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Author(s):
Bernauer, Thomas; Koubi, Vally

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Taking Firms and Markets Seriously: A Study on Bank Behavior, Market Discipline, and Regulation

By Thomas Bernauer and Vally Koubi
ETH Zurich

Universität Zürich
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Taking Firms and Markets Seriously:
A Study on Bank Behavior, Market Discipline, and Regulation

Thomas Bernauer* and Vally Koubi**

Abstract

We argue that accounting for the behavior of firms and markets is important for understanding the extent and form and the effectiveness and efficiency of government regulation, particularly in economic policy. We examine the US banking sector and its regulation in the 1990s to gain insights on how studies along these lines could be constructed. We begin by observing that US bank capitalization exceeds governmental capital adequacy requirements by a substantial margin. This observation suggests that banks must also have reasons other than government intervention for selecting high levels of capital. We focus on the main alternative driving force to government regulation, market discipline, and in particular the effect of bank capital on banks' borrowing costs. We find that better capitalized banks have indeed experienced lower borrowing costs. But we also find that, while competitive pressure can help in mitigating the bank solvency problem, it cannot not fully counter free riding of "unhealthy" banks on a well-capitalized banking sector. These results show that recent US and international (Basel Accord) regulatory reform efforts, which are designed to increase transparency and enhance competition in the banking sector, can be interpreted as an effort to align market forces and regulation in ways that minimize the need for costly government enforcement or bailouts.

Keywords: government regulation, market discipline, banking sector, capital adequacy requirements

* **Correspondence:** Thomas Bernauer, Center for Comparative and International Studies, ETH Zurich, Seilergraben 49 SEI, 8092 Zurich, Switzerland; Phone +41-1-632-6466, Fax +41-1-632-1289, bernauer@ir.gess.ethz.ch, http://www.ib.ethz.ch

** Vally Koubi, Center for Comparative and International Studies, ETH Zurich, Seilergraben 49 SEI, 8092 Zurich, Switzerland; Phone +41-1-632-6776, Fax +41-1-632-1289, vally.koubi@vwi.unibe.ch, http://www.ib.ethz.ch

1. Introduction

When analyzing regulation and public policy more generally political scientist have focused almost exclusively on government and interest group behavior. We submit that particularly with respect to economic policy this top-down perspective should be complemented by a bottom-up view that systematically accounts, from the micro-level upwards, for the behavior of economic actors and markets and their implications for regulation and public policy.

We examine the US banking sector and its regulation in the 1990s to gain insights on how studies of this nature could be constructed. We focus on the banking sector because it is characterized both by market competition and extensive government regulation. The banking sector thus provides us with a good opportunity to examine a crucial area of economic policy through the lens of bank behavior and market processes, and to complement existing studies in political science that have adoped primarily a top-down perspective (e.g., Murphy 2004; Genschel and Plumper 1997; Lutz 2000; Simmons 1999).

Since the late 1980s national authorities from the G-10 and some other countries have engaged in increasingly complex national and international regulatory reforms in the banking sector. The aim of regulatory activity, a large part of which concentrates on the capitalization of banks, notably capital-asset ratios (CAR), has been to mitigate bank solvency problems that could destabilize national and international financial systems. The motivation behind the proliferation of regulatory activity is found in the presumption that banks, if left alone, would select to remain undercapitalized relative to the level required for bank solvency.

A glance at Figure 1 reveals no tendencies for under-capitalization. On the contrary, banks systematically and significantly *over-comply* with regard to capitalization standards set by government (Figure A1 reveals a similar tendency at the international level). Why do banks select such high levels of capital that appear to render regulation redundant? It has been suggested that market discipline may be responsible for this puzzling behavior. In particular, in the absence of explicit or implicit, catholic – that is, covering all types of bank liabilities – guarantees by the government, banks may have an incentive to satisfy "implicit capital adequacy requirements" in order to lower their riskiness and hence create liabilities at more favorable terms. In this paper we examine the quantitative significance of this mechanism by studying the entire population of US banks in the 1990s (approximately 130,000 bank-years). We find that better capitalized banks indeed experience lower borrowing costs and that this effect is substantial (elasticity of –0.5).

