Multiple Bank Regulators and Risk Taking

Itai Agur (IMF - Singapore Regional Training Institute)*

May 29, 2012

Abstract

The potential for banks to arbitrage between regulators exists both in the US, which has three federal banking supervisors, and in Europe, where multinational banks can pressure national regulators. How does a multiple regulator environment influence financial stability? This paper models multiple regulators that have an agency bias, and shows that several salient pre-crisis developments interact with banks’ arbitrage opportunities. An equilibrium with strong regulation can break down in the face of financial innovation or rising bank leverage. Regulatory competition is also shown to increase the likelihood of a freeze on banks’ market for wholesale funding.

Keywords: Supervision, Arbitrage, Bank default, Adverse selection, Wholesale funding

JEL Classification: G21, G28

*Email: iagur@imf.org. Phone: +65 6225 5311. Postal address: 10 Shenton Way, MAS Building #14-03, Singapore 079117. This paper has benefited from the author’s discussions with Xavier Freixas, Ernst-Ludwig von Thadden, Thomas Cooley, Viral Acharya, Christian Stoltenberg, Luc Laeven, Moshe Kim, Falko Fecht, Fabio Castiglione, Hans Degryse, Gabriele Galati, Karl Schlag, Burcu Duygan and Martin Peitz, and from the interaction with audiences at the 2009 EABCN conference, Universitat Pompeu Fabre, the University of Mannheim, and at De Nederlandsche Bank. Part of the work for this paper was done when the author was employed by the Research Department of De Nederlandsche Bank (Dutch Central Bank). The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management. The same disclaimer applies with respect to De Nederlandsche Bank.
1 Introduction

"Retaining multiple regulatory agencies preserves the regulatory arbitrage that allows institutions to pick the oversight scheme that benefits them most, often at the expense of consumers and the health of the system overall" Letter by US Senator Schumer to US Treasury Secretary Geithner.¹

The potential for competition between bank regulators to harm regulatory standards is high on the political agenda, in the US as well as in Europe. In the US banks can in effect select their primary regulator by choosing their charter and deciding on Fed membership. The OCC regulates all nationally chartered banks, the Fed state-chartered member banks and the FDIC state-chartered non Fed-members. When President Obama revealed plans for a new system of US financial regulation in 2009, his administration backed away from consolidating all banking regulation in one agency. If, indeed, banks have the ability to play out regulators against each other, what are the implications for financial stability? How does a multiple regulator environment interact with recent developments in the financial sector, such as financial innovation and banks’ increased reliance on wholesale finance?

This paper analyzes these questions by building a model with multiple bank regulators, who compete with each other because, in addition to welfare, they care about the size of their mandate. The founding assumption of our theory is thus that regulators have empire building considerations and want to increase the number of banks that they supervise. The reason for this may be financial, in that regulators’ funding directly depends upon their size. This is the case for the OCC, for instance.² In fact, when Chase Manhattan Bank switched regulators in 1995, the OCC lost fees worth 2% of its budget (Rosen, 2003). However, beyond the funding considerations, regulators may also value a large mandate intrinsically. The literature on regulatory capture by firms has a long history (Stigler, 1971), and "empire building" is one

²"[...] the OCC’s operations are funded primarily by assessments on national banks. National banks pay for their examinations, and they pay for the OCC’s processing of their corporate applications." http://www.occ.treas.gov/about/index-about.html
of the reasons for such capture. Several case studies document the importance of regulatory capture in the financial sector (Kane, 1990, 2001; Woodward, 1998).

Moreover, Rosen (2003) finds that regulatory switches by US banks are an empirically prevalent phenomenon. Over his 1983-1999 sample period 10% of banks switched regulators at least once, and these are often large banks. Switches are not just due to technical issues, like mergers and acquisitions. Nonetheless, Rosen finds that the increases in bank risk following switches are not large. However, even when there are no major differences among regulatory standards within the multiple regulator equilibrium, there can be a gap between standards in a multiple and a single regulator regime. This indeed our theory finds.

Although we discuss our model in terms of the US setting, because of the empirical occurrence of regulatory switches there, we believe that it may also be of relevance to Europe. In the EU national regulators could compete for the presence of multinational banks, either through branches (which are locally supervised) or through the relocation of headquarters. Admittedly, there is no direct evidence that this actually happens. However, there is at least casual evidence that politicians in various European countries wanted to attract or retain international financial institutions by ensuring that domestic regulations were not overly tough. An example can be found in the minutes of a Dutch parliamentary debate (Tweede Kamer, 2007), in which political parties express concern that new proposed regulations might be harsher than in other European countries.

Our model is based on banks that exert effort to monitor borrowers, which reduces their probability of failure. However, because of social externalities to their own bankruptcy, banks may underinvest in monitoring. Regulators can force banks to change behavior, but only if they understand enough about their activities. To gain sufficient insight regulators need to exert supervisory effort. Banks can observe the type of regulator they are dealing with - a tough regulator that invests in supervision, or a lax regulator that does not. And, paying a switching cost, banks can change regulator. We show that two subgame perfect Nash equilibria are possible, namely a good equilibrium in which all regulators exert high effort and a "race to the bottom" in which none do. The latter is a classic Prisoners’ Dilemma, because despite
the fact that regulators are better off in the good equilibrium, it can be unsustainable. When other regulators are tough, a given regulator has the incentive to deviate and increase its size.

We investigate the relation between the regulatory equilibrium, bank behavior and several salient pre-crisis developments in the financial sector. Firstly, in the years leading up to the crisis, the rising complexity of assets made it more difficult for regulators to understand what activities banks engage in, and how risky these are. We model a decline in regulators’ capacity to understand bank activities as a decrease in the probability that supervisory effort leads to sufficient insight. This has a direct effect on risk taking, because banks know they are less likely to be caught. But there is also a feedback through the regulatory equilibrium. The good equilibrium becomes less stable, because the benefit of supervisory effort declines, and deviations to lax standards happen sooner.

