Ulf Maier:

Multinational banks: Supranational resolution regimes and the importance of capital regulation

Munich Discussion Paper No. 2016-10

Department of Economics
University of Munich

Volkswirtschaftliche Fakultät
Ludwig-Maximilians-Universität München

Multinational banks:
Supranational resolution regimes
and the importance of capital regulation

Ulf Maier[*]

University of Munich

July 2016

Abstract

The lack of coordination in the resolution of multinational banks has led to demands for the increased centralization of resolution regimes. However, as this paper argues, the anticipation of resolution procedures affects the incentives of host countries to impose capital standards on their resident banks. Critically, it is shown that overall welfare can even be decreased by introducing a centralized resolution regime without fully centralizing capital requirements. As, in the aftermath of the financial crisis, only countries that are not part of a supranational resolution regime unilaterally and significantly increased the capital requirements for their largest resident banks, this paper can help to understand and study the heterogeneity of the observed regulatory approaches.

Keywords: regulatory competition, multinational banks, capital requirements, bank supervision

JEL Classification: G21, G18, G33, F36, H73

[*]Seminar for Economic Policy, Akademiestr. 1/II, D-80799 Munich, e-mail: Ulf.Maier@econ.lmu.de

1 Introduction

During the recent financial crisis, government responses towards ailing banks were largely driven by the attempt to limit the damage for national taxpayers. However, as the liquidation procedure of Lehman Brothers Holding Inc. (LBHI), the parent company of Lehman Brothers, illustrated, this approach caused serious international contagion effects. While the US authorities refused to support LBHI, they did support the US broker-dealer subsidiary that could be later merged successfully with Barclays Capital. In contrast, the resolution of the remaining subsidiaries that were present in 49 countries was more costly. This was especially due to the high degree of centralization and complexity of the LBHI, that would have made it necessary for the national authorities to cooperate (Claessens et al., 2010). Similar patterns could be observed during the crises of the Icelandic banking system, where banks had established a Europe-wide system of savings accounts that broke down at the onset of the financial crisis (see Benediktsdottir et al., 2011). Further, the large amount of governmental support towards Fortis, a multinational bank with large presence in Belgium, the Netherlands and Luxembourg, was mainly attributed to the lack of cooperation between the national supervisory authorities.[1]

As a consequence, improvements in the process and the decision about the resolution of multinational banks are high on the political agenda. Proposals include demands for multinational banks to map their line of business into the corporate entities and clarify key interconnections across affiliates (centralized information). Further measures foresee a better collaboration and more rights to intervene for international supervisory colleges (centralized resolution).[2] These measures are expected to lead to a reduction in expected bankruptcy costs of multinational banks.

Interestingly, however, it is by no means clear that coordinated resolution regimes will also decrease the total expected cost for national taxpayers. On the one hand, once multinational banks are in difficulty, coordinated resolution regimes can reduce the failure costs. On the other hand, as this paper will show, the anticipation of a coordinated resolution approach can increase the need for public intervention. This is

[1]See Claessens et al. (2010) for a study on Fortis and for further cases of cross-border resolution procedures during the recent financial crises.

[2]See Hagan and Vinals (2010), Claessens et al. (2010) and Allen et al. (2011) for discussions on various structures of resolution regimes for multinational banks.

due to its negative effect on the incentives of national authorities to impose adequate capital standards and thus on the capacity of multinational banks to absorb losses.

This paper introduces a model where countries compete for the investment of multinational bank subsidiaries. While each country benefits from the investment in normal times, costs arise in case that the subsidiary is hit by a shock and has to default. There exist two regulatory instruments to curb these costs. First, each regulation authority can impose capital standards for the subsidiary that is resident in its country. However, as this reduces the subsidy from deposit insurance, a unilateral increase will lead to the reallocation of investment to the subsidiary that is located in the other country. Second, each regulation authority can intervene into the operation of its resident subsidiary whenever the probability of default is sufficiently large. Here, national regulation authorities fail to account for the international spillovers that are caused by the reallocation of capital within the multinational bank network in case of unilateral shocks.

First, we show that moving from a national to a global intervention regime changes the non-cooperative equilibrium of capital standards that are chosen by national regulation authorities. Accounting for the externality at the intervention stage, moving towards a global intervention regime raises the value of one unit of bank investment and thus increases the welfare loss when capital standards are unilaterally increased. Further, when national intervention would be too lax from a global welfare perspective, the increase in safety caused by a more global regime makes it less attractive for each regulation to impose strict capital standards. This result of the paper might help to explain why countries like Switzerland, the United Kingdom and the United States, which all host large multinational banks but are not integrated in a multinational intervention regime, have substantially tightened bank capital requirements, while countries within the Euro Zone have so far not departed from the minimum standard in the Basel 3 framework.

We then analyse the welfare effect of different intervention regimes. Thereby we study the interaction between the anticipation of supervisory decisions, the determination of capital standards and the externalities that are induced without full coordination in both regulatory instruments. We can then define a condition that whenever bank investment is sufficiently profitable and mobile and thus the externality that arises due to non-cooperative capital standards is large, moving towards a more centralized intervention regime is welfare decreasing.

This paper wants to add to the current policy debate about the strategies in the intervention and resolution of multinational banks. Our analysis is especially important for Europe, where multilateral resolution procedures are aimed at in the new banking union. Most authors support the idea of a more centralized approach (Claessens et al., 2010; Beck and Wagner, 2016). However, until now, the determination of precise intervention criteria and the (partial) transfer of budgetary sovereignty in case of default have impeded the full implementation.[3] This is similar to the harmonization in bank capital standards, where European countries still differ in the application of rules that have to be put in place at the Member state level (Basel Committee on Banking Supervision, 2014). Importantly, as this paper argues, both initiatives should only be negotiated and agreed upon in a closely coordinated approach. Otherwise, unilateral approaches towards more centralization in the resolution of multinational banks might even prove to be economically harmful.

The analysis in this paper builds on several strands of the literature. Various authors examined 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. However, introducing bank mobility, the existing literature shows that in the non-cooperative equilibrium capital requirements are set inefficiently low from a global welfare perspective (Sinn 1997, 2003; Dell'Ariccia and Marquez, 2006).[4]

Several papers discuss the inefficiencies that derive from a decentralized supervision regime.[5] Beck et al. (2013) and Beck and Wagner (2016) analyze the distortions in the intervention decision of host country regulators that are caused by foreign ownership

[3]See "Banking on a new union - The promises and pitfalls of the euro zone's next big idea", The Economist, December 14, 2013.

[4]The decision for banks to operate multinational is analyzed in the theoretical paper by Niepmann (2015). Dell'Ariccia and Marquez (2010) analyze the decision of multinational banks between branch-based and subsidiary-based corporate structures.

[5]Different aspects regarding the role of supervision within the regulatory framework have been discussed in the literature. Aghion et al. (1999) and Mitchell (2000) analyse incentive schemes to overcome the information problem between the management of the bank and the supervisory authority. The distribution of supervisory tasks between different institutions, e.g. central bank and deposit insurance fund, is analyzed in the work of Repullo (2000) and Kahn and Santos (2005). The adequacy of different measures of intervention, e.g. liquidation or restructuring, is analyzed in Dewatripont and Freixas (2011). Calzolari and Loranth (2011) focus on the effect of the multinational bank's organizational structure on the distortions that arise from national supervision authorities.

of bank assets, bank equity and bank deposits. Goodhart and Schoenmaker (2009) analyze ex-ante burden sharing agreements between hosting nations of multinational banks that can be implemented to overcome the inefficient ex-post negotiations on the recapitalization of failing banks.

However, to the best of knowledge, so far no paper has analyzed the combined role of capital standards and supervisory regimes in a multinational bank framework. Closest to this paper, Acharya (2003) studies the interaction of capital standards and bailout policies. In the framework of Acharya (2003), however, international spillovers arise due to national banks that compete on regional bank markets. In this paper, in contrast, externalities arise due to the reallocation of capital between different subsidiaries within a multinational bank network. The importance of this internal capital market at multinational banks, which allocates capital between its affiliates, has been stressed in the recent empirical literature (see e.g. Cetorelli and Goldberg 2012). The findings of this literature on the role of multinational banks during times of financial distress can be summarized as follows. On the one hand, the internal capital market of multinational banks can play a supportive role for subsidiaries that face idiosyncratic shocks (see e.g. Navaretti et al., 2010). At the same time, the reallocation of funds between affiliates of a multinational bank network might also lead to the propagation of local shocks (see e.g Peek and Rosengren, 1997; De Haas and Van Horen, 2012). In our model, we account for both of these possible outcomes.

The remainder of this paper is set up as follows. Section 2 describes the setup of the model. The basic model is solved by backward induction in section 3, while the welfare analysis is carried out in section 4. Section 5 concludes.

2 The model

2.1 Bank investment

We consider one representative multinational bank that owns two subsidiaries and has a unique technology of monitoring entrepreneurs. One subsidiary is located in country A while the other subsidiary is resident in country B. Each subsidiary has access to an unlimited amount of domestically raised (insured) deposits at cost of one. In contrast, the supply of bank equity is assumed to be fixed at the level of the multinational bank.[6] The amount of equity at the subsidiary in country A is denoted α. The allocation decision will be analyzed below. Further, we assume that firms do not have any funds of their own so that one unit of loan distributed in country i translates into one unit of investment I_i.