Having established that market discipline is likely to have mitigated bank solvency problems, we turn to a more general question: can market competition also counter the free riding problems that exist in the banking sector due to systemic risk? We first show, from a theoretical viewpoint, that whether the banking sector is under- or over-capitalized relative to the social optimum depends on the relative importance of idiosyncratic bank risk (the risk profile of individual banks) and systemic risk (the "healthiness" of the entire banking sector) for banks' borrowing costs. Undercapitalization – and hence a need for regulation – is more likely to occur when systemic bank risk dominates. We also argue that the presence of other government interventions, such as government deposit insurance and government-led bank bailouts, makes undercapitalization even more likely. We then examine empirically whether the effect of market discipline on bank capital dominates that of free riding. We find that this is not the case, that is,

banks are undercapitalized relative to the social optimum (even when they are overcapitalized relative to the regulatory requirements).

We can draw at least two conclusions from these findings. First, there clearly are complementarities in the relationship between regulatory and market forces; that is, regulatory policy and market competition may reinforce each other. In the context of our analysis, regulation that increases transparency (such as reporting requirements for bank capitalization) can create and sustain competition among economic actors (banks), and can thus play an important role in mitigating the problems that motivate governmental regulatory activity. Regulators have been quite aware of this complementarity. One may in fact argue that the main element of national and international (Basle Accord) regulation of bank capital has not been the imposition of minimum capital requirements per se, but rather how these regulations have transformed the financial market. In particular, they have increased transparency and hence competition by demanding that banks adhere to well defined capital requirements, which are reported publicly and are easily comparable across banks and countries. The increased market pressure that followed these measures has promoted compliance and even over-compliance as banks rushed to raise capital levels in order to signal their quality. These mutually reinforcing effects of regulation and competition have also transformed policy-making in this area. While policy-makers and banks were, in the 1980s and 1990s very much focused on defining minimum capitalization levels to create a level playing field for banks at national and international levels current efforts concentrate much more on how to measure risk and how to enhance transparency. We can interpret the latter policies as efforts to align market forces and regulation more effectively in ways that minimize the need for costly government enforcement or bailouts.

Second, it seems worthwhile to examine whether similar complementarities exist in other areas of national and international policy-making, how they function, or if they do not exist why so and how they could be created. Obvious candidates for such analysis include corporate environmental performance and social responsibility standards, accounting rules, and corporate governance rules. Take corporate accounting standards as an example. To the extent that corporate scandals (e.g., Enron and Parmalat) have sensitized global markets, firms may have an incentive to adopt greater transparency and best practice accounting standards to lower their borrowing costs and/or draw funds from global equity markets (the same way that banks increase their capitalization beyond that required by regulators to improve their competitive position). That is, firms can signal their quality to financial markets by adopting more transparent and stringent standards. The fact that the most important firms in a large number of countries and industries are linked to global financial markets implies that such incentives are present throughout the world economy. Regulators can trigger and/or enhance this process by selecting the appropriate set of standards. To the extent that the appropriate standards are similar across countries there will be a tendency for international policy convergence and market forces will further promote convergence.

The following section (2.) reviews the relevant literature. Section three contains the theoretical model. In section four we present the results of the empirical analysis. Section five concludes.

2. Review of Relevant Literature

2.1 Why Capital Adequacy Requirements?

Government regulation is usually needed in the presence of market failures emanating from public goods, externalities, monopolies or information asymmetries between buyers and sellers. In the case of banks, regulation is justified on the grounds that depositors, or bank clients more generally, are unable to monitor their banks' financial soundness (asymmetric information) and that there is a risk of systemic crisis (notably, bank failures creating bank runs and credit crunches).

Dewatripont and Tirole (1993a, 1993b) and Miles (1995) argue that if depositors could effectively monitor their banks then this would limit socially suboptimal bank behavior. But monitoring is expensive and there are limits to information. Moreover, bank debt is mainly held by depositors who hold only a relatively small deposit each and who lack incentives to perform efficient monitoring. Thus, depositors need to be represented by a *regulator* who can intervene on their behalf to correct market failure.

Bank runs may, in principle, be prevented by a variety of measures, including for example: establishment of "narrow banks" (i.e., banks that invest only in riskless securities); funding banks with equity rather than demand deposits; using central banks as lenders of last resort (Bagehot 1873); and offering government deposit insurance (Diamond and Dybvig 1983). Unfortunately, although such measures may insulate banks from runs, they have serious drawbacks since some of them can lead to moral hazard, as is the case with the lender of last resort solution and deposit insurance.