Secondly, we show that when banks’ cost of monitoring borrowers goes up, which may have happened through the increasing share of intangible-asset firms in the economy as well as the distance between borrowers and final lenders induced by financial innovation, there is also a direct effect and an indirect effect through the regulatory equilibrium. When monitoring costs rise, banks become more willing to pay the switching cost, raising the pressure on regulators.

Thirdly, extending the model to endogenous bank leverage, we show that the same is true when debt instruments become cheaper, which happened in the runup to the crisis due to both relatively accommodative monetary policy (Taylor, 2009; Adrian and Shin, 2009; Borio and Zhu, 2011) and the increasing availability of wholesale funding (Brunnermeier et al., 2009; Diamond and Rajan, 2009). Cheaper debt raises levering incentives, which, in turn, are complementary with monitoring incentives, because banks experience a smaller cost of default. The more attractive risk taking becomes, the greater the incentive to switch regulator, amplifying the effect on equilibrium bank risk. This result relates to the so-called "risk taking channel of monetary policy" (Borio and Zhu, 2011), implying that the strength of such a channel depends upon the regulatory equilibrium.

We extend the model to analyze the relationship between the regulatory environment and the potential for a freeze in wholesale funding as witnessed briefly in 2007 and subsequently
for a longer time after the collapse of Lehman Brothers in 2008. The wholesale market is modelled similarly to Freixas, Parigi and Rochet (2004), introducing exogenous liquidity shocks. Financiers are unable to disentangle if a bank is illiquid or insolvent. This matters because insolvent banks want to borrow and use the acquired funds to gamble for resurrection, giving rise to adverse selection. Declining regulatory capacity or rising monitoring costs first show up as higher bank risk taking. But beyond a threshold the wholesale market breaks down. We show that this funding gridlock is more likely to come about in a multiple regulator environment. Essentially, there is now a two-sided Prisoners’ Dilemma. Not only regulators can end up in a bad non-cooperative state, but so can banks, because they collectively have an interest to limit risk and keep the wholesale market open, but individually deviate to higher risk. Banks’ and regulators’ Prisoners’ Dilemma’s influence each other, which is why the presence of multiple regulators matters here.

2 Literature

Our theory focusses on the potential negative effects of regulatory competition and is based on the idea that existing multiple regulator regimes evolved for historical, not economic, reasons. In Europe separate nation states are the obvious reason for the emergence of multiple regulators. But also for the US it is often claimed that its system came about through a combination of historical events and is sustained as a political equilibrium (Scott, 1977). The difficulty of altering that equilibrium has been highlighted by the recent episode of regulatory reform. One Financial Times article argues that "the administration has decided not to consolidate more regulators due to the political difficulties involved" (Guha and Braithwaite, 2009). In another US Senator Warner (2009) states that "as past administrations have learnt, the status quo has many stakeholders who will bitterly oppose even the most objectively meritorious change".

This is not to deny that there could also be positive effects associated to regulatory competition, which we do not model. These include the efficiency of regulatory services (Kane,
1984; Dermine, 1991), horizontal differentiation between regulators (Tiebout, 1956) and the prevention of collusion between the regulator and firms (Laffont and Martimort, 1999). However, the theoretical literature on competition in bank regulation (as opposed to general firm regulation) has tended to focus on its negative implications, and our paper is no exception to this.\(^3\)

The existing theoretical literature on multiple bank regulators focusses on cross-border externalities rather than on banks that switch regulators. This line of research analyzes the interplay between multinational banking and national supervision. National regulators of multinational banks do not internalize the effects of their supervision on the welfare of other countries, and therefore supervise too little. In Dell’Ariccia and Marquez (2006) the trade-off is between internalizing the externalities imposed by international banking and losing regulatory flexibility in a union. Hardy and Nieto (2011) extend Dell’Ariccia and Marquez’s framework, portraying how deposit insurance overprovision interacts with banking supervision underprovision under cross-border externalities. In Dalen and Olsen (2003) externalities imply sub-optimal capital requirements, but national regulators’ concern for the cost of deposit insurance induces them to raise loan quality standards in response. And Holthausen and Rønde (2004) use a "cheap talk" game to show that national regulators underprovide information to each other. In Acharya (2003) in addition to capital requirements regulators can also close down troubled banks. Acharya shows that when regulators are heterogeneous in their degree of forbearance, the international harmonization of capital requirements can backfire, as regulators regress towards the worst closure policy.

In the above papers banks’ allocation to regulators is fixed. That is, there is a single regulator per country and banks do not relocate headquarters across borders. This paper instead considers regulators’ competition in attracting banks (either within a country (US) or internationally (EU)), and in that sense it is closer to the literature on governments that compete on taxes to draw in multinational firms.\(^4\) Compared to that literature our paper

\(^3\)See, however, Boyer and Ponce (2011), who apply the argument of Laffont and Martimort (1999) to banking, and show how concentration of regulation can lead to capture by banks, lowering welfare.

\(^4\)See Krautheim and Schmidt-Eisenlohr (2011) for references.
contributes by adding the elements that are specific to a banking dimension, such as risk taking and funding.

3 Model

This section first describes the modelling of banks, then that of regulators and finally the timing of the game between them.