The investment of banks is prone to country specific shocks. Consequently, the return to each unit of bank investment is perfectly correlated within each country and perfectly uncorrelated between both countries. If the shock does not hit country i, each unit of investment leads to the production of one unit of a homogenous consumer good in this country. We assume that both countries are symmetric with respect to the size of the market A and that each national output market is characterized by the inverse demand function $p_i = A - ay_i$. Allowing for free entry of firms that can produce at zero cost, the return of each unit of bank investment in country i in case of successful production is therefore equal to the price on the national output market and given by

$$R_i = A - aI_i \; . \tag{1}$$

Obviously, as all profits accrue to the bank subsidiary, R_i is a positive function of the exogenous parameter A and a negative function of total investment in country i. When the investment is successful, the bank subsidiary will be able to repay its depositors and pay out the surplus to the equity holders. Including the surplus to consumers and given that the subsidiary in country i is not hit by a shock, each unit of bank investment generates

$$v_i = R_i + CS_i = A - \frac{a}{2} I_i \; . \tag{2}$$

If, in contrast, country i is hit by a shock, the return of the investment will be zero. Abstracting, for now, from the internal capital market of the multinational bank that reallocates capital between its subsidiaries, the bank subsidiary that is located in country i will not be able to repay its depositors. In this case, the repayment obligations will be shifted to the deposit insurance system. The existence of a deposit insurance system, which equals common practice in virtually all developed countries, can be explained by the prevention of expectation-driven bank runs. These runs would occur due

[6] This simplification is often made in the literature, e.g. Dell'Ariccia and Marquez (2006). It represents the notion that bank capital is difficult to raise on short notice. All results would remain qualitatively unaffected if we would instead assume that the bank can raise additional equity but faces higher expected cost than for deposits.

to the possibility for depositors to withdraw their funds at any time. The welfare costs of these bank-runs have been well documented (see e.g. Bryant 1980 and Diamond and Dybvig 1983). Critically, as shown in the analysis of Acharya and Dreyfuss (1988) and Chan et al. (1992) among others, due to asymmetric information and timing problems, it might not be possible to charge banks with fair insurance rates. Experienced difficulties to (fully) recoup the vast amount of financial support from taxpayers during and after the financial crisis confirm this feature of deposit insurance as a subsidy to bank owners. We model this by assuming that the default of the bank subsidiary that is located in country i causes social costs for each unit of investment equal to

$$c^d = c(1 - k_i) \ . \tag{3}$$

The exogenous parameter c captures the cost of raising one unit of funds to reimburse depositors. These costs are primarily due to distortions caused by the collection of public funds. Further, as we only allow for two different types of funds, deposits and equity, the amount of insured deposits for each unit of investment is equal to the total investment net of the amount of equity k_i that the subsidiary in country i is required to hold by the national regulation authority.

2.2 Bank regulation

In this model, the role for regulation follows from two facts. First, as shown in Eq. (3), the default of the bank subsidiary in country i has social costs. Second, due to the limited liability of bank owners and the presence of the deposit insurance system, bank owners have no incentive to curb these costs.

We allow for two regulatory instruments. First, the national regulation authority in country i can impose capital requirements k_i. This standard determines the amount of equity that the subsidiary in country i has to invest for each unit of loan. Equation (3) illustrates the buffer function of capital standards. As an increase in k_i decreases the amount of fixed claims (deposits) for each unit of investment, the expected cost of default decreases in turn. At the same time, however, due to the fixed amount of equity, which we normalize to one, capital standards also limit the total investment of each subsidiary which is given by

$$I_i = \frac{e_i}{k_i} \ , \tag{4}$$

where $e_A = \alpha$ is the amount of equity that the multinational bank allocates to the subsidiary in country A, while $e_B = 1 - \alpha$ is the amount of equity at the subsidiary in country B. Below, we will analyze the allocation of equity between both subsidiaries.

Second, we assume that a supervisory authority can intervene into the activity of each bank subsidiary. The modelling approach for this part follows Beck and Wagner (2016). After the investment of each subsidiary, but before the realisation of the shock, the supervisory authority will receive a signal indicating the probability λ_i that the investment of the subsidiary in country i will be successful. To simplify, we assume λ_i to be uniformly distributed between $[0, 1]$.[7] Then, for a given intervention threshold $\tilde{\lambda}_i$, which we will derive below, we can differentiate between three scenarios. First, for $\lambda_i < \tilde{\lambda}_i$ and thus with probability $\tilde{\lambda}_i$, the supervisory authority will intervene. We assume that in this scenario the regulation authority is able to recover the initial investment I_i.[8] Second, given that the supervisory authority will not intervene, the probability that country i will not be hit by a shock is equal to $\frac{1+\tilde{\lambda}_i}{2}$. Consequently, the ex-ante probability of successful investment is equal to $(1 - \tilde{\lambda}_i)\frac{1+\tilde{\lambda}_i}{2} = \frac{1-\tilde{\lambda}_i^2}{2}$. Third, the subsidiary is allowed to continue but then hit by a shock. The ex-ante probability of this scenario is equal to $\frac{(1-\tilde{\lambda}_i)^2}{2}$.

In this model, we are mainly interested in the interaction of capital standards and intervention thresholds in the case that countries do not fully coordinate in the determination of both regulatory instruments. Even in the presence of the Basel 3 Accord, a global regulatory framework, this setting should be a realistic reflection of the current situation. First, the Basel 3 Accord constitutes only a voluntary framework that further leaves scope for national evaluations, e.g. with respect to the discretionary surcharge of a 'counter-cyclical buffer' of up to 2.5%. Second, it seems to be widely believed that the capital standards that are specified in the Basel 3 framework are insufficient for large multinational banks.[9] The United States have already introduced a minimum leverage

[7]While this distribution corresponds to the ex-ante shock probability being equal to 1/2, our results would not be affected qualitatively by different values.

[8]The intervention can take different forms, e.g. assumption of operation involving another bank, and might also incur specific costs. However, as long as these costs are sufficiently small relative to the costs arising after the shock, the same qualitative results would be obtained.

[9]See www.financialstabilityboard.org/wp-content/uploads/TLAC-Condoc-6-Nov-2014-FINAL.pdf for a consultative document of the Financial Stability Board in response to the G20 St. Petersburg Summit in 2013 that discusses Pillar 1 total loss absorbing capital requirements for systemically important banks and proposes capital standards in the range of $16 - 20\%$.

ratio of $5-6\%$ for eight systemically important financial institutions.[10] This level is well above the leverage ratio of 3% that is foreseen under the Basel 3 framework. Similarly, the United Kingdom and Switzerland have also tightened the capital standards for their largest banks above the minimum standards of Basel 3.[11] Therefore, we assume that the capital standards in the first stage of our model are determined non-cooperatively. Starting from this assumption, we are then interested in the evaluation of supervisory regimes that differ with respect to the degree of centralisation.

2.3 Internal capital market of the multinational bank

Each affiliate of the multinational bank is organized as a subsidiary. Therefore, it is a locally incorporated stand-alone entity endowed with own capital and protected by limited liability at the affiliate level. Consequently, in the case of financial difficulties at the level of one subsidiary, there would be no legal obligation for the multinational bank to relocate capital between subsidiaries to solve this problem. However, and crucially, there might be other reasons.

The primary reason for the multinational bank to prevent the insolvency of its subsidiaries is reputational. The particular importance of this argument is connected to the characteristic of banking. Due to the illiquidity of its asset side (e.g. loans), the large amount of short-term liabilities and the opaqueness of the financial market, it is of critical importance for each bank to be viewed as trustworthy by all stakeholders (borrowers, investors and regulation authorities). Therefore, the failure of one subsidiary might cause an interruption to the provision of liquidity for all subsidiaries within the bank network and thus amplify the cost for the multinational bank. Further, regulation authorities might also demand the replacement of the multinational bank management following the default of subsidiaries that are part of the multinational bank network.

As already discussed, the empirical literature shows that due to the reallocation of capital within the multinational bank network, subsidiaries, in contrast to purely domestic banks, can either be more stable or more prone to external shocks. We try to account for both of these possible outcomes by modelling multinational bank behaviour in the following way. In case that either no or both subsidiaries are hit by a shock, no capital

[10] see www.federalreserve.gov/newsevents/press/bcreg/20140408a.htm

[11] see www.bankofengland.co.uk/pra/Documents/publications/ss/2013/ss313.pdf and www.admin.ch/opc/de/classified-compilation/20121146/201501010000/952.03.pdf

reallocation between both subsidiaries will take place. In contrast, whenever only one subsidiary is hit by a shock, the multinational bank can react and reallocate capital to the affected subsidiary. However, as we assume that the shock will take place before the end of the period and thus before the investment in both countries pays off, the subsidiary in the non-affected country has to incur liquidation losses to meet the immediate capital demand. In expected terms, we assume these cost to be smaller than the reputational costs that would arise from a partial default of the subsidiary that was hit by the shock. Consequently, given a unilateral shock, the multinational bank will always decide to liquidate the subsidiary's investment in the non-affected country. To allow for a rich set of possible outcomes, we assume that l, the liquidation loss per unit of investment, is distributed according to the function $h(l)$ that generates positive probabilities for the following three scenarios:

$$\underbrace{\int_0^{l^r} h(l)dl}_{p^r} + \underbrace{\int_{l^r}^{l^c} h(l)dl}_{p^m} + \underbrace{\int_{l^c}^{R} h(l)dl}_{p^c} = 1 \tag{5}$$

where

$$l^r = R_i - (1 - k_i) - (1 - k_j) \ , \tag{6}$$

$$l^c = R_i - (1 - k_i) \ . \tag{7}$$

To illustrate the effect of capital reallocation within the multinational bank, we analyze the different outcomes of the scenario in which the subsidiary in country j is hit by a shock and, thus, the subsidiary in country i liquidates its assets to reallocate capital to the affected subsidiary. First, if the liquidation loss of the subsidiary in country i is sufficiently small ($l \leq l^r$), the multinational bank will be able to reallocate capital to the subsidiary in country j to allow for the repayment of depositors in both countries. Therefore, in this case, the subsidiary in country j that is hit by a shock will be rescued through the internal capital market by funds of the subsidiary in country i. The expected liquidation loss given that $l \leq l^r$ is labeled $\mu^r(l)$. Second, for liquidation losses within the range of $l^r < l < l^c$, the subsidiary in country i will be able to repay its local depositors but the remaining funds will be too small to further repay the depositors in country j. Consequently, the subsidiary that is located in country j will default, while the subsidiary in country i will remain open. The expected liquidation loss given that $l^r < l < l^c$ is labeled $\mu^m(l)$. Third, if the liquidation loss is sufficiently severe ($l > l^c$), even the subsidiary in country i will not be able to repay its depositors. Thus, in this scenario the shock in country j is contagious in the sense that it triggers the default of the subsidiary in country i that was not hit by a shock. The expected liquidation loss given that $l > l^c$ is labeled $\mu^c(l)$.

