Regulatory competition in capital standards with selection effects among banks

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Abstract

This paper studies regulatory competition in the banking sector in a model where banks are heterogeneous and taxpayers come up for the losses of failing banks. Capital requirements force the weakest banks to exit the market. This gives rise to a selection effect of capital standards, as borrowing firms anticipate the higher average quality of banks in a more strictly regulated country. In this model, regulatory competition in capital standards may lead to a 'race to the top' for two different reasons. First, if the selection effect is sufficiently strong, the overall demand for loans from the high-quality banks of the regulating country rises, even though the number of active banks in this country is reduced. Second, if governments are heavily concerned about the tax revenue losses arising from bank failures, strict capital requirements are imposed to improve the pool quality of the domestic banking sector and reduce the risk to taxpayers.

Keywords: regulatory competition, capital requirements, bank heterogeneity

JEL Classification: G21, G18, F36, H73

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1 Introduction

The regulation of banks, and in particular the setting of capital adequacy standards, is arguably one of the most important policy issues in the aftermath of the financial crisis. In many countries, large, commercial banks needed to be recapitalized with public funds in recent years. In several countries, such as Ireland or Iceland, the public bailout was so massive that it threatened the entire state of public finances. The new Basel III capital standards, which foresee the ratio of core capital to rise to 7 percent of the banks' outstanding loans until 2019, are therefore widely believed to represent a critical step forward in ensuring more resilient banking sectors around the world.[1] At the same time, the higher capital standards are also expected to lead to a consolidation of banking sectors, with smaller or weaker banks having to exit the market.

The financial sectors of many countries have grown dramatically in recent decades and represent an important source of value added, highly paid jobs, and - in good times - tax revenue.[2] Therefore, an important concern in policy discussions is that the national setting of higher capital adequacy standards will not distort international competition between the banking sectors of different countries, and maintain a 'level playing field'.

Interestingly, however, it is by no means clear whether individual countries, which may be tempted to pursue 'beggar-thy-neighbor' policies, have an incentive to set their national capital standards above or below that of neighboring jurisdictions. On the one hand is the conventional concern that maintaining low adequacy rules reduces the cost of doing business for domestic banks, thus securing an 'unfair' advantage in the international competition for bank customers. As an example, several critical voices were raised in the United States during 2011 against the new Basel rules, and the implementation of these rules was eventually delayed. This raised concerns among

[1] Thus Mervyn King, then Governor of the Bank of England, noted in October 2010 that "the broad answer to the problem [of finding adequate regulatory tools] is likely to be remarkably simple. Banks should be financed much more heavily by equity rather than short-term debt" (www.bankofengland.co.uk/publications/Documents/speeches/2010/speech455.pdf). Similarly, Timothy Geithner, then U.S. Secretary of the Treasury, emphasized in February 2010 that "first, we are going to make sure that financial firms hold a lot more capital than they did before the crisis" (www.treasury.gov/press-center/press-releases/Pages/tg808.aspx).

[2] Auerbach et al. (2010, Figure 9.5) document the increasing fiscal importance of the financial sector in the United States and the United Kingdom. In both countries, corporate tax revenues from financial corporations made up more than 25% of total corporate tax revenues in 2003, before the financial crisis.

several European policymakers that the United States might eventually refrain from adopting the tighter Basel III standards for its banks.[3]

On the other hand, several countries, such as Switzerland, have enacted capital standards that substantially exceed the Basel rules. Similarly, the United Kingdom announced in May 2012 that it planned to introduce national capital requirements above the Basel standards to protect domestic taxpayers. This announcement also met with resistance from most EU partners, who favored instead a strict harmonization of national capital requirements along the Basel standards.[4] This suggests that there may also be fears of a competitive advantage for banking sectors that operate under capital standards *above* those of their competitors.[5]

The present paper studies regulatory competition in capital standards for the banking sector in a model that incorporates several of the concerns that have featured prominently in these recent policy debates. Our model allows for banks that are heterogeneous in their monitoring ability, and hence in their expected profitability. This implies that the least profitable banks will exit the market in response to tougher capital requirements. In this framework, national capital standards cause selection effects, as loan-taking firms anticipate that higher capital standards will drive the least efficient banks from the market and thus improve the pool quality of banks in the regulating country. Finally, we also incorporate the concerns about national public finances by introducing a savings deposit insurance scheme that must be funded by taxpayers in the event of bank failure.

In this model a rich set of possibilities emerges as the outcome of regulatory competition. In particular, a downward competition of regulatory standards (the "competition of laxity") is only one of the possible outcomes that arises when neither selection effects nor the effects on taxpayers are strong. In contrast, a 'race to the top' in capital standards emerges in two very different situations. A first instance arises when selection effects are sufficiently pronounced so that higher capital standards in one country increase the aggregate loan volume of banks in this country, even though the number

[3]See "Delay seen in implementing U.S. bank capital rules". Reuters, November 9, 2012.

[4]See "European Leaders to weigh new capital requirements for banks", The New York Times, May 1, 2012.