3.1 Banks

There are $M$ identical banks in the economy, each of which funds one project. For simplicity, we consider that banks are all equity financed, an assumption that is relaxed in sections 5 and 6. All projects are identical and yield a return of $R$ to the bank if successful. But the project can also fail, in which case the bank is forced to default. The probability of success of the project is not exogenous to the bank, however. By monitoring the borrower, the bank can reduce the probability of project failure. In particular,

$$ q_i = f(e_i) $$

where $q_i$ is the probability of default of bank $i$’s project and $e_i \in \{0, h\}$ is the bank’s monitoring effort. Here, 0 and $h$ stand for no effort and effort, respectively. And

$$ 1 > f(0) > f(h) > 0 $$

so that the probability of default is smaller when $e_i = h$. Exerting monitoring effort is costly to the bank, however. The bank pays $c_h > 0$ if it chooses $e_i = h$. We assume that this effort cost is non-pecuniary: it is the disutility of effort personally experienced by bank management. This matters in that we will not consider it as part of social welfare.

In the event of default the bank experiences a cost of $\gamma^b > 0$. Instead, society experiences
a cost of $\gamma^w > \gamma^h$. This is what provides the rationale for regulation in the model. Banks have too little incentive to exert monitoring effort because they do not fully internalize the costs of their potential default. Without loss of generality we normalize $\gamma^w = 1$ so that $\gamma^b \in (0, 1)$. We interpret the difference between the social and private cost of bank default ($\gamma^w - \gamma^b$) as arising from lost intangibles, such as the bank-borrower relationship. For instance, an entrepreneur needs to spend time and effort to find a new bank, and build up a relationship with it. The usual justification of social externalities from deposit insurance does not come about in the basic version of the model, since the banks are equity financed.

In the absence of regulation bank management would maximize

$$\max_{e_i \in \{0,h\}} \left\{ (1 - q_i) R - q_i \gamma^b - c_{e_i} \right\}$$

where $(1 - q_i) R$ represents revenues in the event no default, while $q_i \gamma^b$ are the costs when default occurs.

We impose the parameter restrictions

$$(1 - f(0)) R > (1 - f(h)) R - c_h$$

and

$$(1 - f(0)) R - f(0) < (1 - f(h)) R - f(h) - c_h$$

which mean that when the bank experiences no costs of default ($\gamma^b \to 0$) it would prefer not to monitor, whereas when the bank fully internalizes all the costs associated to its default ($\gamma^b \to 1$) it would choose to monitor even in the absence of regulation. Thus, there exists a $\tilde{\gamma}^b \in (0, 1)$ for which the bank is precisely indifferent between monitoring and not monitoring its borrower.
3.2 Regulators

There are $N$ identical regulators whose task is to make banks exert high monitoring effort. This will limit the probability of bank default, and associated social costs $\gamma^w$. However, a regulator cannot perfectly observe a bank’s activities. We assume that banks’ projects are complex assets. To understand what a bank is doing a regulator has to actively supervise it, paying visits, thoroughly interviewing staff members, and so forth. The supervisory effort of regulator $k$ is called $\theta_k \in \{0, h\}$. The cost of this effort is $\lambda_{\theta_k} \in \{0, \lambda_h\}$ per supervised bank. A regulator can impose high monitoring effort, $e_i = h$, upon a supervised bank. However, we assume that a regulator can only do this if it obtains sufficient insight into a bank’s activities. This is a reduced form for the idea that a regulator needs to know in what respects the bank is engaging in overly risky behavior, in order to be able to tell the bank what it must change. The probability that a regulator reaches a sufficient level of insight, $\pi(\theta_k)$, depends upon the supervisory effort, with $\pi(h) > \pi(0) = 0$. The regulator sets one supervisory effort level for all the (identical) banks under its supervision.

Similar to the bank’s effort, we assume that $\lambda_{\theta}$ is a personal, non-pecuniary cost that is experienced by the bank regulator’s management, representing its disutility of effort. It does not enter social welfare, therefore, which is given by

$$w = \sum_i \left[ R (1 - q_i) - q_i \gamma^w \right]$$

which represents banks’ social value added, which differs from equation (3) because, firstly, it includes the social cost of default, $\gamma^w$, rather than banks’ private cost of default, $\gamma^b$, and secondly it does not count the bank manager’s personal, non-pecuniary effort cost $c_{e_i}$ (nor the supervisory effort cost $\lambda_{\theta}$). By $\gamma^w = 1$ and the fact that there are $M$ banks, we can rewrite the above equation to:

$$w = (M) (R) - \sum_i (R + 1) q_i$$

The social optimum of the model is straightforward: since society experiences no costs to
supervisional effort, high supervisional effort is best, because that increases the probability \( \pi(\theta_k) \) that the regulator reaches sufficient insight to force the banks to high monitoring effort. This, in turn, minimizes the probability of bank default \( (q_i = f(e_i)) \), thereby maximizing \( w \) in equation (7).

We assume that

\[
(M)(R) - \sum_i (R+1) q_i \bigg|_{\theta_k = h} - \lambda_h > (M)(R) - \sum_i (R+1) q_i \bigg|_{\theta_k = 0} - 0
\]

which means that if regulators consider only welfare and their effort cost, they would implement the social optimum, and which can be written to

\[
\Leftrightarrow (M)(R) - (M)(R+1)[\pi(h)f(h) + (1-\pi(h))f(0)] - \lambda_h > (M)(R) - (M)(R+1)[f(0) + (1)f(0)]
\]

which becomes

\[
\Leftrightarrow f(0) - f(h) > \frac{\lambda_h}{\pi(h)(R+1)}
\]

This condition can be read as saying that the difference between the probability of default when the bank does not monitor and the probability of default when the bank does exert monitoring effort is sufficiently large. When this is so then a regulator that is concerned with welfare will find it worthwhile to choose high supervisinal effort.