Equations (5)-(7) illustrate the positive welfare effect of an increase in capital standards on the outcome of the internal capital reallocation by the multinational bank. Due to the fact that capital standards define the buffer that can take losses, following an increase in k, each affiliate can withstand greater liquidation losses, which leads to an increase of p_r and a decrease of p_c.[12]

Besides the liquidation costs that are private to the bank owners, additional social cost arise.[13] These costs arise when entrepreneurs depend on the continuous funding of the bank subsidiary and are thus not able to finish their projects, leading to a reduction in consumer surplus. Further costs might be due to the loss of private information between the entrepreneur and the bank following the termination of the relationship. These expected additional liquidation costs are labeled $\mu^e(l)$. Therefore, the total expected social liquidation cost for each unit of investment are given by

$$c^l = p^r \mu^r(l) + p^m \mu^m(l) + p^c \left[\mu^c(l) + c^d\right] + \mu^e(l)\ . \tag{8}$$

While the expected cost in the first two terms of (8) are private to the bank owners, the expected cost in the third term are only private to the degree that the bank owners stock of equity is depleted. The remaining losses measured in the third term, as well as the losses captured in the fourth term of (8) are not internalized by the bank owner. However due to the prevention of the subsidiaries' default whenever $l \leq l^r$, the overall welfare effect of the internal capital reallocation of the multinational bank remains ambiguous.

2.4 Time structure

The sequence of events in this model is illustrated in figure 1. In the first period, regulation authorities in both countries non-cooperatively set capital standards for the subsidiary that is resident in the respective country. In the second period the multinational bank allocates its equity between the subsidiaries in country A and country

[12]See Anginer et al., 2016 for a empirical study that analyses the default risk of foreign bank subsidiaries. The authors find a positive effect of equity holding at the subsidiary level on the contagion risk within the multinational bank network.

[13]See Dell'Ariccia et al (2008) and Chor and Manova (2012) for empirical studies that support this assessment.

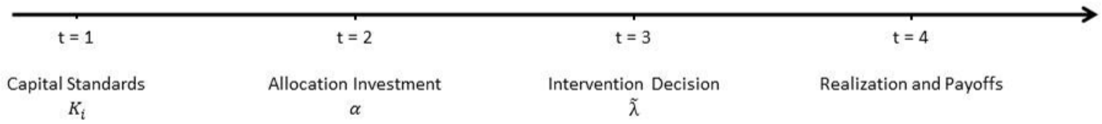

Figure 1: The timeline of events

B. In the third period the supervision authority will receive a signal about the success probability of the investment in both countries. It will intervene into the operation of the subsidiary in country i whenever the success probability λ is below the threshold $\tilde{\lambda}$. At this stage we will analyze the differences between the outcome of a national and a global regime. Between the third and the fourth period each subsidiary, when allowed to continue, can be affected by a shock in its resident country. In case that one of the two subsidiaries is hit by a shock, the subsidiary that is not hit by the shock will liquidate its assets, thereby incurring liquidation losses of l that follow the distribution $h(l)$. Finally, in the fourth period, the payoffs will realize. We will solve the model by backward induction.

3 Nationally optimal capital standards with different intervention regimes

3.1 t=4: Payoffs

For each country, the expected payoff from the activity of the resident subsidiary of the multinational bank depends on the regulatory framework (k and $\tilde{\lambda}$) and on the allocation of capital by the multinational bank (α). The resulting welfare function of country A is then given by

$$E[WF_A] = \left\{ \tilde{\lambda}_A + \frac{1-\tilde{\lambda}_A^2}{2}\left[v_A - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^l \right] - \frac{(1-\tilde{\lambda}_A)^2}{2} c_A^d \left[1 - \frac{1-\tilde{\lambda}_B^2}{2} p_A^r \right] - 1 \right\} \frac{\alpha}{k_A} \ . \quad (9)$$

The first term in (9) measures the expected return from the intervention of the supervision authority into the investment of the subsidiary in country A. It is equal to $\tilde{\lambda}_A$ due to the fact that the regulation authority will intervene whenever $\lambda < \tilde{\lambda}_A$ and recover the initial investment of one in this case. The second term in (9) captures the expected payoff in case that the subsidiary is allowed to continue and not hit by a shock. Then, whenever the investment is not liquidated early, each unit of investment will yield the social return of v_A[see eq. (2)]. In contrast, when the subsidiary in country B is hit by a shock, the welfare in country A will be reduced by the expected liquidation cost c^l_A [see eq. (8)]. The expected cost in case that the supervision authority does not intervene and the subsidiary is hit by a shock is given in the third term of (9). Here, the return of the bank investment will be zero and the additional default costs c^d_A, which are given in (3), will arise, unless the subsidiary will be rescued. This will happen whenever the subsidiary in country B is not hit by a shock and the liquidation losses are sufficiently small. Finally, the last term in (9) is equal to the opportunity cost of each unit of investment.

3.2 t=3: Supervisory intervention: national vs. global regime

At this stage, the supervisory authority receives a signal about the probability λ_i that the bank investment in country i will be successful. Due to the reallocation of capital by the multinational bank in case that one subsidiary is hit by a shock, the intervention decision in country i affects the expected welfare in country j [see eq. (9)]. We want to compare two regimes that differ in the degree that this externality is taken into account. We start with the decision of a national supervisory regime. Therefore, we derive the first order condition of (9) with respect to the intervention threshold $\tilde{\lambda}_A$ and get:

$$\frac{\partial WF_A}{\partial \tilde{\lambda}_A} = \left\{ 1 - \tilde{\lambda}_A \left[v_A - \frac{(1-\tilde{\lambda}_B)^2}{2} c^l_A \right] + (1-\tilde{\lambda}_A) c^d_A \left[1 - \frac{1-\tilde{\lambda}^2_B}{2} p^r_A \right] \right\} \frac{\alpha}{k_A} = 0 \quad (10)$$

Equation (10) shows that a marginal increase in the intervention threshold $\tilde{\lambda}_A$ increases the expected return from intervention (first term) and decreases the expected cost from failure (third term). However, clearly, it also reduces the expected return from successful investment (second term). Therefore, the intervention threshold is chosen relatively low whenever the expected return from successful investment is relatively large, while for large expected costs from failure, the intervention threshold is relatively high.

The ambiguous sign of the interaction term between the intervention threshold in each country is due to the ambiguous welfare effect that follows from the reallocation of capital by the multinational bank. As explained in the previous section, the continuation of the subsidiary in country B will be welfare increasing for country A from an ex-post perspective, whenever the shock unilaterally hits the resident subsidiary. However, it can also be welfare decreasing, whenever only country B is hit by a shock. Whenever the expected cost from liquidation is large, the positive effect of a marginal increase in $\tilde{\lambda}_B$ on the expected return from continuation outweighs the negative effect on the expected cost from continuation that is due to the lower probability of rescue. Therefore in this case it holds that $\frac{\partial \tilde{\lambda}_A}{\partial \tilde{\lambda}_B} < 0$, while for low expected cost from liquidation and thus high probability of rescue we get $\frac{\partial \tilde{\lambda}_A}{\partial \tilde{\lambda}_B} > 0$.

Taking into account the effect of k_A, Equation (10) shows that a marginal increase in k_A decreases the optimal intervention threshold for three reasons. First, marginally increasing k_A reduces the expected cost from liquidation due to the lower probability of contagion [see eqs. (5) and (7)]. This in turn increases the expected return from successful investment and thus decreases the optimal intervention threshold. Second, an increase in k_A reduces the expected cost from default by limiting the amount of public funds [see eq. (3)], while third it increases the probability of rescue [see eqs. (5) and (6)]. Both effects decrease the expected cost of continuation and thus also lead to a decrease in the optimal intervention threshold.