[5]This is very different from the issue of tax harmonization, for example, where the concern is almost exclusively about a downward competition of tax rates (see Fuest et al., 2005, for a survey). Where EU-wide legislation exists, as in the field of value-added taxation, only minimum tax rates are therefore stipulated.

of active banks is simultaneously reduced. Secondly, an upward competition in capital standards can arise even in the absence of strong selection effects when governments are sufficiently concerned about the tax revenue losses arising from bank failures. In this case, strict capital requirements are imposed to protect taxpayers, but the downsizing of the domestic banking sector will lead to market entry of banks abroad, worsening the pool quality of the banking sector there. Hence, the risk of paying for bankrupt banks is shifted from domestic to foreign taxpayers.

Our analysis is related to several strands in the existing literature. A first set of papers analyzes the effects of capital regulation on financial institutions (Rochet, 1992; Hellman et al., 2000; Repullo, 2004). This literature stresses that capital regulation increases the risk buffer of banks and curbs risky behaviour. In one of the few contributions that incorporate bank heterogeneity, Morrison and White (2005) show that capital regulation also serves to address adverse selection problems in the banking sector. Another paper that models bank heterogeneity in a framework with capital regulation is Kopecky and VanHoose (2006). All these models stress that capital regulation is costly for banks. An opposing view is taken by Admati et al. (2010), who argue that higher capital requirements reduce the risk premia incorporated in banks' equity capital, and therefore need not raise the overall financing costs of banks.

The existing literature on regulatory competition in the banking sector stresses the result that nationally set capital standards are inefficiently low from a global welfare perspective. Sinn (1997, 2003) models the competition in regulatory standards as a direct application of the classical lemons problem (Akerlof, 1970), arguing that consumers are unable to discriminate between different levels of regulatory quality. Acharya (2003) models competition between bank regulators that choose both the level of capital requirements and the bailout policy when banks become insolvent. Our approach is closest to Dell'Ariccia and Marquez (2006), where regulators choose nationally optimal capital requirements by trading off the aggregate level of banks' profits against the benefits of financial stability. None of these papers incorporates heterogeneity of banks, nor a benefit to the banking sector that arises from the selection effect of higher capital standards.

A reputation effect that benefits banks is also present in the model of Morrison and White (2009). In their framework, however, the beneficial effect arises from the quality of the regulator, for which capital requirements act as a substitute. Hence, high capital requirements act as a negative signal in their paper, contrary to our approach.

Moreover, Morrison and White (2009) do not model international competition between banks and their focus is on the question whether a uniform regulatory standard is beneficial for countries that differ with respect to the quality of their national regulator.

A different channel for cross-border spillover effects of decentralized bank regulation is presented in the empirical papers by Houston et al. (2012) and Ongena et al. (2013). They show that multinational banks that face higher minimum capital requirements in their home country tend to take on higher risk in foreign markets. Further, Carbo-Valverde et al. (2012) demonstrate that cross-border banking mergers can be partly explained by differences in the size and character of safety-net benefits available to banks in individual EU countries. Thus, in this strand of the literature, the spillover effect of national bank regulation is due to the reallocation of cross-border activities by multinational banks. Contrary, in our model, the spillover effect is due to the change in the structure of the national banking sector that affects competition on the international market.

The heterogeneity of banks that we model in our paper has become an important topic in the recent international trade literature. Buch et al. (2011) show a close empirical link between size, productivity and international activity in the banking sector that is similar to the well-established patterns for the manufacturing sector. Niepmann (2013) develops a model of banking across borders models that is driven by both differences in factor endowments and differences in banking sector efficiency. Finally, the recent public economics literature has stressed the qualitative similarities between regulation and taxation of the financial sector (Keen, 2011). It has also provided first empirical results showing that recent bank levies have been effective in increasing the equity-to-asset ratio of European banks (Devereux et al. 2013).

The remainder of this paper is set up as follows. Section 2 describes the basic model. Section 3 analyzes the nationally optimal regulation policy and the possible outcomes of regulatory competition between the two countries. Section 4 discusses various extensions of our benchmark model. Section 5 concludes.

2 The basic model

2.1 Banks

We consider a region of two countries $i \in \{1, 2\}$, which are identical in all respects. Banks in each country extend loans to firms in an integrated regional market. In each country, multiple, heterogeneous banks operate under the authority of a local regulator who imposes capital requirements k_i for all national banks. The number of active banks in each country and the volume of loans given by each bank are endogenous.