3.3 Agency bias

In addition to welfare, however, regulators have agency considerations. Each regulator wants to maximize the size of its mandate, which we take to be the number of banks under its supervision. In particular, the objective function of a regulator is

\[
\alpha w + (1-\alpha)m_k - \lambda_\theta
\]
where $m_k$ is the number of banks that regulator $k$ supervises, and $(1 - \alpha)$ is the weight that it places on the size of its mandate. Instead, $\alpha \in (0, 1)$ is the weight that a regulator places on welfare. The regulator maximizes his objective to his effort level, $\theta_k$:

$$\max_{\theta_k \in \{0, h\}} \left\{ \alpha \left( (M) (R) - \sum_i (R + 1) q_i \right) + (1 - \alpha) m_k - \lambda_{\theta_k} \right\}$$

(11)

where $\sum_i q_i$, $\lambda_{\theta_k}$ and $m_k$ can all be endogenously affected by $\theta_k$.

For $\alpha = 1$ (the regulator has no agency bias), the regulator’s problem returns to equation (8), so that regulators will always choose high supervisory effort. But because of their empire building considerations, regulators will not always exert supervisory effort when it is socially optimal to do so.

### 3.4 Switching

The last important element of the setup is regulatory switching by banks. We assume that initially banks are randomly assigned to regulators. At a subsequent stage (the precise timing is discussed below) banks are allowed to switch regulator. It is banks’ potential to threaten switching in conjunction with regulators caring about how many banks they supervise, which generates regulatory competition in the model. However banks face costs, $s$, if they decide to switch between regulators. This captures the idea that banks are currently at various regulators and will only switch if the potential benefits outweigh the administrative costs of organizing the switch (or, in the European case, relocating headquarters to another country).
3.5 The game

The timing of the game between regulators and banks is as follows:

<table>
<thead>
<tr>
<th>Table 1: Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Banks randomly assigned to regulators ($k_{i0}$)</td>
</tr>
<tr>
<td>2. Regulators set supervisory effort ($\theta_k$)</td>
</tr>
<tr>
<td>3. Banks choose:</td>
</tr>
<tr>
<td>- Regulatory switch (cost $s$)</td>
</tr>
<tr>
<td>- Monitoring effort ($e_i$)</td>
</tr>
<tr>
<td>4. Regulators learning realized ($\pi(\theta_k)$)</td>
</tr>
<tr>
<td>5. Regulators may force banks (to $e_i = h$)</td>
</tr>
<tr>
<td>6. Banks pay out or default ($q_i$)</td>
</tr>
</tbody>
</table>

Here $k_{i0}$ is the name for the regulator to which bank $i$ is assigned at the first stage. Stages 2 and 3 are the decision stages. At stage 2 regulators set their supervisory effort, taking into account how this will impact upon bank behavior (both monitoring and switching) in stage 3. We assume that banks know whether a regulator is lax ($\theta = 0$) or tough ($\theta = h$). Thus, after regulators decide on what type they want to be, banks can observe this. Banks’ stage 3 maximization problem can be written as:

$$
\max_{e_i \in \{0,h\}, k_i \in k} \left\{ As + (1 - I)(1 - \pi(\theta_{k_i})) \left[ ([1 - f(h)] R - f(0) \gamma^b) \right] \right. \\
\left. + ((1 - I) \pi(\theta_{k_i}) + I) \left[ ([1 - f(h)] R - f(h) \gamma^b - c_h) \right] \right\} 
$$

(12)

where $A$ and $I$ are indicator variables: $A = -1 \iff k_i \neq k_{i0}$ and $A = 0 \iff k_i = k_{i0}$; and $I = 1 \iff e_i = h$ and $I = 0 \iff e_i = 0$. Here $k_i$ is the regulator that bank $i$ chooses at stage 3, and $k_i \neq k_{i0}$ indicates a switch: the chosen regulator is unequal to the initial one. We assume that if a bank does decide to switch, but is indifferent between a group of regulators (all those who set $\theta_k = 0$) then it will randomly select one regulator out of that group.

Finally, stages 4, 5 and 6 are the event stages. Stage 4 determines whether a regulator gains insight into bank activities (with probability $\pi(\theta_k)$); in stage 5 those banks that regulators
gained sufficient knowledge about may be forced to adjust their activities (if \( e_i = 0 \)); and in stage 6 banks either pay out to their shareholders (with probability \( 1 - q_i \)) or default (with probability \( q_i \)).

4 Results

**Lemma 1** There exist two possible subgame perfect Nash Equilibria:

1. The good equilibrium: \( \theta_k = h \forall k \)
2. The "race to the bottom": \( \theta_k = 0 \forall k \)

No other subgame perfect Nash Equilibria exist.

**Proof.** In the appendix. ■

The game described above can give rise to two types of equilibria. There can be a "good equilibrium" in which all regulators exert supervisional effort. But there can also be what we term a "race to the bottom" equilibrium, wherein all regulators refrain from supervising banks. Consider that banks have enough incentives to switch. Given that all other regulators exert supervisional effort, then a given regulator has to choose between keeping welfare high by also exerting high effort, or defecting from the equilibrium and gaining supervision over the entire banking sector. If it selects the latter then all other regulators remain without banks to supervise. This means that they cannot affect welfare, but they do lose out on their agency considerations. Therefore, they follow the defector and will all cease to invest in supervision.

Overall, regulators are all worse off in the "race to the bottom" equilibrium than in the "good equilibrium". All retain the same share of banking supervision they had initially, but welfare is lower. This is the classic Prisoners’ Dilemma (though in a multi-stage setting): coordination between the regulators would prevent the bad outcome. But in the uncooperative world the bad Nash equilibrium is possible. What, contrary to the Prisoners’ Dilemma, prevents this from being the only Nash equilibrium, is firstly the fact that regulators do also
place a weight on welfare (which the prisoners do not), and secondly that banks have switching costs implying that they are not always willing to switch.