Complete government deposit insurance can protect banks from runs but it is socially costly because the government will have to tax other sectors of the economy (which creates a deadweight loss), and also leads to moral hazard. When the government provides deposit insurance, depositors know that they will not suffer losses if a bank fails. Hence they do not impose the discipline of the marketplace on banks by withdrawing deposits when the bank is taking on too much risk, and they do not demand an interest payment that reflects the risk that the bank takes. Deposit insurance – like the "too big to fail"[1] policy – insulates banks from potential market discipline, and it leads to lower levels of bank capital[2]. Moreover, when the insurance scheme charges banks a flat rate premium, banks do not internalize the full cost of risk and may take on even more risk[3].

Requiring banks to hold certain levels of capital[4] thus seems to be an obvious regulatory[5] response to the risk of systemic crisis as it promises to improve the soundness and safety[6] of the

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[1] Bank regulators are usually reluctant to allow a big bank to fail, especially if they believe that its failure makes it more likely that a major financial disruption will occur.

[2] Berger, Herring and Szego (1995) note that the safety net may be responsible for the low equity-to-asset ratios that banks have relative to other firms in any industry; and that the introduction of the various types of the safety net played an important role in the decline in bank capital ratios during the 20th century.

[3] This problem would be eliminated if deposit insurance premiums fully responded to changes in risk.

[4] Bank capital helps prevent bank failure and the amount of capital affects returns for the owners (equity holders) of the bank. See Berger, Herring and Szego (1995) for the role of capital in financial institutions.

[5] See Santos (2000) for an excellent review of the literature on bank capital regulation.

banking sector. It is widely believed that requirements that force banks to hold sufficient capital may change bank's incentives to take risk. When a bank is forced to hold a large amount of equity capital, the bank has more to lose if it fails, and is thus more likely to pursue less risky activities.

Benston and Kaufman (1996) and Dowd (1999, 2000) have contested the arguments in defense of bank regulation. They claim that capital adequacy regulation is both unnecessary and incapable of improving banks' capital position *more* than the banks could do on their own. In Dowd's view, shareholders can enforce proper risk behavior. Moreover, they both note that the best argument for capital adequacy regulation is that it might help to counter the negative effects of other government interventions, such as moral hazard created by bank deposit insurance and bailouts of large banks.

2.2 Capital-Asset Ratios

Most banks have capital-asset ratios that exceed the ones required by regulators. Figure 1 shows that in the US banking sector average capital-asset ratios have, before and after the adoption and implementation of the Basle capital adequacy standards, persistently exceeded regulatory requirements (4% Tier 1 CAR and 8% Tier 1+2 CAR; standards adopted in 1988, in force since 1990/1992).[7] Figure A1 in the Appendix shows very similar trends at the international level.

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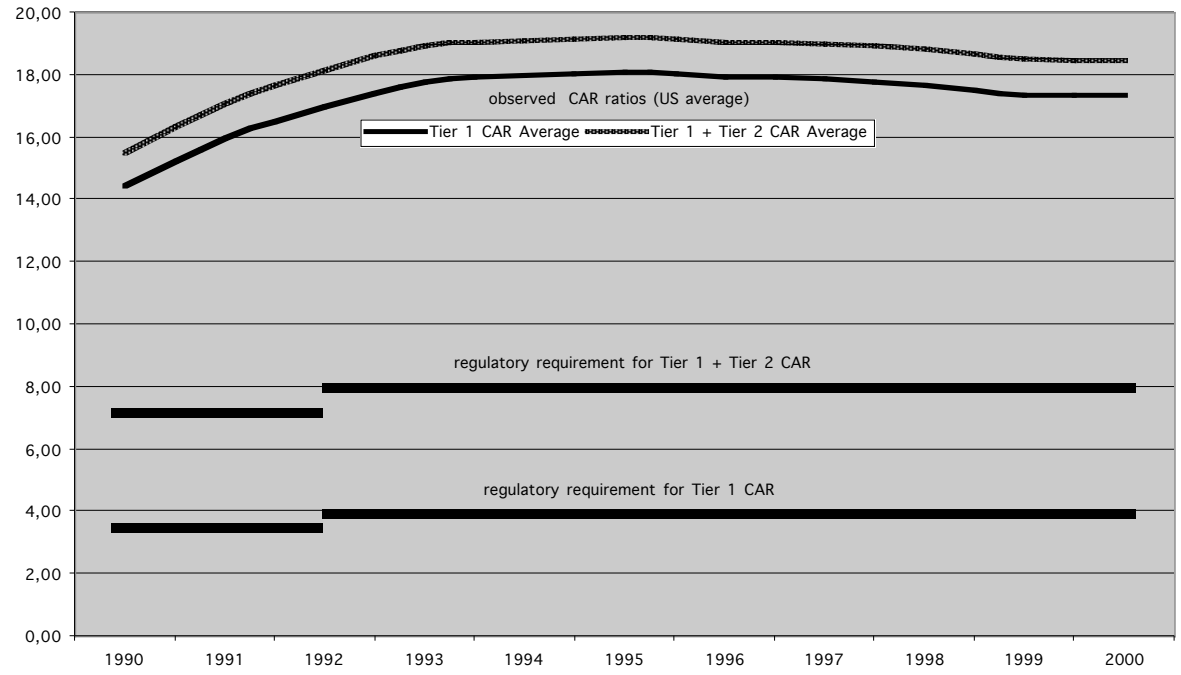
[6] Requiring banks to issue subordinated debt, extending the liability of bank shareholders, and restricting banks from holding risky assets such as common stock are a few other regulations for making banks avoid too much risk.

