etc.), a broad regulatory perimeter, and tight controls on financial innovation.

The third and fourth options cover the middle ground. One option is to assemble an “all-terrain” regulatory framework, a hybrid of a little bit of all of the elements drawn from different paradigms. However, this may open a wide room for policy inconsistencies and regulatory arbitrage, and end up being too inflexible to deal with large and relatively rapid changes in systemic risk buildup. The alternative is a state-contingent (bi-modal) regulatory framework that focuses in normal times on market discipline (the agency paradigm) but shifts in exceptional times to a focus on systemic risk buildup (the collective paradigm). This latter option is itself not free of pitfalls, however. For starters, it presupposes that the normal-times oversight is effective enough to detect fault lines in the financial system before it is too late.⁷⁶ In addition, it presupposes that the regulator can be relied upon to switch from normal-times to exceptional-times prudential oversight at the right time (i.e., in a sufficiently forward-looking, preventive-focused fashion). In other words, a well-functioning bimodal regime presupposes an agile, benevolent and independent regulator, which in many cases may not be a realistic assumption.

Indeed, policy makers are themselves hardly immune to policy failures under any of the paradigms. Regulatory authorities are clearly vulnerable to agency frictions, particularly those related to asymmetric information. They can be captured by the regulated and thus fail to adequately represent the unsophisticated. They may also have incentives to pursue their own interests at the expense of the taxpaying public (their ultimate principal). They are also exposed to coordination and other collective action failures, particularly when oversight is shared across multiple agencies. The assumption of rationality of the supervisor also requires some benevolence, as the supervisor too can be swept by mood swings. To top it all off, the more activist policy becomes and the broader the range of policy interventions, the larger will be the scope for policy error and public moral hazard. Thus, a proper balance between *laissez-faire* and policy activism also needs to be found.

c. Filling in the knowledge gaps

Progress towards bridging the gap between theory and practice will require better identifying the main frictions and failures at work, formally incorporating them, assessing their welfare impact, and sorting out constrained efficiencies from constrained inefficiencies. This effort will need to be accompanied by further efforts to estimate and calibrate the net impact of regulations, while at the same time gauging their unintended side effects. In this context, more research will be needed to *map some key cross-domain boundaries*. One such boundary—between the agency frictions-driven dynamics of the GFA domain and the externalities-driven dynamics of the GFC domain—deserves particular attention. The need for prudential regulation is often derived from agency frictions-based models of financial volatility where externalities are present in the background but are not formally incorporated and their impact not quantitatively assessed.⁷⁷ Yet, even when externalities are hard to disentangle, knowing the contours of the

⁷⁶ This is consistent with the findings in Bianchi (2011) that a Pigouvian tax is most effective in an intermediate (“high externality”) region where leverage is neither so low that pecuniary externalities are not relevant (the “low externality” region), nor so high that further borrowing is already heavily constrained and a crisis is *de facto* already under way.

⁷⁷ For example, Brunnermeier and Sannikov (2012a) identify (and stress) the presence of welfare-relevant pecuniary externalities in their model (agents take prices as given). However, they do not formalize these externalities and, hence, do not quantify their effects. It is thus impossible to distinguish between inefficient crisis dynamics driven by uninternalized externalities and efficient crisis dynamics driven strictly by agency frictions. The authors indeed

GFA/GFC boundary (i.e., *where externalities start to be fully internalized*) is essential when setting prudential requirements. In effect, it conditions the Value-at-Risk type tolerance level (i.e., the level of tail risk beyond which *it is no longer socially optimal to protect the system against*).

A broader but equally fruitful area for future research would aim at understanding better how collective and agency frictions interact. Another useful line of research will be to breakdown the frictions and their impact according to the side of the market (demand or supply) and the type of market participant (investors, levered intermediaries, unlevered asset managers, and borrowers).⁷⁸ Yet another key research effort will be to assess whether it is more cost-effective to develop an ex ante prudential regulation that mitigates systemic risk buildup head on, or whether it is better to emphasize ex post policies that limit the severity and duration of financial crises once they occur.⁷⁹ How to contain the public moral hazard implications of ex post interventions should be of course a key component of this research. Finally, mapping more fully the boundaries and interactions (including the complementarity versus substitutability) between monetary policy (MP) and macroprudential policy (MPP) is likely to remain another major item in the research agenda for years to come.

recognize that a full-fledged welfare analysis of financially constrained equilibria is still some way off into the future.

⁷⁸ Adrian, Colla and Shin (2012) provide a thought provoking first step in this direction.

⁷⁹ Rather remarkably, Bianchi (2011) finds that the welfare gain from introducing a Pigouvian tax is rather limited (only 0.1 percent of permanent consumption), reflecting an uneasy trade-off between reducing the probability of an uncertain future bust and imposing a certain immediate cost as regard limiting the amplitude of the current boom. Everything else equal, this would seem to shift the balance in favor of ex post policies. Benigno et al (2012b) reach a rather similar conclusion. These results are clearly preliminary, however. This is an area that needs much more research.

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