Which of the two equilibria emerges depends upon parameter values. Below we investigate comparative statics, relating changes in several parameters to pre-crisis developments. What we are particularly interested in is how these comparative statics affect the "likelihood" that banks take on high risk. By high risk we mean that they choose not to monitor borrowers, which raises their probability of default. And by the "likelihood" of this occurrence we mean that banks' incentive to choose $e_i = 0$ has increased. To make this more precise we can think of regulators' welfare weight, $\alpha \in [0, 1]$, and banks' moral hazard, $\gamma^b \in [0, 1]$, being random variables drawn before the game begins. We then say that the likelihood of high bank risk has increased when there exist more pairs of $(\alpha, \gamma^b)$ for which $e_i^* = 0$. That is, the ex-ante probability that a pair $(\alpha, \gamma^b)$ will be drawn that leads to the outcome $e_i^* = 0$ is larger.

### 4.1 Regulatory capacity

In the years before the financial crisis, various forms of financial innovation and the prevalence of off-balance sheet items made the task of monitoring bank activities increasingly complex for regulators. In terms of our model this means that $\pi(h)$ declines. It is less likely that regulators gain insight into the asset side activities of banks.

**Proposition 1** A decline in regulatory capacity, $\pi(h)$, increases the likelihood of high bank risk. This happens through two channels:

1. The direct effect: less effective regulation
2. The indirect effect: "race to the bottom" more likely

**Proof.** In the appendix. ■

Proposition 1 shows that a decline in regulatory monitoring capacity raises the likelihood that banks choose not to monitor borrowers and therefore take on high default risk. This happens through two channels: a direct effect and an indirect effect through the regulatory
equilibrium. The direct effect is that when banks are less likely to be caught by the regulator, they have stronger incentives to refrain from monitoring. The indirect effect is that, as supervision becomes less effective, the good regulatory equilibrium becomes less stable. When the benefit of investing in supervision is smaller, a regulator’s trade-off leans more towards defecting from the good equilibrium. The "race to the bottom" becomes a more likely outcome.

4.2 Monitoring costs

Over the past decades monitoring entrepreneurs has become an increasingly complicated task. A larger share of economic activity takes place in sectors that contain much human capital and intangible assets, rather than traditional tangible production like manufacturing or agriculture. Moreover, some financial sector developments, such as securitization, may have raised the distance between the final holder of the loan and its borrower.

Proposition 2 A rise in monitoring costs, $c_h$, increases the likelihood of high bank risk. This happens through two channels:

1. The direct effect: less incentive to monitor
2. The indirect effect: "race to the bottom" more likely

Proof. In the appendix.

Proposition 2 shows that when the cost of monitoring borrowers rises, two things happen. Firstly, banks are likely to substitute away from costly monitoring, and, therefore, take on more risk. Secondly, they become more willing to incur the switching cost and move to a lax regulator. This is so because with higher risk taking incentives it becomes more worthwhile to "invest" in a regulatory switch. This, in turn, means that regulators are more likely to face pressure to soften regulation and the good equilibrium becomes more difficult to sustain. Thus, regulatory competition amplifies the effect of costlier borrower monitoring on bank risk.
5 Wholesale market freeze

We now consider a wholesale bank funding market that is subject to potential freezes. This is modelled similarly to Freixas, Parigi and Rochet (2004). In addition to the endogenous probability of insolvency, banks are also subject to liquidity shocks. However, wholesale financiers are unable to disentangle the type of shock that a bank is subject to. This matters because insolvent banks have an incentive to borrow and use the acquired funds to gamble for resurrection, giving rise to adverse selection. When adverse selection becomes too severe, the market ceases to function. The importance of such mechanisms in the recent crisis is discussed by Morris and Shin (2012), Brunnermeier (2009) and Heider, Hoerova and Holthausen (2009).

We can use our framework to highlight the interaction between the likelihood of a wholesale freeze and the regulatory environment. We model the timing as follows:

<table>
<thead>
<tr>
<th>Table 2: Timing with interbank market</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Banks randomly assigned to regulators ($k_{i0}$)</td>
</tr>
<tr>
<td>2. Regulators set supervisory effort ($\theta_k$)</td>
</tr>
<tr>
<td>3. Banks choose:</td>
</tr>
<tr>
<td>- Regulatory switch (cost $s$)</td>
</tr>
<tr>
<td>- Monitoring effort ($e_i$)</td>
</tr>
<tr>
<td>4. Regulators learning realized ($\pi(\theta_k)$)</td>
</tr>
<tr>
<td>5. Regulators may force banks (to $e_i = h$)</td>
</tr>
<tr>
<td>6. Banks hit by solvency shock (probability $q_i$)</td>
</tr>
<tr>
<td>7. Banks hit by liquidity shock (probability $\omega$)</td>
</tr>
<tr>
<td>8. Wholesale borrowing and lending</td>
</tr>
</tbody>
</table>