Banks within each country differ exogenously in their monitoring skills.[6] These monitoring skills determine the 'quality' of a bank, which is expressed by the variable q and is distributed uniformly in the interval [0,1]. Moreover, we abstract from the analysis of the specific form of complementarity between banks' and firms' abilities in good production and assume that the quality q of the bank corresponds to the likelihood that the investment financed by the bank's loan is successful.[7]

We think of several interpretations of q that capture the specific role of bank quality that improve the payoff of borrowers during the production process. First, due to their repeated interaction with different customers, banks will have knowledge complementary to that of firms (see Boot and Thakor (2000)). In this sense, q refers to the general and sector-specific expertise of each individual bank that affects the probability of successful production. Second, during the process of production, firms might face additional random liquidity shocks that could force them to terminate the project. Therefore, firms will optimally protect themselves by demanding lines of credit at their bank (see Holmstrom and Tirole (1998)). However, as shown by Boot et al. (1993), the ability of banks to offer these flexible, discretionary financial contracts will depend on the quality of the issuing bank. As a consequence, interpreting q as the ability of banks to monitor projects and thus manage the liquidity pool of its portfolio, the probability of successful production will be a function of bank quality.[8] Recent financial crises have illustrated the importance of long and stable relationships to banks. After the insol-

[6] See Morrison and White (2005) for a similar assumption. The bank's monitoring decision could also be modelled explicitly, as in Dell'Ariccia and Marquez (2006). This however, would complicate our analysis without changing its qualitative results.

[7] The mechanism that is at work in our model would be active with any form of complementarity.

[8] See Inderst (2013) for a model where the expected payoff of projects depends on the ability of banks to roll over loans.

vency of its bank, firms loose the advantage of relationship-based cost advantages (see Slovin et al. (1993)) while they have to face new banks that sharply reduce lending in order to comply with binding capital requirements (see Peek and Rosenberg (1997), Duchin et al. (2010), and Popov and Udell (2012)). In contrast, firms with stable bank relationship can draw down on lines of credit (see Ivashina and Scharfstein (2010)) or receive more favorable credit terms for new loans (see Bolton et al (2013)). Last, the quality of the bank might also affect the attractiveness of firms to other investors. Typically, firms will choose to use multiple financial instruments (see Rajan (1992) and Detragiache et al. (2000)) or change instruments over their life cycle(see Diamond (1989) and Diamond (1991)). Then, as noted by Fama (1985), due to the inside information gained by banks in the process of screening and monitoring the firm, the lending decision by banks serves as a credible quality signal to other investors.[9] Consequently, the monitoring quality of each bank will affect the quality of the certification and thus also the ease for firms to receive additional funding to successfully complete their projects.[10]

Each bank can fund itself either through equity capital, or through external funds, which we take to be saving deposits of individuals. In our benchmark model we assume that the savings deposits are fully insured by the government of the country in which the bank is located and we normalize the costs of deposits for the bank at unity.[11] In contrast, the cost per unit of equity is $\rho > 1$. Consequently, the bank will never choose to hold equity capital in excess of the minimum level k_i stipulated by the regulator.[12] The profit function for a bank in country i with quality q that chooses to distribute a

[9]See Besanko and Kanatas (1993) for a model that analyzes the interrelationship between the lending and monitoring decisions of the bank and the effect of these decisions on the terms under which the firm can acquire additional funds from the capital markets.

[10]There is large evidence that banks play a unique role as transmitters of information in capital markets. While James (1987) finds a positive stock price response to the announcement of new bank credit agreements, Lummer and McConnell (1989)show the importance of the bank's decision on loan revision. Billet et al (1995) document the influence of lender identity on the markets reaction to loan announcement. Shockley and Thakor (1997) show the benefit to firms from unused loan commitments. Cook et al. (2003) find that reputable lenders are able to exact a certification premium from their borrowers.

[11]In Section 4, we will consider an extension of our model where deposits are not insured and capital regulation helps to overcome the asymmetric information problem faced by depositors vis-à-vis the bank's owners.

[12]See Allen et al. (2011) for a model where banks choose to voluntarily hold equity beyond the required level, in order to signal a commitment to monitoring to its borrowers.

total number of l loans is then given by:

$$\pi_i(q,l) = \{q\underbrace{[R_i - 1 + k_i]}_{\equiv\phi_i} - k_i\rho\}l - \frac{1}{2}bl^2 \ , \tag{1}$$

where R_i is the return on the bank's loan and ϕ_i labels the return net of deposit costs. The quadratic cost term $(1/2)bl^2$ limits the operations of each bank. It can be thought of as increased transaction costs when the bank's level of operation rises.[13] Equation (1) incorporates that the return on the bank's loan is zero, if the borrowing firm's risky investment fails. In this case the bank will also go bankrupt and savers will be compensated by payments from the national deposit insurance fund. Equity holders of the bank are residual claimants and receive all profits, less their opportunity costs ρk_i.

We assume that all banks are small and take R_i as given when choosing l. The optimal loan volume l for each bank is then given by

$$l_i^* = \frac{q[R_i - 1 + k_i] - k_i\rho}{b} \ . \tag{2}$$

It is clear from (2) that the volume of lending for each bank increases in its quality and the loan rate, while it decreases with the amount of capital it has to hold. Thus, a better bank is also larger.