[7] In Figure 1, we use Tier 1 and Tier 1+2 risk-based capital-asset ratios (Tier 1 ratio: FDIC code RBC1RWAJ, restrictions imposed 0<RBC1RWAJ<100; Tier 1+2 ratio: FDIC code RBCRWAJ, restrictions imposed 0<RBCRWAJ<100). Tier 1 capital (core capital) includes common stock, non-cumulative perpetual preferred stock and minority interest in the equity accounts of consolidated subsidiaries less goodwill, while Tier 2 capital (supplementary capital) includes cumulative perpetual preferred stock, perpetual and term subordinated debt, parts of pretax net unrealized holding gains, certain hybrid capital instruments, and loan and lease loss reserves. Assets are weighted by a risk factor (e.g. 0 for government bonds, 1 for credits extended to companies). For more detailed definitions, see Matten 1996, http://www.occ.treas.gov/fr/cfrparts, http://www.bis.org. Between December 31, 1990, and December 30, 1992, all banks were expected to maintain a Tier 1+2 ratio of 7.25%, of which 50% had to be made up of Tier 1 capital. The standard for the Tier 1+2 ratio was raised to 8%, starting December 31, 1992.

Figure 1
Average Capital-Asset Ratios in the US Banking Sector



Analysts of domestic and international banking regulation have resorted to market pressure arguments to account for this observation, which cuts against prevailing views on how regulation affects the banking sector.

Those studying domestic banking sectors have argued that banks experience opportunity costs and may face reduced profits when they increase CAR. If these reasons were not enough to motivate minimal compliance or non-compliance with capital adequacy regulation, the existing "safety net" (deposit insurance and the "too big to fail" problem) should do so (see Avery/Berger 1991; Wall/Peterson 1995; Berger 1995; Calomiris 1997; Basle Committee on Banking Supervision 1999). The fact that banks, on average, have capital-asset ratios well above the regulatory minimum is not compatible with these assertions.

Similarly, those studying international banking regulation have argued that, since capital adequacy regulations impose substantial costs on banks, preferences and behavior of both regulators and banks are strongly shaped by "level playing field", i.e. international competitiveness, considerations. Yet, if compliance with capital adequacy regulations were very costly and thus affected the competitiveness of banks within and across countries, as many authors have claimed (e.g. Murphy 1995; Wagster 1996; Oatley/Nabors 1998; Murphy and Oye 1998), why would national regulators tolerate such large cross-national differences in CAR? And why would most banks' ratios exceed the minimum requirements (see Figure 1A in the Appendix)? If the regulatory process were strongly driven by "level playing field" (competitiveness) concerns, we should have observed convergence of CAR across and within countries around the minimum Basle standards (Tier 1+2 CAR = 8%).

Some authors (e.g. Genschel/Plümper 1996; Matten 1996) have mainly pointed to market pressure as an explanation for the rapid acceptance and diffusion of the Basle capital adequacy

standards. They have argued that these standards have increased transparency, allowing financial markets to punish poorly capitalized banks or entire national banking systems faster and harder, and to reward banks and banking systems with higher CAR. Rating agencies, for whom CAR have become simple focal points in an otherwise highly complex market, are hypothesized to have been instrumental in promoting national and international capital adequacy regulations and driving CAR up. While this argument is *prima facie* plausible and may explain high capital ratios it is insufficiently specified and has yet to be systematically developed and tested.