Up to stage 6 the timing is the same as in the basic game (table 1). At stage 7 banks have a probability $\omega$ of being hit by a liquidity shock. If the bank was already insolvent in stage 6, this makes no difference to it. But a solvent bank would default as a consequence of a liquidity shock, unless it can access additional funding on the wholesale market. We abstract from the possibility to give the project loan as collateral, and focus on unsecured lending (as in Freixas, Parigi and Rochet, 2004). This is stage 8. The wholesale market is serviced by rational,
risk-neutral creditors and is perfectly competitive, but imperfectly informed (creditors cannot observe whether banks are insolvent or illiquid). Moreover, there are no explicit or implicit government guarantees. Banks that became insolvent at stage 6 participate on the market and use any acquired funds to gamble for resurrection. That gamble succeeds with probability $g \in (0, 1)$. The interest rate that creditors demand, $r^d_i$, has to satisfy

$$
\frac{r^d_i}{(1 - q_i) (1 - \omega)} + \frac{g q_i}{(1 - q_i) (1 - \omega) + q_i} = r^f
$$

where $r^f$ is the risk-free rate (consistently with $R$ all rates are in gross returns, i.e. 5% risk-free rate means $r^f = 1.05$). This can be rewritten to

$$
r^d_i = r^f \frac{(1 - q_i) (1 - \omega) + q_i}{(1 - q_i) (1 - \omega) + g q_i} \tag{13}
$$

where for $g \to 1$ the adverse selection problem vanishes. For any $g < 1$ it is the case that $r^d_i$ is increasing in credit risk, $q_i$. Beyond a threshold adverse selection problems become so severe that the wholesale market breaks down.

Our game is now subject to a two sided coordination failure. Banks, like regulators, may be stuck in a Prisoners’ Dilemma. If they could coordinate, they might all choose high monitoring effort in order to make the wholesale market function smoothly. But individually each bank would have the incentive to deviate from such an equilibrium, since by its own it makes little difference to the overall functioning of the wholesale market.

**Proposition 3** *The likelihood that the wholesale market freezes (weakly) increases when:*

1. Regulatory capacity declines ($\pi (h)$), or monitoring costs increase ($c_h$)
2. There are more regulators ($N$)

**Proof.** In the appendix. ■

Proposition 3 derives comparative statics on the likelihood (in terms of $(\alpha, \gamma^b)$ pairs) of a wholesale market freeze. Declining regulatory capacity and rising borrower monitoring
costs can cause a wholesale market freeze. But the likelihood of observing such a freeze is larger in a multiple regulator environment. The reason is that if a "race to the bottom" occurs, adverse selection problems are worsened. As the share of lemons on the wholesale market rises, the feasibility of liquidity provision by rational outside investors declines. Even when strong regulation cannot prevent banks from taking high risk, the regulatory regime still matters, because at least some banks will be caught and forced to change profile under stringent regulation, reducing adverse selection problems.

6 Leverage

One of the alleged driving factors behind the pre-crisis risk buildup by banks was their access to cheap debt, due to accommodative monetary policy and expanded access to wholesale funding markets. This section investigates the effect of the availability of cheap debt, extending the model to an endogenous levering decision by banks, and performing comparative statics on the risk-free rate. In this manner we analyze the interaction between the availability of cheap debt and regulatory competition.

Introducing an endogenous liability side decision by banks, we adjust the bank maximization problem such that in the absence of regulation bank management would maximize

\[
\max_{e_i \in \{0,h\}, d_i \in \{d^l,d^h\}} \left\{ (1 - q_i) \left( R - r^f d_i \right) - q_i \gamma^b (d_i) - c_{e_i} \right\}
\]

Here banks can either choose low leverage or high leverage: \( d_i \in \{d^l,d^h\} \). Debt is held by retail depositors whose funds are fully guaranteed by a deposit insurance (or an explicit bailout scheme), which is funded on an ex-post basis using taxpayer money. This is unlike the pricing of bank debt by rational, unsecured financiers, such as the wholesale investors in the previous section. We stem off the relationship between bank risk and the price of its funding in this manner, because it allows us to introduce the endogeneity of leverage in a tractable way. The guaranteed deposits receive the risk-free rate, \( r^f \). The alternative to deposit finance is to use
internal funds (internal equity). However, the advantage to the bank of higher leverage is that default becomes less costly (as costs are borne by outsiders, namely the taxpayers funding the deposit insurance scheme):

$$\gamma^b(d^b) < \gamma^b(d^f)$$  \hspace{1cm} (15)

Welfare is now given by

$$w = \sum_i [R(1-q_i) - q_i \gamma^w(d_i) - q_i r_f d_i]$$

$$= (M)(R) - \sum_i q_i (R + \gamma^w(d_i) + r_f d_i)$$  \hspace{1cm} (16)

where the last term, \(-q_i r_f d_i\), appears because in the event of default taxpayers incur the losses through the ex-post funded deposit insurance.

The timing of the game becomes

<table>
<thead>
<tr>
<th>Table 3: Timing with leverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Banks randomly assigned to regulators ((k_{i0}))</td>
</tr>
<tr>
<td>2. Regulators set supervisional effort ((\theta_k))</td>
</tr>
<tr>
<td>- Regulatory switch (cost (s))</td>
</tr>
<tr>
<td>3. Banks choose: - Monitoring effort ((e_i))</td>
</tr>
<tr>
<td>- Leverage ratio ((d_i))</td>
</tr>
<tr>
<td>4. Regulators learning realized ((\pi(\theta_k)))</td>
</tr>
<tr>
<td>5. Regulators may force banks (to (e_i = h))</td>
</tr>
<tr>
<td>6. Banks pay out or default ((q_i))</td>
</tr>
</tbody>
</table>

Regulators’ stage 2 optimization is unchanged compared to (11). However, the stage 3 opti-

---

5Essentially, we assume that banks can either fund themselves with much retained earnings and little debt, or they can pay out some retained earnings as dividends, and issue more debt instead. New external equity is assumed to be too costly. This type of reduced form abstraction from Modigliani-Miller is encountered elsewhere in the literature (Thakor, 1996) and is implicitly based on arguments as those of Myers and Majluf (1984) on the negative signalling properties of external equity issuance.
mization problem of the bank becomes

$$\max_{e_i \in \{0,h\}, d_i \in \{d^l,d^h\}, k_i \in k} \left\{ \begin{align*} & A_s + (1 - I) \left( 1 - \pi (\theta_{k_i}) \right) \left[ \left( 1 - f(0) \right) (R - r^f d_i) - f(0) \gamma^b(d_i) \right] \\ & + ((1 - I) \pi (\theta_{k_i}) + I) \left[ \left( 1 - f(h) \right) (R - r^f d_i) - f(h) \gamma^b(d_i) \right] - c_h \end{align*} \right\}$$

(17)

instead of (12).