Substituting (2) in (1) determines the optimized profits of a bank of quality q:

$$\pi_i^*(q) = \frac{[q[R_i - 1 + k_i] - k_i\rho]^2}{2b} \ . \tag{3}$$

The equilibrium number of banks in each country is determined by the condition that the critical bank with quality $\hat{q}_i$ receives zero expected profits from its operations:

$$\pi(\hat{q}_i) = \hat{q}_i(R_i - 1 + k_i) - k_i\rho = 0 \ . \tag{4}$$

Consequently, only banks with $q_i \geq \hat{q}_i$ will be active in the market. Equation (4) shows that capital standards in country i directly affect the quality level $\hat{q}_i$ of the marginal bank, by increasing the cost of capital for all banks. As low-quality banks benefit most from limited liability and cheap deposit funding, they are hit hardest by an increase in capital standards. Without any capital requirements ($k_i = 0$), all banks will be active in the market ($\hat{q}_i = 0$) as they do not lose any equity capital in case of failure. In

[13] See Acharya (2003) for a similar assumption.

contrast, full equity financing of banks ($k_i = 1$) results in $\hat{q}_i = \rho/R_i$. Hence, a necessary condition for a positive number of banks to stay in the market even with full equity financing is that the cost of equity ρ is lower than the equilibrium return on loans R_i. For any given level of k_i, the number of active banks and their profit is larger if either equity is relatively cheap (ρ is low), or if the loan market is attractive (R_i is high).

It remains to determine the aggregate loan volume of all active banks in country i. We assume that $\bar{L}$ is the exogenously given number of potentially entering banks. To arrive at the aggregate loan volume, we have to integrate the volume choice of each bank from (2) over the range of all active banks. This gives

$$L_i = \bar{L} \int_{\hat{q}_i}^{1} l_i(q)dq = \bar{L}(1 - \hat{q}_i) \, \frac{[R_i - 1 + k_i] - k_i\rho}{2b} \, , \tag{5}$$

where the term $\bar{L}(1 - \hat{q}_i)$ gives the number of active banks in country i, whereas the remaining term on the RHS of (5) measures the average loan volume per active firm.[14]

2.2 Final goods and the determination of the loan rate

We assume that there is a large number of identical, potential producers in a final goods market, which do not have any private source of funds. The potential producers compete for credit in an integrated loan market. Each firm that enters the market in equilibrium demands one unit of credit to produce one unit of output. However, each loan only translates into one unit of output according to the quality of the issuing bank. Thus, total output in the integrated market depends on the expected number of successful loans from banks in both countries, which is given by:

$$y \equiv y_i + y_j = \bar{L} \int_{\hat{q}_i}^{1} q_i l_i(q_i)dq_i + \bar{L} \int_{\hat{q}_j}^{1} q_j l_j(q_j)dq_j = L_i \underbrace{\left(\frac{2 + \hat{q}_i}{3} \right)}_{q_i^e} + L_j \underbrace{\left(\frac{2 + \hat{q}_j}{3} \right)}_{q_j^e} \, . \tag{6}$$

Due to the positive effect of bank quality on bank size [see eq. (2)], two thirds of all loans will lead to successful production, even in the absence of all capital requirements ($\hat{q} = 0$). Obviously this expected success rate, which we denote as q^e, increases with $\hat{q}$.

We are now left to determine the firms' willingness to pay for one unit of loan. Each potential entrant in the final goods sector has to incur fixed costs c for its project.

[14] It is seen from (2) that this term is the average of the loan volume given by the best bank with $q = 1$, and the loan volume of the marginal bank $\hat{q}_i$, which is zero.

Further, as the firm can not observe the quality of the contracting bank, it has to form expectations (q_i^e) about the average quality of loans distributed by all banks located in country i. In case of successful production the firm then sells its product on the common market which is characterized by the inverse demand function $p = A - y$ where A is an indicator of market size. The firm will not repay the loan if the project fails, but the fixed cost c must be paid in any case. Thus, allowing for free entrance into the output market, the zero profit condition for entering, risk-neutral firms is given by

$$q_i^e(p - R_i) = c \; . \tag{7}$$

Equation (7) implies that producing firms make zero aggregate profits. Effectively, all profits are transferred to banks via the loan rate R_i.

To derive banks' equilibrium return to loans R_i we can now rearrange (7) and substitute output as given in(6) into the inverse demand function so that we arrive at:

$$R_i = A - L_i \left(\frac{2 + \hat{q}_i}{3} \right) - L_j \left(\frac{2 + \hat{q}_j}{3} \right) - \frac{c}{q_i^e} \; . \tag{8}$$

Thus the loan price decreases in total output and in the amount of fixed costs c as this reduces the net return of the project and hence the firms' willingness to pay for the loan. Moreover, (8) shows that loan rates are country-specific and depend positively on the expected quality of the banking sector in country i. A higher expected quality of the banking sector reduces the probability of a firm to end up with a failing project, thus raising its willingness to pay for the loan. Hence, in our model, national capital requirements k_i act as a selection mechanism of the pool quality of domestic banks, which affect the price that borrowers are willing to pay for a bank loan from country i.[15] Consequently the price of bank loans differs systematically between the two countries whenever their capital requirements differ, so that banks from the country with the higher expected bank quality get a higher return.