Some other studies suggest that capital-asset ratios have an impact on banks' funding costs.[8] Keeley (1990), based on a sample of 77 U.S. bank holding companies from 1984 to 1986, finds that banks paid an interest rate premium on uninsured deposits (those greater than $100,000) that was related to banks' default risk. He concludes that a 1 percent increase in banks' CAR lowered their rate on certificates of deposit (CD) by 14 basis points, and that a 1 percent increase in bank' market-to-book asset ratio (an indicator for market power) reduced the average CD cost by 16 - 18 basis points.[9]

Berger (1995) examines why and to what extent capital-asset ratios affect after-tax returns on equity. Based on a study of US banks in 1983-1989 he observes that higher returns-on-equity (ROE) followed higher CAR chiefly because of reduced interest rates on uninsured purchased funds.[10] He suggests that one of the driving forces for this positive relationship may be market discipline. He also finds that the ratios of total interest expenditure to equity and to assets decreased with increasing CAR.[11] The studies by Keeley, Berger and others cover only US banks in the 1980's and are predominantly empirical.

Jacques and Nigro (1997), in an analysis of about 2,500 US commercial banks in 1990-91, observe that banks with CAR ratios higher than the required minimum (i.e., banks presumably exposed to less regulatory pressure) responded to the new capital adequacy regulations by increasing their capital-asset ratios and reducing portfolio risk more than banks with capital-asset ratios closer or below the regulatory minimum. The authors conclude that "this result could reflect either the desire of very well capitalized banks to maintain a large buffer stock of capital, or the desire of these banks to signal to both regulators and the market that they not only met, but clearly exceeded, minimum regulatory capital standards." (p.543)

In one of the very few studies on non-US banks, Rime (2000) notes that Swiss banks holding large capital buffers beyond the regulatory minimum may have been driven by market considerations, such as volatility of capital, liquidity of markets for bank stocks, access to capital

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[8] See Flannery (1998) on the general question of using market information in prudential regulation.

[9] Keeley also claims that banks with high capital-asset ratios have a lower default probability and a lower incentive to increase asset risk and thus should pay lower rates for certificates of deposit (CD).

[10] Berger's (1995) analysis lends support to the "expected bankruptcy cost" hypothesis: increases in CAR reduce the expected costs of financial distress (e.g. deadweight liquidation costs) and therefore contribute to raising expected earnings, especially in time periods where exogenous (systemic) risks and expected costs of bankruptcy are higher. Berger assumes that this was the case in the 1980s. Increases in expected bankruptcy costs, resulting from changes in the banking environment that increase the probability of bank failure or the liquidation costs per failure, increase the optimal CAR so as to reduce the probability of bank failure and expected bankruptcy costs. Such costs are borne by the shareholders in so far as they are anticipated through higher risk premia on bank debt or higher premia banks pay for deposit insurance (the FDIC in the US).

[11] This result is somewhat artificial because total interest expenditure decreases almost automatically with increasing CAR because there is less debt on which interest must be paid.

markets, the cost of raising capital, and other factors. In contrast to Jacques/Nigro (1997), he finds that banks closer to or below the regulatory minimum increased their CAR more than banks clearly above the minimum standard. In virtually all studies of this type, capital adjustment rates are interpreted in terms of regulatory pressure, without distinguishing whether pressure emanates from regulators or from markets.

Finally, Madura and Zarruk (1993) argue that share prices of US banks with lower capital-asset ratios were more negatively affected by the introduction of uniform capital requirements in 1987 and 1988 than banks with higher capital-asset ratios.

In summary, the above mentioned studies on market discipline suggest that banks with higher CAR may be rewarded by markets with lower funding costs, which motivates banks to exceed minimum capital-asset ratio requirements set by regulators. But these studies are almost exclusively atheoretical, based on a limited number of observations over limited time periods for US banks in the 1980s, and do not evaluate the popular presumption that market discipline is insufficient to overcome free riding problems. Dowd (1999) notes that "no one has yet provided a convincing case for capital adequacy regulation on market failure grounds... No one has yet shown that there is anything wrong with laisser-faire banking that capital adequacy regulation would put right" (p.46). In this paper, we attempt to examine whether market forces can act as a substitute for capital adequacy requirements by explicitly considering both market forces (interest rate on deposits) and government intervention (deposit insurance).

3. Theoretical Model

In this section we develop a formal model that explains banks' choice of CAR. In the subsequent section, we carry out two tests. One concerns the relationship between CAR and banks' funding costs. The second test focuses on the relative strength of market forces and free riding problems.