**Proposition 4** A reduction in the risk-free rate, $r^f$, increases the likelihood of high bank risk. This happens through two channels:

1. The direct effect: more incentive to lever
2. The indirect effect: "race to the bottom" more likely

**Proof.** In the appendix.

Proposition 4 identifies the channels through which the availability of cheaper debt (a reduction in $r^f$) affects bank risk. As before, there is a direct effect on banks’ incentives and an indirect effect on the regulatory equilibrium. The direct effect runs through the complementarity between leverage and asset risk. As debt becomes cheaper, banks have the incentive to take on more of it. However, with greater leverage banks experience a smaller cost of default, and are more likely to refrain from monitoring borrowers. That is, when debt becomes cheaper, the combined profile of high leverage and high asset risk becomes more attractive.

But that is not all that happens. The third decision of the bank is also affected: whether to switch regulators. The more attractive the risky profile becomes, the greater the willingness of banks to incur the switching costs if they can find a laxer regulator. This raises pressure on regulators. Retaining the good equilibrium is harder, and it is more likely to break down and give way to the "race to the bottom". Thus, regulatory competition amplifies the effects that cheap debt has on bank risk.

Recently, there has been much interest in the so-called "risk taking channel of monetary policy" (Borio and Zhu, 2011), whereby rate cuts translate into higher bank risk taking.
Empirical papers have given credence to this hypothesis, especially if low rates are maintained for extended periods of time (Altunbas, Gambacorta and Marquez-Ibanez, 2010; Delis, Hasan and Mylonidis, 2011; Maddaloni and Peydro, 2011). And theoretical work has described several channels through which this transmission can come about (Agur and Demertzis, 2011; Valencia, 2011; Dell’Ariccia, Laeven and Marquez, 2010).6

The result of this section adds one aspect to this debate, namely that the strength of the risk-taking transmission channel depends upon the regulatory environment. When the regulatory structure is such that competition between bank supervisors can be induced, then an increase banks’ incentives to take risk can translate into greater pressure on the quality of regulation. Again, regulatory competition proves to be an amplification mechanism, in this case of the impact that monetary policy has on financial stability.

7 Policy implications

Regulatory reform is a costly affair. It requires a great deal of time and effort from politicians and civil servants to draw up proposals and get them approved by parliaments. And, even after a reform act has been approved, working out its exact implementation can take years, and divert the attention of regulators away from monitoring banks to internal restructuring. Thus, regulatory consolidation in the US, or the formation of EU level banking supervision are something to be embarked upon only if the benefits are clear and sizeable.

The crucial question is therefore how important the prevention of banks’ arbitrage opportunities among regulators is. This paper highlights that the answer to this cannot be seen separately from the success of regulatory reform in a broader sense. To the extent that new prudential regulations - such as those in the new Basel III accord - manage to prevent a future leverage cycle or the creation of new complex assets, having multiple regulators may matter little. Instead, if these measures fail, then regulatory competition can exacerbate the cycle of

---

6The empirical references are papers in which the length of the rate cut is shown to affect risk taking. There are six more papers showing that bank risk taking is influenced contemporaneously by the interest rate. See Agur and Demertzis (2011) for references, as well as for a review of the theoretical literature on this topic.
risk creation. Similarly, to the extent that short-term wholesale finance takes off once more, or asymmetric information problems are a permanent feature of the bank funding market, the potential for regulatory competition to be harmful rises. The need for regulatory consolidation thus depends on the success of the new prudential framework as a whole.

Appendix: Proofs

Proof of Lemma 1. We first prove that both of these equilibria are possible, and then that no other equilibrium is possible. Consider first $\alpha \rightarrow 1$ in (11): regulators place full weight on welfare. Of banks’ stage 3 decision in (12) regulators then only care about $e_i$, and not about $k_i$. Then, by (9) it follows that (11) is maximized by $\theta_k = h$. Hence, $\alpha \rightarrow 1 \Rightarrow \theta_k = h \forall k$.

Next consider $\alpha \rightarrow 0$ and $\gamma^b < \hat{\gamma}^b$: regulators care only about their agency consideration, while banks prefer $e_i = 0$. Since $m_k$ is maximized by attracting banks, and regulators care only about $m_k$ it follows that $\theta_k = 0 \forall k$.

Therefore, there exist parameterizations such that $\theta_k = h \forall k$ and others such that $\theta_k = 0 \forall k$. But only these two equilibria exist. All other equilibria would involve some regulators setting $\theta_k = h$ and others $\theta_k = 0$. To see that this cannot be a Nash Equilibrium, consider that for some regulators to set $\theta_k = 0$ it must be true that some banks are willing to switch. If this were not the case they would gain nothing on $m_k$ by setting $\theta_k = 0$, but they would lose out on $-\sum_i (R + 1)q_i$ in (11). However, given that some banks are willing to switch, it means that all banks are willing to switch, since banks are identical. When all banks are willing to switch, they will all switch to the $\theta_k = 0$ regulators. Since then the $\theta_k = h$ remain without supervised banks, they gain nothing on $\sum_i q_i$, but they could do better on $m_k$ by setting $\theta_k = 0$. Therefore, some regulators setting $\theta_k = h$ and others $\theta_k = 0$ cannot be an equilibrium. 