2.3 Capital standards, average bank quality, and loan volumes

In this section we analyze the impact of minimum capital requirements k_i on average bank quality and output in both countries. We first turn to the effects of capital

[15] One possible reason why firms care about the riskiness of the banks is that loans are typically given in installments. Hence the firm's continued access to credit will depend on the survival of the bank. See Inderst (2013) for an explicit modeling of this relationship, and for empirical references that support it.

standards on the the critical quality level $\hat{q}$ of the last bank entering the market.

From eq. (4) we see that an increase in k_i affects $\hat{q}_i$ directly through an increase in funding costs and indirectly through a change in the return on loans. The loan rate R_i depends on the expected loan quality and on the total loan volume [see eq. (8)], which in turn is a function of both $\hat{q}_i$ and $\hat{q}_j$ [see eq. (6)]. Thus it becomes clear that the effects of k_i in the critical level of bank quality in countries i and j interact. In a first step, we substitute the aggregate loan volumes from (5) into the equilibrium loan rates for banks in both countries in (8) and solve for R_i and R_j as functions of k_i, k_j, $\hat{q}_i$ and $\hat{q}_j$. In a second step, we then use the implicit function theorem on the zero expected profit condition for banks in eq. (4) to arrive at a system of two equations in the two unknowns $\partial q_i/\partial k_i$ and $\partial q_j/\partial k_i$. Solving this equation system gives:

$$\frac{\partial \hat{q}_i}{\partial k_i} = \frac{(\rho - \hat{q})\chi + \hat{q}\bar{L}(1-\hat{q})\kappa}{(\phi + \tilde{c}\hat{q})\chi} > 0 \tag{9}$$

$$\frac{\partial \hat{q}_j}{\partial k_i} = \frac{\hat{q}\bar{L}(1-\hat{q})\kappa}{(\phi + \tilde{c}\hat{q})\chi} \tag{10}$$

where

$$\kappa = \tilde{c}\rho(1-\hat{q})(2+\hat{q}) - \phi[(2+\hat{q})(\rho-1) + (1+2\hat{q})(\rho-\hat{q})] \gtrless 0, \tag{11}$$

$$\chi \equiv 6b(\phi + \tilde{c}\hat{q}) + 2\phi\bar{L}(1-\hat{q})(2+\hat{q}) + 2\phi\hat{q}\bar{L}(1-\hat{q})(1+2\hat{q}) > 0, \tag{12}$$

and

$$\tilde{c} \equiv \frac{c}{2(q^e)^2}. \tag{13}$$

The first term in (9) captures the cost effect of an increase in capital standards on the marginal bank $\hat{q}_i$. This bank has to replace one unit of savings deposits, which carries expected costs of $\hat{q}_i$ due to the bank's limited liability, with one unit of equity capital that bears costs ρ. The second term in (9) is the same as in (10). It is labeled κ and summarizes the ambiguous effect of capital standards on competition in the international loan market. For an increase in k_i, this effect determines whether the quality of the critical bank in country j will rise or fall. In contrast, the critical quality level of banks in country i will always rise when capital requirements are increased in this country, no matter what the sign of κ is.

For our further analysis it is important to analyze the effects summarized by κ in detail. As shown in (11), the total effect of k_i on loan market competition can be decomposed in two parts. The first term involving $\tilde{c}$ captures the positive effect of a higher k_i on the pool quality of banks from country i, which results in a higher willingness to pay for

loans from this country. As the size of each bank is a positive function of the loan rate [see eq. (2)], this isolated *selection effect* of capital standards leads to a higher total number of successful loans [see eq. (16) below] and lowers the equilibrium loan rate. This increases the competitive pressure on the lowest quality banks in both countries. The second term in κ captures the negative effect of an increase in funding costs on bank size [see eq. (2)]. This isolated *cost effect* of higher capital standards will reduce the total supply of performing loans, increasing the equilibrium loan rate and attracting additional banks into market j, where capital requirements remain constant.

Overall, we can show that an increase in k_i always raises $\hat{q}_i$ and thus increases the pool quality of banks in country i. Intuitively, the positive selection effect of capital standards in country i can only occur when the increase in k_i results in the exit of the lowest quality banks in country i. In contrast, the effect of k_i on the pool quality of banks in country j is determined by the relative strength of the *selection* and *cost effects*. An increase in k_i will lower $\hat{q}_j$ and decrease the pool quality of banks in country j whenever the *cost effect* of higher capital standards dominates and $\kappa < 0$. In contrast, an increase in k_i will raise $\hat{q}_j$ when the *selection effect* dominates, driving the marginal bank in country j out of the market.