3.1 Bank competition and capital requirements

Many industries in OECD countries have recently experienced a reduction of government intervention. An important exception to this pattern is the banking sector. Since the mid- to late 1980s, national regulators have introduced stricter prudential regulations and regulatory efforts have to a growing extent been coordinated at the international level.[12] National and international prudential regulation has focused heavily on capital adequacy requirements. It is widely assumed

[12] The justification offered for more international regulation is related to the increase in international financial integration and involves two elements. The first element is the standard solvency argument recast in the context of a globalized financial system. Bank failures within a country are now thought to have more "global" spillover effects, which necessitates a more global treatment of the problem. The second justification arises from the fact that regulatory asymmetries across countries are assumed to induce differences in the cost of conducting international banking as a function of a bank's location. For instance, banks in countries with extensive government provided deposit insurance and laxer capital adequacy requirements may possess an advantage in attracting deposits and offering loans at more favorable terms than competitor banks located in countries with no deposit insurance and stricter capital requirements. International regulation is then a means of undoing the effects of such cross-country differences in institutions and restoring fairness in international competition.

that banks would be undercapitalized (and would also select excessively risky portfolios) from a social point of view if they were left unregulated. The reason is that banks do not fully internalize the implications of their actions, i.e., the cost of a bank failure is not borne exclusively by the failed bank. In the presence of an explicit or implicit "safety net" (notably deposit insurance and government sponsored bailouts), part of the cost of a bank failure is born by deposit insurance, taxpayers, or other banks. The "safety net", partly the result of earlier government intervention, may thus create "free-rider" and moral hazard problems in the banking sector, which requires additional regulation.

In our model, we investigate whether and under what conditions these problems motivate individual banks to hold socially sub-optimal levels of capital. In particular, we examine whether competition among banks for deposits (and other sources of funding) can overcome these problems and lead to sufficient capitalization in the absence of government-mandated capital adequacy requirements. We show that when the explicit (or implicit) guarantee by the government of private deposits is less than complete – as it appears to be the case in practice – a bank's riskiness (and hence attractiveness among depositors) is related to the amount of that bank's capital-asset ratio. A highly capitalized bank is less likely to fail. A bank can thus attract funding at lower cost by improving its relative attractiveness through a higher individual (relative to other banks) capital-asset ratio.

Whether the positive effect of competition on capital-asset ratios is sufficient to overcome the tendency for undercapitalization that is created by free riding and moral hazard is ambiguous. We show that a necessary condition for competition to lead to higher CAR is that the banking system as a whole is "special" but individual banks are not. More precisely, we show that bank deposits are imperfect substitutes for other types of assets that are available to investors, but that the deposits of any individual bank are good substitutes for the deposits of other banks. Furthermore, in the absence of government guarantees of deposits, this condition is also sufficient for producing higher CAR.

Our model suggests that measures to strengthen competition within the banking sector (but not necessarily between competing financial industries) can increase CAR. Thus competition can also promote compliance with capital adequacy regulations and may even result in over-compliance. The empirical implications of the model with regard to the desirability of capital adequacy requirements hinge on two conditions: the existence of government deposit insurance; and the elasticity of substitution between individual bank deposits relative to the elasticity of substitution between bank deposits and other assets. We are not aware of any studies that have calculated these parameters. Nevertheless, it is still possible to assess the role of competition among banks by linking differences in funding costs across banks to differences in capital-asset ratios.

3.2 The Model

The banks in our model are entities that intermediate funds between lenders (depositors) and borrowers. They make loans, at exogenously given interest rates, and they finance them with deposits and their own capital. Each bank selects the interest rate it offers on its deposits in order to maximize profits. We assume that all banks are identical.

For exposition purposes, we will first discuss a benchmark case in which banks operate without any restrictions on borrowing and lending activities. We then introduce government

provided deposit insurance. The main result of the paper is obtained in the benchmark case and retains its relevance under the alternative specifications.

Within this setup we ask how banks select their capital-asset ratio, and whether the unregulated ratio exceeds or falls short of the socially optimal one. In the former case no government intervention in the form of capital adequacy requirements is necessary. Existing capital adequacy standards mandated by the government would, in that case, merely reflect what banks would do anyway.