We now turn to the intervention threshold that is chosen by a global supervisory regime:

$$\frac{\partial WF}{\partial \tilde{\lambda}_A} = \frac{\partial WF_A}{\partial \tilde{\lambda}_A} + (1 - \tilde{\lambda}_A)\frac{1 - \tilde{\lambda}_B^2}{2} c_B^l - \tilde{\lambda}_A \frac{(1 - \tilde{\lambda}_B)^2}{2} p_B^r c_B^d = 0 \; . \tag{11}$$

Equation (11) shows two externalities that are taken into account by the global supervisory regime. The first externality, which is captured in the second term of (11) is positive. The marginal increase in the intervention threshold for the subsidiary located in country A benefits country B due to the fact that it reduces the probability of failure for the subsidiary in country A and thus decreases the expected cost from liquidation for the subsidiary in country B. In contrast, the second externality that is equal to the third term of (11) is negative. This is caused by the negative effect of a marginal increase in $\tilde{\lambda}_A$ on the ex-ante success probability of the investment by the subsidiary in country A, which in turn reduces the probability that the subsidiary in country B will be rescued through the internal capital market of the multinational bank.

We can now use (11) to compare the intervention threshold of the national and the global supervisory regime. As $\frac{\partial^2 WF_A}{\partial \tilde{\lambda}_A^2} < 0$ follows directly from (10), it is clear that the intervention threshold chosen by the global supervisory regime can be either more strict or more lenient than the intervention threshold by the national supervisory regime. It will be more strict whenever the positive welfare effect of an increase in $\tilde{\lambda}_i$ on the expected cost from liquidation in country j outweighs the negative welfare effect that is due to the decrease in the rescue probability. However, and clearly, if we stopped at this stage, the global supervisory regime would be welfare superior to the national regime independent of the direction of the deviation between both regimes.

3.3 t=2: Investment decision by the multinational bank

We now want to analyse the allocation of equity between the subsidiaries in country A and country B. The expected profit of the multinational bank is equal to

$$E[\pi] = \left\{ \frac{1-\tilde{\lambda}_A^2}{2} \left[R_A - 1 - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^p \right] - \frac{(1-\tilde{\lambda}_A)^2}{2} k_A \right\} \frac{\alpha}{k_A} + \left\{ \frac{1-\tilde{\lambda}_B^2}{2} \left[R_B - 1 - \frac{(1-\tilde{\lambda}_A)^2}{2} c_B^p \right] - \frac{(1-\tilde{\lambda}_B)^2}{2} k_B \right\} \frac{1-\alpha}{k_B} , \quad (12)$$

where

$$c_A^p = p^r[\mu^r(l) + (1-k_B)] + p^m \mu^m(l) + p^c(R_A - 1 + k_A) \quad (13)$$

$$c_B^p = p^r[\mu^r(l) + (1-k_A)] + p^m \mu^m(l) + p^c(R_B - 1 + k_B) \; . \quad (14)$$

The first row in (12) captures the expected profit of the subsidiary located in country A, while the expected profit of the subsidiary located in country B is displayed in the second row. Abstracting from the success of the subsidiary in the other country, in case of no supervisory intervention and no shock, the net return of the subsidiary's investment in each country will be equal to $R_i - 1$. However, in case that the subsidiary in the other country is hit by a shock additional liquidation costs occur. Equations (13) and (14) show that these costs depend on the severity of the liquidation shock. In case that the liquidation shock is sufficiently weak, the subsidiary will not only incur these losses ($\mu_r(l)$) but also repay the depositors in the other country. For medium liquidation shocks, the subsidiary will still be able to repay its own depositors but lose $\mu_s(l)$ in expectation. However for severe liquidation shocks, the subsidiary will lose the entire return of the project but will benefit from limited liability as the depositors $(1-k_i)$ are reimbursed through the deposit insurance system. Finally, if the subsidiary is allowed to continue but hit by a shock, the bank owner will lose the amount of equity that is invested in the project. In this case, the depositors will either be repayed by the subsidiary in the other country (with probability p_r) or by the deposit insurance.[14]

[14]Due to our assumption of the supervisory regime liquidating with zero costs, the profit of the bank remains unaffected with probability $\tilde{\lambda}$.

We now want to analyse the allocation of equity at the level of the multinational bank that can choose between the subsidiaries in country A and country B. In Appendix A.1 we show that the amount of equity that the multinational bank allocates to the subsidiary that is located in country A is given by

$$\alpha = \frac{1}{2} + \frac{(1-\tilde{\lambda}_A^2)k_A k_B^2 \phi_A - (1-\tilde{\lambda}_B^2)k_A^2 k_B \phi_B + k_A^2 k_B^2[(1-\tilde{\lambda}_B)^2 - (1-\tilde{\lambda}_A)^2]}{2a[(1-\tilde{\lambda}_A)^2 k_B^2 + (1-\tilde{\lambda}_B)^2 k_A^2]} \ , \quad (15)$$

where

$$\phi_A = A - \frac{a}{k_A} - 1 - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^p \quad (16)$$

$$\phi_B = A - \frac{a}{k_B} - 1 - \frac{(1-\tilde{\lambda}_A)^2}{2} c_B^p \quad (17)$$

Equation (15) shows that the multinational bank will equally allocate its equity between its subsidiaries whenever both countries are symmetric. In this case, the second term of (15) becomes zero. Further, deriving the partial derivatives of α with respect to the regulatory instruments k_i and $\tilde{\lambda}_i$ yields the expected result that[15]

$$\frac{\partial \alpha}{\partial k_A} = -\frac{\partial \alpha}{\partial k_B} = -\frac{A - \frac{2a}{k} - 1 - \frac{(1-\tilde{\lambda})^2}{2} c^p}{4a} < 0 \ , \quad (18)$$

$$\frac{\partial \alpha}{\partial \tilde{\lambda}_A} = -\frac{\partial \alpha}{\partial \tilde{\lambda}_B} = \frac{-2\tilde{\lambda}k\left[A - \frac{a}{k} - 1 - \frac{(1-\tilde{\lambda})^2}{2} c^p\right] - (1-\tilde{\lambda})k\left[c^p(1-\tilde{\lambda}^2) - 2k\right]}{4a(1-\tilde{\lambda}^2)} < 0 \ . \quad (19)$$

Equations (18) and (19) make clear that a unilateral increase in one of the regulatory instruments will lead to an outflow of bank capital from this country. Intuitively, when k_i is increased, the subsidiary that is located in country i can use a lower amount of subsidized deposits for each unit of investment. This in turn decreases the attractiveness for the multinational bank to allocate (scarce) equity to the subsidiary that is located in country i. Similarly, an increase in the expected threshold of intervention $\tilde{\lambda}_i$ decreases the expected value of the investment in this country from the perspective of the multinational bank. Obviously, the results hinge on the (realistic) assumption that both regulatory instruments are binding. This will be the case whenever the cost from failure and liquidation that are not internalized by the bank are sufficiently high relative to the benefit of continuation from the perspective of the consumer.[16]

[15] This is shown in Appendix A.2.

[16] See Appendix A.2 for the precise condition.

3.4 t=1: Capital standards

We can now turn to the analysis of the capital standards that are set non-cooperatively in the first stage of our model. Given the symmetric setup, maximizing (9) with respect to k_A yield the following first-order condition:

$$\frac{\partial E[WF_A]}{\partial k_A} = \left(\frac{\partial \alpha}{\partial k_A}\frac{1}{k} - \frac{\alpha}{k^2}\right)\psi + \frac{\alpha}{k}\sigma + \eta = 0 \tag{20}$$

where

$$\psi = \tilde{\lambda} + \frac{1-\tilde{\lambda}^2}{2}\left[A - a\frac{\alpha}{k} - \frac{(1-\tilde{\lambda})^2}{2}c^l\right] - \frac{(1-\tilde{\lambda})^2}{2}c^d\left[1 - \frac{1-\tilde{\lambda}^2}{2}p^r\right] - 1 \tag{21}$$

$$\begin{aligned}\sigma = & c\left[\frac{(1-\tilde{\lambda})^2}{2}\left(1 - \frac{1-\tilde{\lambda}^2}{2}p^r\right) + \frac{1-\tilde{\lambda}^2}{2}\frac{(1-\tilde{\lambda})^2}{2}p^c\right] \\ & + h(l^c)\frac{1-\tilde{\lambda}^2}{2}\frac{(1-\tilde{\lambda})^2}{2}c^d + h(l^r)\frac{(1-\tilde{\lambda})^2}{2}\frac{1-\tilde{\lambda}^2}{2}c^d\end{aligned} \tag{22}$$

$$\begin{aligned}\eta = & \left[(1-\tilde{\lambda})\frac{1-\tilde{\lambda}^2}{2}c^l - \tilde{\lambda}\frac{(1-\tilde{\lambda})^2}{2}p^r c^d\right] \\ & \left\{ D\left[\frac{-(1-\tilde{\lambda})c^d\frac{1-\tilde{\lambda}^2}{2}h(l^r)}{v - (1-\tilde{\lambda})^2 c^l + c^d\left(1 - p^r\frac{1-\tilde{\lambda}^2}{2}\right)}\right]\right. \\ & \left. + (1-D)\left[\frac{h(l^c)c^d\frac{1-\tilde{\lambda}^2}{2}(-1+2\tilde{\lambda}) - c\left[\frac{(1-\tilde{\lambda})^2}{2}(1-2\tilde{\lambda})(p^c - p^r) - (1-\tilde{\lambda})\right]}{v - (1-\tilde{\lambda})^2 c^l + c^d\left(1 - p^r\frac{1-\tilde{\lambda}^2}{2}\right) + \frac{1-\tilde{\lambda}^2}{2}c^l + \frac{(1-\tilde{\lambda})^2}{2}p^r c^d}\right]\right\}\end{aligned} \tag{23}$$

and

$$D = \begin{cases} 0 & \text{if} \quad \text{global supervisory regime} \\ 1 & \text{if} \quad \text{national supervisory regime}\end{cases} \tag{24}$$

Looking at (20), we can decompose the welfare effect of a marginal increase in k_A into three parts. The first term in (20) measures the welfare effect that is due to the change in the subsidiary's investment in country A, while the second term in (20) includes the welfare effect of k_A on the expected cost of liquidation and failure. Finally, the third term in (20) captures the indirect effect of k_A on the intervention threshold in both countries. We will now analyze each effect in turn to emphasize the effect of different supervisory regimes on the level of capital standards at this stage.