We can now analyze the effect of k_i on the expected number of successful loans in each country, and hence on aggregate output. This yields

$$\frac{\partial y_i}{\partial k_i} = \left[\frac{\bar{L}(1-\hat{q})}{\chi} + \frac{2\bar{L}L_i(1+\hat{q}+\hat{q}^2)}{3(\phi+\tilde{c}\hat{q})\chi} \right] \kappa, \tag{14}$$

$$\frac{\partial y_j}{\partial k_i} = \frac{2\bar{L}L_i(1+\hat{q}+\hat{q}^2)}{3(\phi+\tilde{c}\hat{q})\chi}(-\kappa), \tag{15}$$

$$\frac{\partial (y_i+y_j)}{\partial k_i} = \frac{\bar{L}(1-\hat{q})\kappa}{\chi}. \tag{16}$$

From equations (14)-(16) it becomes clear that the effects of an increase in k_i on the aggregate loan volume of national banking sectors depend exclusively on the sign of κ. If $\kappa > 0$, and hence the *selection effect* of capital standards dominates, then a higher capital requirement in country i will benefit the banking sector in this country in the aggregate, while the lowest quality banks in country i will exit the market. In this case the resulting increase in the pool quality of banks in country i will lead firms to increase their willingness to pay for loans from the remaining banks in i by so much that the aggregate loan volume in this sector rises. The resulting reduction in the equilibrium loan rate implies that the aggregate lending volume must fall for the banking sector in

country j. The effects of an increase in k_i on national banking sectors are reversed, if the *cost effect* dominates and $\kappa < 0$.

In addition to these changes in the market share of national banking sectors, there is an effect on the total loan volume in the integrated market, which is given from (16). This shows that the effect of k_i on the expected level of performing loans, and hence output, in country i always overcompensates the counteracting effect on output in country j. Consequently, aggregate output increases in k_i when $\kappa > 0$ and decreases when $\kappa < 0$.

3 Competition in regulation policies

3.1 Nationally optimal capital regulation

We are now prepared to analyze the welfare implications of capital standards. We consider a national regulator in each country i who sets capital requirements so as to maximize social welfare. The welfare function of country i comprises the expected profits of all national banks that are active in the regional market, less the expected costs to the taxpayer when banks fail and depositors must be compensated for their losses through the deposit insurance fund. In line with past experience, we thus assume that the costs of bank failures are fully borne by taxpayers.[16] In the following, we weigh one Euro of taxpayers' expected losses, relative to one Euro of banks' profits, by the factor β. Moreover, we abstract from international contagion effects and assume that the losses from failed banks arise only in the country in which the bank is located.[17] Finally, in our benchmark model we ignore the effects on consumer surplus which arise from changes in the aggregate output volume.[18]

[16]Several countries, such as Germany, are currently building up special funds financed by compulsory bank levies, in order to make the banking sector participate in the costs of bank restructurings. The size of these insurance funds is (still) very small, however. In Germany, for example, the volume of this 'restructuring fund' is only slightly above 1 billion Euro after two years of collecting bank levies, out of a target volume of 70 billion Euro.

[17]See Goodhart and Schoenmaker (2009), Niepmann and Schmidt-Eisenlohr (2013) and Beck and Wagner (2013) for analyses of international regulatory coordination when bank failures in one country have adverse effects on the other country.

[18]This implies that the consumer good that is produced with financing from regional banks is sold in a third market. See, for example Brander and Spencer (1985) for a well-known analysis using this assumption. In Section 4, we will extend our model to allow for the effects of capital regulation on consumer surplus.

With these specifications, the welfare function of country i is:

$$\begin{aligned} W_i &= \bar{L}\int_{\hat{q}_i}^{1}\pi_i^B(q)dq - \beta\bar{L}\int_{\hat{q}_i}^{1}(1-k_i)(1-q)l(q)dq \\ &= \frac{L_i[R_i - 1 - k_i(\rho-1)]}{3} - \beta(1-k_i)L_i\left(\frac{1-\hat{q}}{3}\right). \end{aligned} \tag{17}$$

We arrive at the first term in (17) by integrating banks profits from (3) over the range of all active banks. Aggregate profits are a positive function of the volume of distributed loans and of the net revenue earned by bank owners in case of success. The expected losses to taxpayers, captured in the second term of (17), depend on the amount of insured deposits $L_i(1-k_i)$, and on the expected probability of default for each loan $(1-\hat{q})/3$.

The nationally optimal capital requirement is obtained by differentiating W_i with respect to k_i. This gives:[19]

$$\begin{aligned} \frac{\partial W_i}{\partial k_i} &= L_i\left[\frac{\partial R_i}{\partial k_i}\left(\frac{2+\hat{q}}{3}\right) - \left(\rho - \frac{2+\hat{q}}{3}\right)\right] \\ &+ \beta\left[\left(\frac{1-\hat{q}}{3}\right)L_i + \left(\frac{1-k_i}{3}\right)\left(\frac{\partial \hat{q}_i}{\partial k_i}L_i - \frac{\partial L_i}{\partial k_i}(1-\hat{q})\right)\right]. \end{aligned} \tag{18}$$

The first term in (18) measures the effect of k_i on the profits of the remaining banks in country i. Thus, total bank profits in country i will increase whenever the increase in the expected average return on loans dominates the increase in expected average funding costs. Abstracting from total bank profits, one can also see that an increase in k_i affects the distribution of bank profits within country i. This is due to the fact that banks of high quality benefit most from the increase in loan rates, while low quality banks suffer most from the increase in funding costs.