What role does bank capital play in this environment? First, bank capital is a direct source of funds for loans. Second and more important, capital matters for the perceived riskiness of bank deposits. An undercapitalized bank is more likely to turn insolvent in the face of adverse developments on the asset side of its balance sheet than a sufficiently capitalized one. If deposits are less than fully insured, bank failure inflicts losses on the depositors[13]. Banks with higher capital-asset ratios are, consequently, perceived as safer managers of borrowed funds and will be able to attract deposits at more favorable terms (lower rates) than banks with low capital-asset ratios. A bank then can use its capital-asset ratio as a means of establishing a cost advantage against its competitors.

At the same time, an individual bank's interest rate depends also on the perceived safety of the banking system as a whole (systemic risk). A highly capitalized banking industry makes bank deposits relatively safer in comparison to other investments (from the investor-depositor's point of view), thereby benefiting all banks.

When an individual bank selects its preferred level of capital it takes into account the fact that more own capital increases the relative attractiveness of its deposits among competing banks (substitution effect). But she will typically ignore the fact that her capital also contributes to the overall safety of the banking system (the general effect), lowering risk premia on deposit rates across the board. Such a lack of internalization of spillover effects is standard in markets characterized by externalities.

The profits of an individual bank are given by equation (1)

$$\Pi = R^L \langle (k+q) - R(k-k^*,k^*) \langle q - c(k) \qquad (1)$$

Where Π is profits, R^L is the interest rate on bank loans, R is the interest rate on bank deposits, k is the level of own capital, k* the level of average capital in the banking sector, q is the quantity of deposits and c is the cost of raising own capital (with $dc/dk > 0$ and $d^2c/dk^2 > 0$). We assume, purely for the sake of simplicity, that the quantity of deposits received by each bank is fixed.[14] As described above, the interest rate on deposits, R, is a function of relative (k-k*) and systemic (k*) bank riskiness. We also assume that

[13] As was demonstrated by the savings and loans crisis in the United States, undercapitalized banks may also be more likely to engage in excessive risk-taking ("gambling for resurrection"). This propensity can materialize in the presence of deposit insurance when depositors have no incentive to monitor banks' activities.

[14] We could alternatively assume that $q = q(k)$, with $dq/dk > 0$, without affecting the qualitative properties of the results.

$$(2) \qquad \frac{dR}{dk} < 0, \frac{d^2R}{dk^2} \; ? \; 0, \frac{dR}{dk^*}_{|d(k-k^*)=0} < 0, \frac{dR}{dk^*}_{|dk=0} \; ?$$

The first two inequalities indicate that if a bank selects a higher capital-asset ratio then she can lower her funding cost (but at a decreasing rate). The third inequality states that a uniform (across banks) increase in the capital-asset ratio reduces the borrowing cost of all banks (lower systemic risk). The last inequality plays a critical role in the analysis. It asks how an individual bank's borrowing cost is affected when all her competitors increase their capital while she does not. If the sign is negative, then an individual bank can "free-ride" on other banks' "healthiness": the benefits from a reduction in systemic risk more than offset the losses from the increase in relative riskiness (the general effect dominates the substitution effect). If it is positive, then a bank loses (the substitution effect dominates the general effect).

The choice variable of the bank is the level of her own capital (or equivalently, given the fixity of q, the capital-asset ratio). The first order condition for profit maximization is

$$(3) \qquad \frac{d\Pi}{dk} = R^L - q\frac{dR}{dk} - \frac{dc}{dk} = 0$$

Note that in a symmetric equilibrium with n identical firms k* = k. The optimal level of k, say k^p, is given by equation (3). The bank acquires own capital up to the point where the marginal cost of an additional unit is equal to its marginal benefit. The benefit contains two elements: the increase in lending capacity, and the reduction in borrowing costs.

Let us now turn to the society's maximization problem. The inclusion of k* in the R function implies the existence of an externality – the individual bank's choice of a capital-asset ratio has implications for the level of systemic risk in the banking sector as a whole. This externality was not explicitly taken into account in the decision of the individual bank. Were a social planner to decide on how banks ought to behave, he would have chosen a different capital-asset ratio. In particular, the socially optimal k, say k^S, is given by the solution to the following equation

$$(4) \qquad \frac{d\Pi}{dk} = R^L - q\frac{dR}{dk} - q\frac{dR}{dk^*}\frac{dk^*}{dk} - \frac{dc}{dk} = 0$$

The comparison of (3) and (4) reveals that a bank is undercapitalized relative to the society's preferred level ($k^p < k^S$) if $dR/dk^* < 0$. In this case, there is a free-riding problem as the positive spillovers from a reduction in systemic risk outweigh any losses from a deterioration in the bank's *relative* position. If, on the other hand, $dR/dk^* > 0$, then a bank cannot rely on other banks' higher capitalization in order to bring its borrowing costs down. On the contrary, if the other banks strengthen their capital position and she does not follow suit then she has to pay higher rates on deposits to compensate her depositors for the higher relative risk they face.