Proof of Proposition 1. Whenever banks choose $e_i = 0$ the probability that regulators
can make them adjust this to $e_i = h$ declines for a lower $\pi(h)$. Therefore, the likelihood of high bank risk increases. This is the direct effect. Given the direct effect it is true that $\sum_i q_i$ decreases less when $\theta_k$ is raised from 0 to $h$. In (11) this means that the value of high supervisory effort falls, while that of low effort is constant. Hence, there exist more values of $\alpha \in [0, 1]$ for which $\theta_k = 0\forall k$: the likelihood of a "race to the bottom" rises. This is the indirect effect. ■

**Proof of Proposition 2.** In (12) the value of choosing $e_i = h$ is

$$([1 - f(h)] R - f(h) \gamma^h) - c_h$$

which declines in $c_h$ whereas the value of choosing $e_i = 0$ is constant. Therefore, there exist more values of $\gamma^b \in [0, 1]$ for which $e_i^* = 0$: the likelihood of high bank risk increases. This is the direct effect. For any given $s$, banks will then be more willing to switch to a $\theta_k = 0$ regulator, if there is such a regulator: to the bank the benefit of the switch is larger (being allowed to move to $e_i = 0$ is more valuable), whereas the cost, $s$, is constant. Therefore, there exists more values of $\gamma^b \in [0, 1]$ for which banks would be willing to switch regulator ($k_i \neq k_{i0}$). This implies that there exists more values of $\gamma^b \in [0, 1]$ such that in (11) $m_k$ is responsive to $\theta_k$. Hence, when all other regulators set $\theta_k = h$, the benefit to a regulator of $\theta_k = 0$ is greater, while the cost is unchanged. Thus, there exist more pairs of $(\alpha, \gamma^b)$ such that $\theta_k = h\forall k$ is not a sustainable subgame perfect Nash equilibrium, and, therefore, $\theta_k = 0\forall k$. This is the indirect effect. ■

**Proof of Proposition 3.** First consider that weakly increasing here means that the likelihood (in $(\alpha, \gamma^b)$ pairs) either rises or stays constant. In terms of adverse selection problems there are three possible outcomes, ranked in increasing severeness:

1. Banks set $e_i = h\forall i$
2. Banks set $e_i = 0\forall i$ but regulators set $\theta_k = h\forall k$
3. Banks set $e_i = 0\forall i$ but regulators set $\theta_k = 0\forall k$
The ranking in severeness follows from the credit risk premia paid on the wholesale market, equation (13), in each of these outcomes. Post stage 5, \( q_i = f(h) \) in 1; \( f(h)\pi(h) + f(0)(1-\pi(h)) \) in 2; and \( f(0) \) in 3). By Propositions 1 and 2 the likelihood of \( e_i = 0 \forall i \) falls in \( \pi(h) \) and rises in \( c_h \), as does the likelihood of \( \theta_k = 0 \forall k \). Therefore, if for any of 2) or 3) it holds that \( r_i^d > R \), then the likelihood of this occurrence falls in \( \pi(h) \) and rises in \( c_h \).

Finally, when there are more regulators then the good equilibrium is less stable. Consider a given regulator, who at stage 1 got allocated an average initial share of banks: \( \frac{M}{N} \). In the good equilibrium \( m_k = \frac{M}{N} \). Deviation to \( \theta_k = 0 \) leads to \( m_k = M \). The greater is \( N \), the larger is \( (M - \frac{M}{N}) \) and, therefore, the greater the benefit of deviating. Instead, the effect of deviation on welfare, \( w \), is the same regardless of \( N \). Hence, the likelihood of \( \theta_k = h \forall k \) declines in \( N \), which implies that the probability of case 3) rises, and, with it, the likelihood of \( r_i^d > R \). □

**Proof of Proposition 4.** For any \( e_i \) and \( k_i \) it holds in (17) that \( d_i = d^h \) becomes more attractive for a lower \( r^f \). That is, the fact that the cost of leverage, \( r^f \), falls, whereas the benefit \( \gamma^b(d_i) \) remains constant, means that regardless of what the bank decides about \( e_i \) and \( k_i \), its incentive to lever rises. Conversely, however, with \( d_i = d^h \) the choice for \( e_i = 0 \) is more attractive than with \( d_i = d^l \). Leverage and asset risk are complementary. The reason is that as given by (15) \( \gamma^b(d_i) \) falls in \( d_i \) which means that the cost associated to \( e_i = 0 \) (namely, \( f(0) > f(h) \)) is less severe. Using the same terminology of Propositions 1 and 2, then, a lower \( r^f \) implies a higher likelihood of high bank risk: there exist more pairs of \( (\alpha, \gamma^b) \) for which the outcome is \( e_i^* = 0 \). This is the direct effect. Furthermore, as the value of

\[
([1-f(0)](R-r^fd_i) - f(0)\gamma^b(d_i))
\]

rises with respect to that of

\[
([1-f(h)](R-r^fd_i) - f(h)\gamma^b(d_i)) - c_h
\]
the benefit of a regulatory switch that allows the zero effort outcome to materialize with
certainty (as \( \pi (0) = 0 \)) increases. Hence, there exist more pairs of \((\alpha, \gamma^h)\) such that banks are
willing to switch regulators, and therefore there are more such pairs for which \(m_k\) is responsive
to \(\theta_k\). When \(m_k\) is responsive to \(\theta_k\) then a regulator’s benefit of choosing \(\theta_k = 0\) is larger.
Thus, the likelihood of a "race to the bottom" rises. This is the indirect effect. ■

References