The terms collected in the second line of (18) quantify the change in the expected bailout costs for taxpayers in country i. The first term is positive as, for a given level of loans, an increase in k_i reduces the compensation that must be paid to insured depositors in case of default. The sign of the second term is ambiguous as the total level of defaulting loans can either increase or decrease. Although an increase in k_i always leads to a higher pool quality of banks in country i [see eq. (9)] the total loan volume of banks located in country i might also increase due to the selection effect.

[19]Note that the effect of changing the integration boundary $\partial\hat{q}_i/\partial k_i$ on aggregate expected profits is zero, because the marginal active bank with quality $\hat{q}_i$ has zero expected profits from (4).

In sum, the optimal national regulation policy thus trades off the aggregate profits of domestic banks against the savings to national taxpayers which result from a smaller and less risky banking sector.

In the following we assume that the government's objective function is concave in k_i so that the second-order condition for a welfare maximum holds. We further assume that β is sufficiently large so that $\partial W_i/\partial k_i$ is positive at $k_i = 0$, but β is sufficiently low to render $\partial W_i/\partial k_i$ negative at $k_i = 1$. These assumptions are sufficient to ensure an interior optimum for the nationally optimal regulation policy.[20] Finally, assuming that the sum of the terms in the second line of (18) is positive, a higher valuation β of taxpayers' bailout payments will raise the optimal level of k_i.

3.2 The efficiency of decentralized regulation policies

We now turn to analyzing the efficiency of decentralized regulation policies. Since countries are symmetric in our benchmark model, we can simply define regional welfare as the sum of national welfare levels

$$W_W = W_i + W_j \quad \forall\, i, j \in \{1, 2\}, i \neq j, \tag{19}$$

where W_i is given in eq. (17). Choosing k_i so as to maximize aggregate welfare (19) would imply $\partial W_W/\partial k_i = 0$. The nationally optimal capital standards derived in the previous section are instead chosen so that $\partial W_i/\partial k_i = 0$. Hence, any divergence between nationally and globally optimal capital requirements is shown by the effect of country i's policy variable k_i on the welfare of country j. If $\partial W_j/\partial k_i > 0$, then the capital requirements chosen at the national level are too lax from a regional welfare perspective, as an increase in k_i would generate a positive externality on the welfare of country i. The reverse holds if $\partial W_j/\partial k_i < 0$. In this case the externality on the foreign country is negative and nationally chosen capital requirements are too strict from a regional welfare perspective.

[20] Theoretically, $\frac{\partial \Pi^B}{\partial k_i}$ could still be positive at $k = 1$. However, this would only be the case for $A - c$ much larger than ρ.

Differentiating W_j with respect to k_i gives:

$$\begin{aligned}\frac{\partial W_j}{\partial k_i} &= \frac{\partial R_j}{\partial k_i}\left(\frac{2+\hat{q}}{3}\right)L_j - \frac{\beta(1-k_j)}{3}\left[-\frac{\partial \hat{q}_j}{\partial k_i}L_j + (1-\hat{q})\frac{\partial L_j}{\partial k_i}\right] \\ &= \frac{\bar{L}L_j(1-\hat{q})\kappa}{3\chi(\phi+\tilde{c}\hat{q})}\left[\underbrace{-\phi(2+\hat{q}) + \beta(1-k_j)(1+2\hat{q})}_{\equiv\mu}\right]. \qquad (20)\end{aligned}$$

The first term captures the effect of k_i on the profits of all active banks in country j. This shows that banking profits in country j will rise, following an increase in country i's capital standards, iff $\kappa < 0$. From our discussion of (11) we know that this will be the case when the *cost effect* of the tightened capital standards in country i dominates the *selection effect* in the country that changes its regulation policy (country i). Intuitively, in this case the total volume of loans from banks in country i decreases, raising the price of loans in the integrated region and thus increasing the profits of banks in the neighboring country j. Thus, contrary to the effect of k_i on bank profits in country i, an increase in capital standards in country i has no further distributional effects within the banking sector of country j, as the profit of all banks either increase (if $\kappa < 0$) or decrease (if $\kappa > 0$).

The second term measures the effect of k_i on the expected costs for taxpayers in country j that result from changes in the total amount of loans distributed by banks from country j, and from changes in the average quality of country j's banking sector. Again, this term can be fully described through κ. If k_i leads to an increase in competition from banks located in country i, this increases the pool quality of banks in country j [see eq. (10)] while decreasing the size of all banks located in j [eq. (2)]. Thus an increase in capital standards in country i either leads to a banking sector in j that is smaller and less risky ($\kappa > 0$) or larger and more risky ($\kappa < 0$).

We can now analyze the total effect of k_i on welfare in country j. However, as the qualitative effect of k_i on bank profits in country j is always opposed to the effect on taxpayers in country j, we have to differentiate further with respect to the relative valuation of bank profits and expected taxpayers cost, summarized by the term μ. For sufficiently large β, the term μ turns positive, implying that the externality of country j's capital regulation on welfare in country i is dominated by the effects on country i's taxpayers.