According to the first term in (20), bank investment in country A decreases for two reasons when capital standards in country A are unilaterally increased. First, obviously, as the capital standard is binding and the amount of equity is fixed, the only way for the bank to meet the requirement of funding each unit of investment with a larger amount of equity is to reduce the total amount of investment. Second, however, due to the mobility of bank investment [see eq. (18)] the multinational bank will allocate more equity to the subsidiary in country B whenever country A unilaterally increases its capital standard. The welfare loss that follows from this reduction in bank investment is shown in (21). Now, critically, due to the different intervention thresholds that are set by the national and the global supervisory regime [see eqs. (10) and (11)], the marginal social return to bank investment in country A will be higher under the global supervisory regime. Therefore, the negative welfare effect of a marginal increase in k_A that follows from the reduction in bank investment will be larger under the global supervisory regime.

The positive welfare effect of a marginal increase in k_A on the expected cost from bank investment is captured in (22). The first term in (22) measures the decrease in the social cost from bank failure. This will be relevant either when country A is hit by a shock [first term in square bracket of (22)] or when the liquidation loss of the subsidiary located in country A is sufficiently high [second term in square bracket of (22)]. As the probability of bank failure is decreasing in $\tilde{\lambda}$, it is clear that the positive welfare effect of k_A on the social cost of bank failure is reduced when the intervention threshold is higher. Further, as shown in the second line of (22), the marginal increase of k_A changes the probability of the different outcomes that can arise from the reallocation of capital. Both terms are positive as one can directly see from (5)-(7). Intuitively, by increasing the buffer that can take losses without causing insolvency, higher capital standards in country A increase the range of liquidation losses for the subsidiary in country B where it can still rescue the subsidiary in country A. Likewise the range of liquidation losses for which the subsidiary in country A can default itself is reduced. Again, these positive effects are decreasing in the intervention threshold. Consequently, (22) will be larger under the national supervisory regime whenever the global supervisory regime is more strict ($\tilde{\lambda}^g > \tilde{\lambda}^n$).

The third term in (20) captures the indirect welfare effects that are due to the change in the intervention threshold in both countries when k_A is increased. Under the national supervisory regime, we can ignore $\frac{\partial WF_A}{\partial \tilde{\lambda}_A}$ as one can directly see from the optimization problem in (10). Thus (23) measures $\frac{\partial WF_A}{\partial \tilde{\lambda}_B}\frac{\partial \tilde{\lambda}_B}{\partial k_A}$. Here, k_A only affects the intervention decision by the national supervisory regime in B to the degree that it changes the probability of rescue for the subsidiary in B. As an increase in k_A enhances the probability of rescue for the subsidiary in B [see eqs. (5) and (6)], this will decrease the intervention threshold in B. The induced welfare effect for A depends on the relative importance of the rescue to the contagion effect [see eq. (23)]. Consequently, whenever the indirect welfare effect of k_A through λ is relatively strong, then this effect will be positive as A will be positively affected by the decrease in the intervention threshold in B due to the higher probability of rescue. This in turn reinforces the effects in (22) under the national supervisory regime. Turning to the global supervisory regime, we can use the maximization problem in (11) to rewrite $\frac{\partial E[WF_A]}{\partial \tilde{\lambda}_A} = -\frac{\partial E[WF_A]}{\partial \tilde{\lambda}_B}$ so that (23) captures $\frac{\partial E[WF_A]}{\partial \tilde{\lambda}_B}\left(\frac{\partial \tilde{\lambda}_B}{\partial k_A} - \frac{\partial \tilde{\lambda}_A}{\partial k_A}\right)$. Under the global supervisory regime there exist two indirect effects of k_A through $\tilde{\lambda}$. First, the decrease in the contagion risk in A leads to a decrease of the intervention threshold in both countries. Here, given that the lower intervention threshold partially reverses the decrease in the contagion risk, this indirect effect has negative welfare implications for country A whenever this effect is relatively strong.[17] Compared to the national supervisory regime, this again reduces the positive welfare effects of a marginal increase in k_A under the global supervisory regime. Second, the increase in k_A reduces the cost of default, which in turn reduces the intervention threshold in country A and country B under the global supervisory regime. While the effects of lower intervention thresholds in A and B partly balance each other, the overall welfare effect again depends on the relative importance of the rescue and contagion externality. We can now summarize our findings at this stage in:

Proposition 1 *When the intervention of national supervisory authorities into the local operation of multinational bank subsidiaries is less strict than globally optimal, then changing to a regime of global supervision will reduce the capital standards that are set non-cooperatively. The reduction in capital standards is less pronounced and can even be reversed when the intervention threshold of the national supervisory authorities is inefficiently high.*

Proposition 1 tells us that the incentives of national regulation authorities to impose capital standards on the resident subsidiaries of multinational banks are affected by the expectation about the procedure and the externalities that arise from the intervention

[17]This effect is not present in the case of a national supervisory regime as the contagion risk of the other country is not included in the maximization problem.

regime. As the analysis of (20) has shown, this is mainly for two reasons. First, increasing the efficiency of intervention by changing to a global supervisory regime raises the value of one unit of bank investment from the perspective of the national regulation authority. This in turn increases the competition between the regulation authorities in both countries to attract mobile bank investment and thus decreases the amount of capital standards that are set non-cooperatively. Second, each regulation authority imposes capital standards to increase the safety of its banking system. Obviously, the incentive to impose strict capital standards depends on the probability of bank failure, which in our model is a negative function of the intervention threshold $\tilde{\lambda}$. Therefore, when national intervention regimes are too lax from a global welfare perspective, moving to a global supervisory will result in higher $\tilde{\lambda}$. This reinforces the incentive for national regulation authorities to decrease its capital standards. In contrast, whenever the positive externalities of bank continuation dominate, introducing a global supervisory regime will lower $\tilde{\lambda}$ and therefore, ceteris paribus, increase k. Thus, in this case we can not unambiguously sign the effect of a more centralized intervention regime on the level of capital standards that are set non-cooperatively.

4 The welfare effect of moving towards a global supervisory regime

We now want to use the results from the analysis in section 3 to discuss the welfare implications of a more centralized supervisory regime. Therefore, we assume that the supervisory regime takes account of the net externality that arises at the stage of intervention [see eq. (11)] with a factor $0 \leq \gamma \leq 1$. We start at $\gamma = 0$ and analyse the welfare effect of a marginal increase in γ. In Appendix A.3 we show that, given the symmetry of countries and thus $\delta\tilde{\lambda}_A/\delta\gamma = \delta\tilde{\lambda}_B/\delta\gamma = \delta\tilde{\lambda}/\delta\gamma$, the welfare effect of a marginal increase in the centralization of the supervisory regimes is given by

$$\frac{\partial E[WF_A]}{\partial \gamma} = \frac{\partial \tilde{\lambda}}{\partial \gamma}\left[\frac{\partial E[WF_A]}{\partial \tilde{\lambda}_B}\left(1 + \frac{\partial \tilde{\lambda}_B}{\partial \tilde{\lambda}_A}\right) + \frac{\partial E[WF_A]}{\partial k_B}\left(\frac{\partial k_B}{\partial \tilde{\lambda}_B} + \frac{\partial k_B}{\partial \tilde{\lambda}_A}\right)\right] \tag{25}$$

where

$$\frac{\partial\tilde{\lambda}}{\partial\gamma} = \frac{(1-\tilde{\lambda})\frac{1-\tilde{\lambda}^2}{2}c^l - \tilde{\lambda}\frac{(1-\tilde{\lambda})^2}{2}p^r c^d}{v - \frac{(1-\tilde{\lambda})^2}{2}(c^l + p^c c^d) + c^d\left(1 - \frac{1-\tilde{\lambda}^2}{2}p^r\right) + \gamma\left[\frac{1-\tilde{\lambda}^2}{2}(c^l + p^c c^d) + \frac{(1-\tilde{\lambda})^2}{2}(p^r c^d)\right]}\ , \tag{26}$$

$$\frac{\partial E[WF_A]}{\partial\tilde{\lambda}_B} = (1-\tilde{\lambda})\frac{1-\tilde{\lambda}^2}{2}(c^l + p^c c^d) - \tilde{\lambda}\frac{(1-\tilde{\lambda})^2}{2}p^r c^d\ , \tag{27}$$

$$\frac{\partial E[WF_A]}{\partial k_B} = \frac{\partial\alpha}{\partial k_B}\frac{1}{k}\psi + h(l^r)\frac{1}{2k}\frac{(1-\tilde{\lambda})^2}{2}\frac{1-\tilde{\lambda}^2}{2}c^d > 0\ , \tag{28}$$

$$\frac{\partial k_B}{\partial\tilde{\lambda}_B} + \frac{\partial k_B}{\partial\tilde{\lambda}_A} = \frac{\frac{1}{2}\left(\frac{\partial\sigma_B}{\partial\tilde{\lambda}_A} + \frac{\partial\sigma_B}{\partial\tilde{\lambda}_B}\right) - \frac{\partial\psi_B}{\partial\tilde{\lambda}_A}\left(\frac{\partial\alpha}{\partial k_B} + \frac{1}{2k}\right)}{\frac{\partial\psi_B}{\partial k_B}\left(\frac{\partial\alpha}{\partial k_B} + \frac{1}{2k}\right) - \frac{1}{2k}\frac{\partial\sigma_B}{\partial k_B}}\ . \tag{29}$$

Equation (25) shows that moving towards a global supervisory regime affects the welfare of each country through two channels. The first effect, which is always positive, is due to the fact that the externality at the intervention stage is taken into account. This is the effect on which the theoretical literature(see Beck and Wagner 2016) as well as policy reports (see Claessens et al. 2010) have focused. The second effect is due to the interaction of the regulatory instruments. As we have already analyzed in the previous section, this relation critically depends on the sign of the externality. Therefore, we discuss both scenarios one after the other.