The standard case discussed in the literature arises when $\kappa < 0$ and $\mu < 0$. In this case, a higher capital requirement in country i places this country's banks at a competitive

disadvantage and benefits the banking sector in the competing country j, whereas the effects on country j's taxpayers are of secondary importance. This leads to capital standards in each country being set too low from a regional welfare perspective. This case corresponds to the 'competition of laxity', on which the existing literature has focused (see Sinn, 2003; Acharya, 2003; Dell' Ariccia and Marquez, 2006).

Our analysis show, however, that a 'race to the top' is equally possible in regulatory competition. This can arise for two very different reasons. The first case arises when $\kappa > 0$ and $\mu < 0$. Hence, the effects of country i's capital requirement on the profits of country j's banking sector are more important than the effects on country j's taxpayers. However, the *bank selection effect* of strict capital standards is so strong that an increase in capital standards increases the aggregate volume of bank loans in the country that imposes the strict regulation. This in turn hurts the banking sector in the neighboring country and thus gives a first incentive to each country to impose overly strict capital requirements.

The second instance of a 'race to the top' arises when $\kappa < 0$ and $\mu > 0$. In this case, the conventional wisdom holds that high capital standards in country i place this country's banks at a competitive disadvantage and benefit the competing banks in country j. However, the effects on aggregate bank profits are now dominated by the spillover effects on taxpayers in the other country j. In this case, each country wants to protect domestic taxpayers by shrinking the domestic banking sector and simultaneously improving its average quality by driving the riskiest banks from the market. In equilibrium, the consolidation of country i's banking sector will, however, induce market entry in country j and thus reduce the average quality of the banking sector there. In effect, taxpayers' risks are therefore shifted from the country that tightens its capital standards to the other country. In a competitive policy equilibrium, this is a second reason why nationally optimal capital standards may be excessively strict from a regional welfare perspective.

4 Extensions

1. Incorporating the effects on consumer prices. So far, our analysis has ignored the effects that a change in capital standards has on the aggregate loan volume in the integrated regional market, and hence - through the competition among producing firms - on consumer surplus in the goods market. Incorporating the beneficial effect of

a higher aggregate loan volume on consumer surplus also takes account of the concern, often voiced in policy discussions, that bank regulation must be compatible with a sufficient supply of credit to the real economy.

To compute national consumer surplus, we assume that the total output $\hat{n} = y_i + y_j$ of the regional good market is shared equally between both countries so that:

$$CS_i = \frac{1}{2}\int_0^{\hat{n}} (A - n - p)dn = \frac{(y_i + y_j)^2}{4} \tag{21}$$

As shown in eq. (16), aggregate output on the regional market and thus consumer surplus is positively affected by an increase in k_i whenever $\kappa > 0$. Analyzing the choice of nationally optimal capital regulation, it becomes clear that incorporating consumer surplus considerations increases the optimal capital standard when the *selection effect* is relatively large, whereas it decreases optimal capital standards when the *cost effect* dominates for banks in country i.

To incorporate consumer surplus considerations to the analysis of the efficiency of decentralized regulation policies we add $\frac{\partial CS_j}{\partial k_i}$ to equation (20) so that:

$$\frac{\partial W_j}{\partial k_i} = \frac{\bar{L}L_j(1-\hat{q})\kappa}{3\chi(\phi + \tilde{c}\hat{q})}\left[\tilde{c}\hat{q}(2+\hat{q}) + \beta(1-k_j)(1+2\hat{q})\right]. \tag{22}$$

Equation (22) shows that, given the assumption of equally shared output between both countries, the effect of k_i on welfare in country j can now be unambiguously described as a function of κ. Thus, for $\kappa < 0$ an increase in k_i exerts a negative externality on welfare in country j. In this case, the positive effect on bank profits in j is dominated by the negative effect on consumers and tax payers that is caused by a larger, less qualitative national banking sector combined with a smaller global banking sector.

2. The model without deposit insurance. In our benchmark model we have assumed that national governments, and thus taxpayers, provide full insurance for saving deposits. This assumption corresponds to the institutional framework in most developed countries. It eliminates, however, a further role that capital requirements can play in reducing moral hazard problems and increasing the volume of savings available to banks. In the following we extend our model to incorporate this additional function of capital requirements.

(to be continued)

5 Conclusions

In a setting with international competition between heterogeneous banks and a taxpayer bailout for failing financial institutions, we have shown that a 'race to the top' in capital regulation is an equally plausible scenario as a 'race to the bottom', on which the existing literature has focused. This 'race to the top' can arise for two entirely different reasons. First, countries imposing capital standards that are tighter than those of their neighbors may do so because the aggregate loan volume of their banking sector may in fact rise as a consequence of a selection effect, as tighter capital standards drive out the lowest-quality banks in the regulating country. Alternatively, tough capital standards can be an instrument that protects domestic taxpayers, shifting the risk from bailing out bankrupt financial institutions from the home to the foreign country.

Both of these scenarios may explain why countries such as Switzerland and the United Kingdom, which are characterized by large banking sectors and accordingly a high risk exposure of national taxpayers, resort to capital adequacy rules that exceed the Basel III standards. At the same time, it may also explain why most European countries insist on setting *upper* limits on capital standards, along with lower ones.

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