4.1 Case 1: national supervision that is too lax

We start with the scenario that $\tilde{\lambda}^g > \tilde{\lambda}^n$. Obviously, in this case a marginal increase in the centralization of the supervisory regime increases the intervention threshold in both countries [see eq. (26)] and thus increases the welfare in each country [eq. (27)]. This effect is mitigated by the interaction between the intervention threshold in both countries ($\delta\tilde{\lambda}_B/\delta\tilde{\lambda}_A < 0$). The increase of the intervention threshold in country A lowers the probability of contagion in country B and thus leads to a decrease in the intervention threshold of country B as the expected return of continuation is increased.[18]

Now interestingly, the indirect welfare effect of a more centralized supervisory regime that is due to the interaction of $\tilde{\lambda}$ and k is negative. This follows from the unambiguously negative effect of $\tilde{\lambda}$ on the capital standard that is set non-cooperatively [see eq. (29)], which in turn decreases the welfare in country A [see eq. (28)]. The negative

[18] Formally, this can be seen by using the implicit function theorem on (10).

sign in (29) is due to two effects. On the one hand, the marginal increase of $\tilde{\lambda}$ decreases the positive effect of capital standards on the expected cost of bank failure [first term in the numerator of (29)], while at the same time it increases the marginal social return of bank investment in country A [second term in the numerator of (29)]. Both effects lead to a decrease in the capital standards that are set non-cooperatively as summarized in Proposition 1. This in turn reduces the welfare in country A for two reasons. First, it reinforces the externality in the first stage of the model that is due to the competition for mobile bank investment [first term in (28)]. Second, the probability that the bank subsidiary in country A can draw on liquidation funds of the bank subsidiary that is located in country B is reduced [second term in (28)].

In Appendix A.4 we derive the total welfare effect. This shows that a sufficient condition for the overall welfare effect of a marginal increase in the centralization of the supervisory regime to be negative is given by:

$$\left(A - \frac{2a}{k} - 1 - c^l\right)\left[\frac{\psi}{k}\left(A - \frac{2a}{k} - 1 - c^l\right) - 2 + 4k^2 c\right] > 16k^4 c\left[h(l^r) + h(l^c)\right] \ . \quad (30)$$

We can analyse condition (30) in the following way. If the externalities that are caused by the capital reallocation of the multinational bank react very sensitive to a marginal increase of capital standards, the right hand side of (30) will be very high. Thus, in this case the overall welfare effect of an increase in the centralization of supervision will very likely be positive. Intuitively, this is due to the fact that each national regulation authority will then only slightly decrease its capital standard when a more centralized intervention regime is introduced. Thus, the negative welfare effect that is illustrated in (28) is limited. In contrast, the left hand side is a positive function of the profitability of bank investment. Intuitively, in this case the positive externality of k is very high [see eq. (18)]. Therefore, the decrease in the non-cooperative equilibrium of capital standards that follows from a more centralized resolution regime imposes higher welfare losses. While k enters both sides of (30), we can directly see that it is weighted by different parameters. Whenever a is relatively low and thus bank investment is relatively profitable, the left hand side of (30) will be reduced to a lower degree. Similarly, whenever c is relatively low, the (positive) effect of k on the right hand side of (30) will be small. Therefore, we can summarize our findings at this stage in:

Proposition 2 *Whenever the capital standard is set non-cooperatively and the resulting externality due to the mobility of bank investment is sufficiently severe [* (30) *holds],* *moving from a national intervention regime with too little intervention to a more globally oriented resolution regime will be welfare decreasing.*

Our model thus shows that in the presence of further regulatory instruments, the desirability of a more centralized intervention regime that was brought forward in the recent literature is no longer unambiguous. The reasoning follows the theory of the second best.[19] This is due to the fact that in our model, there exist externalities at multiple stages. First, when national regulation authorities choose the optimal amount of capital standards they only consider the negative effect of an increase in k_i on mobile bank investment ($\delta\alpha/k_i < 0$) in their country. From a global perspective this is a zero-sum game [see eq. (18)]. Second, when national supervision authorities choose the level of intervention they fail to account for the international spillovers that are caused by the reallocation of capital within the multinational bank network in case of unilateral shocks. Now, importantly, when both regulatory instruments are determined non-cooperatively, they partly balance each other. National authorities will impose stricter capital standards when they expect higher costs from the subsidiary that is resident in its country, which in turn partly compensates for the externality at the first stage. Therefore, once full cooperation is not achieved in both regulatory tools, the gains from a more centralized intervention regime might disappear in the presence of lower capital standards that arise due to less protection and more intense competition at the level of national regulation authorities.

4.2 Case 2: national supervision that is too strict

We now move to the case where the intervention threshold that is set by a national supervisory regime is too high from a global welfare perspective. While in this case a marginal increase in γ leads to a decrease in $\tilde{\lambda}$ [see eq. (26)] it obviously also increases the welfare in both countries [see eq. (27)]. Different to case 1, this positive welfare effect is reinforced through the interaction of the intervention thresholds in both countries. This is due to the fact that the decrease in the intervention threshold in country A increases the probability of rescue for the subsidiary that is located in country B. For country B, this in turn increases the expected social return from continuation of its locally resident subsidiary and thus equally decreases the intervention threshold in country B.

[19] See Lipsey and Lancaster (1956) for the seminal paper in this literature.

The indirect welfare effect of an increase in δ that is due to the interaction of $\tilde{\lambda}$ and k has two parts. First, as in case 1, moving to a more globally oriented intervention regime increases the value of each unit of bank investment. Ceteris paribus, this leads to a decrease in the capital standard that is set non-cooperatively [see eq. (20)]. Second, however, the decrease in $\tilde{\lambda}$ also leads to an increase in the expected probability of bank default. Taking the derivative of the failure probability $p_f = \frac{(1-\tilde{\lambda})^2}{2}\left(1 - \frac{1-\tilde{\lambda}^2}{2}p_r\right)$ with respect to the intervention threshold we get that $\frac{\partial p_f}{\partial \tilde{\lambda}} = -(1-\tilde{\lambda})\left(1 - p_r\frac{1+\tilde{\lambda}-\tilde{\lambda}^2}{2}\right) < 0$. Intuitively, the increase in the probability of rescue does not compensate the increase in the probability of bank failure. This in turn, ceteris paribus, increases the capital standard of each country [see eq. (20)]. We can summarize this result in:

Proposition 3 *Moving towards a more globally oriented intervention regime is more likely to be welfare increasing when the externality at this stage is negative, e.g. national supervisory regimes would intervene too often.*

Therefore, comparing case 1 and 2, we can conclude that the conventional result of a more centralized intervention regime being associated with positive welfare effects is more likely to hold when national supervisory authorities would intervene too often from a global welfare perspective. However, this is in contrast to the experience from the recent crisis, where national regulation authorities were accused of intervening only at the last stages (Claessens et al., 2010; Beck and Wagner, 2016). Intuitively, decreasing the intervention threshold (as in case 2) ceteris paribus increases the capital standards and thus reduces the positive externality at the first stage. In contrast, increasing the intervention threshold (as in case 1) ceteris paribus decreases the capital standard and therefore reinforces the positive externality at the first stage.

5 Conclusion

In this model, we analyse the interaction between capital standards and resolution procedures when bank investment is mobile. In our setting, national regulation authorities non-cooperatively choose capital standards at the first stage. The multinational bank then allocates capital between its subsidiaries in the second stage. The outcome of both stages depends on the anticipation of the intervention regime at the third stage. Here we differentiate between a national and global intervention regime. The results of the paper stress the importance of a coordinated approach towards the determination of capital standards and the decision to intervene into the operation of multinational bank subsidiaries. Interestingly, in this regard, Europe and the United States seem to follow different directions.

So far, the United States have abstained from closer international integration in the supervision and intervention of multinational banks. At the same time, however, the leverage ratio for eight systemically important banks has been substantially raised above the level that is foreseen under the Basel 3 framework. This reaction is in line with the results of our paper. As the regulatory authorities in the United States can expect the intervention into multinational banks to be potentially very difficult, they have a strong incentive to impose strict capital standards as the main instrument to limit the potential costs.

In contrast, the introduction of the (not yet fully completed) Single Resolution Mechanism shows the determination of many European countries to move towards a centralized intervention regime for multinational banks. Clearly, this would be welfare optimal if all countries within the eurozone would also fully coordinate with respect to the determination of capital standards. To this regard, all countries within the eurozone have adapted the Basel 3 regulatory framework and are supervised under the Single Supervisory Mechanism. But, due to the lack of common capital definitions and further scope for national authorities, Danièle Nouy, chair of the supervisory board of the ECB, recently pointed out that the process of harmonisation is still far from completed.[20] Applying the results of this paper, we should expect all countries within the Euro Zone to insist on most favorable terms for all banks that are located within their jurisdiction. However, comparing the approaches of the US and the eurozone, this paper suggests that the consistent enforcement of harmonized capital requirements, in all details, will be the critical determinant for the centralised intervention approach of the eurozone to be successful.

[20]See www.bankingsupervision.europa.eu/press/speeches/date/2015/html/se150331.en.html for introductory remarks at the presentation of the first ECB annual report on supervisory activities on 31 March 2015

Acknowledgements

I thank Andreas Haufler, Christian Holzner and seminar participants of the Public Economics Seminar at the University of Munich and of the 2014 Bundesbank Workshop, Eltville for very helpful comments. Financial support from the German Research Foundation (Grant No. HA 3195/9-1) is gratefully acknowledged.

Appendix

A.1 Derivation of Eq. (15)

Maximizing Eq. (12) with respect to α yields

$$\frac{\partial\pi}{\partial\alpha} = \left\{ \frac{1-\tilde{\lambda}_A^2}{2} \left[A - a\frac{2\alpha}{k_A} - 1 - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^p \right] - \frac{(1-\tilde{\lambda}_A)^2}{2} k_A \right\} \frac{1}{k_A}$$
$$- \left\{ \frac{1-\tilde{\lambda}_B^2}{2} \left[A - a\frac{2(1-\alpha)}{k_A} - 1 - \frac{(1-\tilde{\lambda}_A)^2}{2} c_B^p \right] - \frac{(1-\tilde{\lambda}_B)^2}{2} k_B \right\} \frac{1}{k_B} = 0 \, , \tag{A.1}$$

We can then factor out α and get

$$\alpha a \left(\frac{1-\tilde{\lambda}_A^2}{k_A^2} + \frac{1-\tilde{\lambda}_B^2}{k_B^2} \right) = \frac{1-\tilde{\lambda}_A^2}{2k_A} \left[A - 1 - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^p \right] - \frac{(1-\tilde{\lambda}_A)^2}{2}$$
$$- \frac{1-\tilde{\lambda}_B^2}{2k_B} \left[A - \frac{2a}{k_B} - 1 - \frac{(1-\tilde{\lambda}_A)^2}{2} c_B^p \right] - \frac{(1-\tilde{\lambda}_B)^2}{2} \, . \tag{A.2}$$

Then, multiplying all terms with $k_A^2 k_B^2$ and solving for α gives us

$$\alpha = \frac{(1-\tilde{\lambda}_A^2) k_A k_B^2 \left[A - 1 - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^p \right] - (1-\tilde{\lambda}_A)^2 k_A^2 k_B^2}{2a[(1-\tilde{\lambda}_A)^2 k_B^2 + (1-\tilde{\lambda}_B)^2 k_A^2]}$$
$$- \frac{(1-\tilde{\lambda}_B^2) k_B k_A^2 \left[A - \frac{2a}{k_B} - 1 - \frac{(1-\tilde{\lambda}_A)^2}{2} c_B^p \right] - (1-\tilde{\lambda}_B)^2 k_A^2 k_B^2}{2a[(1-\tilde{\lambda}_A)^2 k_B^2 + (1-\tilde{\lambda}_B)^2 k_A^2]} \, . \tag{A.3}$$

Finally, slightly rearranging terms we arrive at Eq. (15).

A.2 Derivation of sign of Eqs. (18) and (19)

Substituting Eqs. (1) and (4) into (12), we can derive the marginal return of investment for the subsidiary in country A:

$$MR_A = A - a\frac{2\alpha}{k_A} - 1 - \frac{(1-\tilde{\lambda})^2}{2} c_A^l \, . \tag{A.4}$$

Now, for k_A to be binding independent of the allocation of equity by the multinational bank it must be true that $MR_A > 0$ even for $\alpha = 1$. Then, looking at Eq. (18), it becomes clear that in this case the numerator of (18) will be negative and thus $\frac{\partial \alpha}{\partial k_A} < 0$. Looking at Eq. (19), we can see that a sufficient condition for $\frac{\partial \alpha}{\partial \tilde{\lambda}_A} < 0$ is that

$$\gamma_1 \equiv -\tilde{\lambda} \left[A - \frac{a}{k} - 1 - \frac{(1-\tilde{\lambda})^2}{2} c_L^p \right] + (1-\tilde{\lambda})k < 0 \,. \tag{A.5}$$

Now, substituting γ_1 into the intervention threshold that is chosen by the supervisory regime in Eq. (10) and rearranging terms we get that

$$\gamma_1 = -\tilde{\lambda} \left[\frac{(1-\tilde{\lambda})^2}{2}(c^l - c^p) - a\frac{\alpha}{2k} \right] - (1-\tilde{\lambda}) \left[1 - k + c^d \left(1 - \frac{1-\tilde{\lambda}^2}{2} p^r \right) \right] \,. \tag{A.6}$$

This shows that $\gamma_1 < 0$ and thus $\frac{\partial \alpha}{\partial k_A} < 0$ whenever it holds that

$$(1-\tilde{\lambda}) \left[1 - k + c^d \left(1 - \frac{1-\tilde{\lambda}^2}{2} p^r + \frac{\tilde{\lambda}(1-\tilde{\lambda})}{2} p^c \right) \right] + \tilde{\lambda}\frac{(1-\tilde{\lambda})^2}{2}(c^l - c^p) > \tilde{\lambda} a \frac{\alpha}{2k} \,, \tag{A.7}$$

where the left hand side of (A.7) is the sum of the failure cost (first term) and the liquidation cost (second term) that is not internalized by the bank. The right hand side measures the consumer surplus that is due to the investment of the subsidiary.

A.3 Derivation of Eqs. (25)-(29)

The welfare effect for country A of a marginal increase in γ is given by:

$$\frac{\partial WF_A}{\partial \gamma} = \left(\frac{\partial WF_A}{\partial \tilde{\lambda}_A} + \frac{\partial WF_A}{\partial \tilde{\lambda}_B}\frac{\partial \tilde{\lambda}_B}{\partial \tilde{\lambda}_A} + \frac{\partial WF_A}{\partial k_A}\frac{\partial k_A}{\partial \tilde{\lambda}_A} + \frac{\partial WF_A}{\partial k_B}\frac{\partial k_B}{\partial \tilde{\lambda}_A} \right) \frac{\partial \tilde{\lambda}_A}{\partial \gamma} \tag{A.8}$$

$$+ \left(\frac{\partial WF_A}{\partial \tilde{\lambda}_B} + \frac{\partial WF_A}{\partial \tilde{\lambda}_A}\frac{\partial \tilde{\lambda}_A}{\partial \tilde{\lambda}_B} + \frac{\partial WF_A}{\partial k_A}\frac{\partial k_A}{\partial \tilde{\lambda}_A} + \frac{\partial WF_A}{\partial k_B}\frac{\partial k_B}{\partial \tilde{\lambda}_B} \right) \frac{\partial \tilde{\lambda}_B}{\partial \gamma} \,, \tag{A.9}$$

which simplifies to Eq. (25) when we use that $\frac{\partial WF_A}{\partial \tilde{\lambda}_A} = \frac{\partial WF_A}{\partial k_A} = 0$ for $\gamma = 0$ and that, due to the symmetry between both countries, it holds that $\delta\tilde{\lambda}_A/\delta\gamma = \delta\tilde{\lambda}_B/\delta\gamma = \delta\tilde{\lambda}/\delta\gamma$. To arrive at Eq. (26), we first substitute Eq. (10) in Eq. (11) to derive the condition for $\tilde{\lambda}$ as a function of γ. This gives us

$$\frac{\partial WF_\gamma}{\partial \tilde{\lambda}_A} = 1 - \tilde{\lambda}_A \left[v_A - \frac{(1-\tilde{\lambda}_B)^2}{2} c_A^l \right] + (1-\tilde{\lambda}_A)c_A^d \left[1 - \frac{1-\tilde{\lambda}_B^2}{2} p_A^r \right]$$

$$+ \gamma \left[(1-\tilde{\lambda}_A)\frac{1-\tilde{\lambda}_B^2}{2} c_B^l - \tilde{\lambda}_A \frac{(1-\tilde{\lambda}_B)^2}{2} p_B^r c_B^d \right] = 0 \,. \tag{A.10}$$

Then, using the implicit function theorem on (A.10) we arrive at Eq. (26). Eqs. (27) and (28) follow directly from taking the first derivative of the expected welfare function in Eq. (9) with respect to $\tilde{\lambda}_B$ and k_B, respectively. To arrive at Eq. (29), we take Eq. (20) and use the implicit function theorem.

A.4 Derivation of condition (30)

As we are only interested in a sufficient condition for $\frac{\partial WF_A}{\partial \gamma} < 0$, we can use that

$$\underbrace{\frac{\partial \tilde{\lambda}}{\partial \gamma}}_{(+)} \underbrace{h(l^r)c^d \frac{1}{2k} \frac{(1-\tilde{\lambda})^2}{2} \frac{1-\tilde{\lambda}^2}{2}}_{(+)} \underbrace{\left(\frac{\partial k_B}{\partial \tilde{\lambda}_B} + \frac{\partial k_B}{\partial \tilde{\lambda}_A} \right)}_{(-)} < 0 \,, \tag{A.11}$$

$$\underbrace{\frac{\partial \tilde{\lambda}}{\partial \gamma}}_{(+)} \underbrace{\frac{\partial \alpha}{\partial k_B} \frac{1}{k}}_{(+)} \psi \underbrace{\frac{1}{2} \left(\frac{\partial \sigma_B}{\partial \tilde{\lambda}_A} + \frac{\partial \sigma_B}{\partial \tilde{\lambda}_B} \right)}_{(-)} < 0 \,, \tag{A.12}$$

$$\underbrace{\frac{\partial \tilde{\lambda}}{\partial \gamma}}_{(+)} \underbrace{\frac{\partial WF_A}{\partial \tilde{\lambda}_B}}_{(+)} \underbrace{\frac{\partial \tilde{\lambda}_B}{\partial \tilde{\lambda}_A}}_{(-)} < 0 \,, \tag{A.13}$$

and therefore leave these terms out of Eq. (25). Further, we can use the fact that $\frac{\partial WF_A}{\partial \tilde{\lambda}_B} = \frac{\partial \phi_B}{\partial \tilde{\lambda}_A}$ in a symmetric setting. Then, as $\frac{\partial \tilde{\lambda}}{\partial \gamma} \frac{\partial WF_A}{\partial \tilde{\lambda}_B} > 0$ we can exclude this term from Eq. (25) and state the following condition:

$$\frac{\partial WF_A}{\partial \gamma} < 0 \qquad \Leftrightarrow \qquad 1 - \frac{\frac{1}{k} \frac{\partial \alpha}{\partial k_B} \psi \left(\frac{\partial \alpha}{\partial k_B} + \frac{1}{2k} \right)}{\frac{\partial \psi_B}{\partial k_B} \left(\frac{\partial \alpha}{\partial k_B} + \frac{1}{2k} \right) - \frac{1}{2} \frac{\partial \sigma_B}{\partial k_B}} < 0 \,, \tag{A.14}$$

where the second term in Eq. (A.14) measures the indirect welfare effect that is due to the decrease in capital standards. Rearranging Eq. (A.14) then yields the following condition for $\frac{\partial WF_A}{\partial \gamma} < 0$:

$$\left(\frac{\partial \alpha}{\partial k_B} + \frac{1}{2k} \right) \left(\frac{\psi}{k} \frac{\partial \alpha}{\partial k_B} - \frac{\partial \psi_B}{\partial k_B} \right) + \frac{\partial \sigma_B}{\partial k_B} \frac{1}{2} > 0 \,, \tag{A.15}$$

where

$$\frac{\partial \psi_B}{\partial k_B} = \frac{1}{2k^2} - c\left[\underbrace{\frac{1-\tilde{\lambda}^2}{2}\frac{(1-\tilde{\lambda})^2}{2}p^c + \frac{(1-\tilde{\lambda})^2}{2}\left(1-\frac{1-\tilde{\lambda}^2}{2}p^r\right)}_{\leq 2}\right] > 0 \; , \tag{A.16}$$

$$\frac{\partial \sigma_B}{\partial k_B} = c\underbrace{\frac{(1-\tilde{\lambda})^2}{2}\left(1-\tilde{\lambda}^2\right)}_{\leq 1}[h(l^r)+h(l^c)] < 0 \; , \tag{A.17}$$

$$\frac{\partial \alpha}{\partial k_B} = \frac{A - a\frac{2}{k} - 1 - \overbrace{\frac{(1-\tilde{\lambda})^2}{2}}^{\leq 1} c^p}{4a} \; . \tag{A.18}$$

Then, we apply the maximum values that are shown in Eqs. (A.16)-(A.18) for all terms that enter negatively in condition (A.15) . Finally, multiplying all terms in (A.15) with $16k^4(1-\tilde{\lambda}^2)^2$, taking the maximum value of $(1-\tilde{\lambda}^2)^2 \leq 1$ for all terms that enter negatively in (A.15) and slightly rearranging terms, we arrive at condition (30).

References

Acharya, S., and Dreyfus, J.F. (1988). Optimal bank reorganization policies and the pricing of federal deposit insurance. *Journal of Finance 44*, 1313-1334.

Acharya, V. (2003). Is the international convergence of capital adequacy regulation desirable? *Journal of Finance 58*, 2745-2781.

Aghion, P., Bolton, P., Fries, S. (1999). Optimal design of bank bailouts: The case of transition economies. *Journal of Institutional and Theoretical Economics 155*, 51-70.

Allen, F., Beck, T., Carletti, E., Lane, P.R., Schoenmaker, D., Wagner, W. (2011). Cross-Border Banking in Europe: Implications for Financial Stability and Macroeconomic Policies. CEPR Report. Center for Economic Policy Research.

Anginer, D., Cerutti, E. and Martinez Peria, M.S. (2016). Foreign bank subsidiaries' default risk during the global crisis. What factors help insulate affiliates from their parents? *Journal of Financial Intermediation*, forthcoming.

Basel Committee on Banking Supervision, 2014. Regulatory Consistency Assessment Programme (RCAP)- Assessment of Basel III regulations - European Union. Bank for International Settlements.

Beck, T., Radomir, T., Wagner, W. (2013). Supervising cross-border banks: theory, evidence and policy. *Economic Policy 73*, 5-44.

Beck, T., Wagner, W. (2016). Supranational supervision - How much and for whom. *International Journal of Central Banking 12*, 221-268.

Benediktsdottir, S., Danielsson, J., Zoega, G. (2011). Lessons from a collapse of a financial system. *Economic Policy 66*, 183-235.

Bryant, J. (1980). A model of reserves, bank runs, and deposit insurance. *Journal of Banking and Finance 4*, 335-344.

Calzolari, G., Loranth, G. (2011). Regulation of multinational banks a theoretical inquiry. *Journal of Financial Intermediation 20*, 178-198.

Cetorelli, N., Goldberg, L.S. (2012). Banking globalization and monetary transmission. *Journal of Finance 67*, 1811-1843.

Chan, Y.S., Greenbaum, S.I., Thakor, A.V. (1992). Is fairly priced deposit insurance possible? *Journal of Finance 47*, 227-245.

Chor, D., Manova, K. (2012). Off the cliff and back? Credit conditions and international trade during the global financial crisis. *Journal of International Economics 87*, 117-133.

Claessens, S., Herring, D., Schoenmaker, D. (2010). A safer world financial system: Improving the resolution of systemic institutions. 12th Geneva Report on the World Economy. International Center for Monetary and Banking Studies, London.

De Haas, R., Van Horen, N. (2012). International shock transmission after the Lehmann Brothers collapse: Evidence from syndicated lending. *American Economic Review: Papers & Proceedings 112*, 231-237.

Dell'Ariccia, G., Marquez, R. (2006). Competition among regulators and credit market integration. *Journal of Financial Economics 79*, 401-430.

Dell'Ariccia, G., Detragiache, E., Rajan, R. (2008). The real effect of banking crises. *Journal of Financial Intermediation 17*, 89-112.

Dell'Ariccia, G., Marquez, R. (2010). Risk and the corporate structure of banks. *Journal of Finance 65*, 1075-1096.

Dewatripont, M., Freixas, X. (2011). Bank resolution: a framework for the assessment of regulatory intervention. *Oxford Review of Economic Policy 27*, 411-436.

Diamond, D.W., Dybvig, P. (1983). Banks runs, deposit insurance, and liquidity. *Journal of Political Economy 91*, 401-419.

Goodhart, C. and Schoenmaker, D. (2009). Fiscal burden sharing in cross-border banking crises. *International Journal of Central Banking 5*, 141-165.

Hagan, S., Vinals, J. (2010). Resolution of cross-border banks - A proposed framework for enhanced coordination. IMF Legal and Monetary and Capital Markets Departments.

Hellman, T., Murdock, K., Stiglitz, J. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough? *American Economic Review 90*, 147-165.

Kahn, C., Santos, J. (2005). Allocating bank regulatory powers: lender of last resort, deposit insurance and supervision. *European Economic Review 49*, 2107-2136.

Lipsey, R.G., Lancaster, K. (1956). The general theory of second best. *Review of Economic Studies 24*, 11-32.

Mitchell, J. (2000). Bad debts and the cleaning, transferring of banks' balance sheets: An application to transition economies. *Journal of Financial Intermediation 10*, 1-27.

Navaretti, G. B., Calzolari, G., Pozzolo, A.F., Levi, M. (2010). Multinational banking in Europe - financial stability and regulatory implications: lessons from the financial crisis. *Economic Policy 64*, 703-753.

Niepmann, F. (2015). Banking across borders. *Journal of International Economics 96*, 244-265.

Peek, J., Rosengren, E.S. (1997). The international transmission of financial shocks: The case of Japan. *American Economic Review 87*, 495-505.

Repullo, R. (2000). Who should act as a lender of last resort? An incomplete contracts model. *Journal of Money, Credit and Banking 32*, 580-605.

Repullo, R. (2004). Capital requirements, market power, and risk taking in banking. *Journal of Financial Intermediation 13*, 156-182.

Rochet, J.-Ch. (1992). Capital requirements and the behaviour of commercial banks. *European Economic Review 36*, 1137-1178.

Sinn, H.W. (1997). The selection principle and market failure in systems competition. *Journal of Public Economics 66*, 247-274.

Sinn, H.W. (2003). Risktaking, limited liability, and the competition of bank regulators. *Finanzarchiv 59*, 305-329.