What are the determinants of the sign of dR/dk*? When an individual investor considers opening an account with a bank she faces two decisions. First, whether she should place her money in a bank account at all rather than in a competing non-bank asset (e.g. government bonds, stocks, and so on). And second which one of the banks to select for opening the deposit account. Systemic risk in the banking sector plays an important role in the first decision. Individual (idiosyncratic) bank risk is more important in the second decision. If the depositors are more concerned about the first decision than about the second (that is, they care more about systemic rather than idiosyncratic risk) then dR/dk* is likely to be negative. Investors consider deposits offered by different banks that differ in terms of capital-asset ratios as close substitutes. In this case, a bank will not have a strong incentive to select a high capital-asset ratio to distinguish itself from its competitors. As a result, banks will tend to choose low levels of capital relative to the socially optimal level. Banks rely on other banks to keep their borrowing cost low.

If, on the other hand, depositors care more about idiosyncratic than about systemic bank risk, then the capital-asset ratio can be a powerful instrument for improving relative bank attractiveness and gaining a cost advantage over one's rivals. In this case, $dR/dk^* > 0$ and competition among banks will drive capital-asset ratios upward, perhaps to levels that exceed the socially optimal level, removing the need for government mandated minimum capital requirements. This situation is more likely to emerge when banks play a unique role in the financial system in the sense that other financial instruments cannot easily replicate the properties of their deposits.

3.3 Deposit insurance

We now examine the implications of government deposit insurance for the capital-asset ratio choices of banks. As discussed above, deposit insurance is the source of another externality[15] and may create a moral hazard problem. The maximization problem faced by the individual bank is now given by equation (5).

$$(5) \qquad \Pi = R^L \langle (k+q) - R(k-k^*, k^*) \langle (q-m) - R^I \langle m - c(k)$$

Where m is the deposits that are insured, q-m those that are left uninsured[16] and R^I is the interest rate offered on insured deposits (which must be the same for all banks in equilibrium). The first order condition for profit maximization is then given by equation (6).

$$(6) \qquad \frac{d\Pi}{dk} = R^L - (q-m)\frac{dR}{dk} - \frac{dc}{dk} = 0$$

[15] Externalities of this type emerge to the extent that the price charged for deposit insurance does not exactly match a bank's contribution to systemic risk. This seems to be the case due to the difficulties of pricing risk correctly.

[16] This specification is based on actual US practice. The FDIC insures individual deposits up to $100,000 in the case of a bank failure. Alternative specifications can be easily accommodated.

Comparison of (3) and (6) reveals that the capital-asset ratio selected in the presence of partial deposit insurance falls short of that selected without deposit insurance[17]. There simply is a smaller incentive on the part of banks to improve the relative safety of their deposits.

The social planner must now internalize two externalities when selecting the socially optimal capital-asset ratio of banks: the one pertaining to systemic risk and the one associated with government provided deposit insurance. We will assume that the function that evaluates the contribution of any bank's actions to social welfare takes the form

$$(7) \qquad \Pi = R^L \langle (k+q) - R(k-k^*,k^*) \langle (q-m) - R^I \langle m - c(k) - L(k)$$

Where L(k) is the social cost resulting from expected bank failures and the obligation to make deposit insurance payments. Obviously dL/dk < 0, that is, the more capitalized the bank the less likely it will fail and the less likely that insurance payments will be made.

The maximization of (7) produces the socially optimal level of bank capital, k^S

$$(8) \qquad \frac{d\Pi}{dk} = R^L - (q-m)\frac{dR}{dk} - (q-m)\frac{dR}{dk^*}\frac{dk^*}{dk} - \frac{dc}{dk} - \frac{dL}{dk} = 0$$

As in the case without deposit insurance, the sign of dR/dk* plays a critical role in determining whether competition among banks can be an efficient alternative to government mandated capital adequacy regulations. It must be noted, though, that the probability of an undercapitalized banking system is now higher because of the presence of the last term in (8). The social planner would like banks to hold high capital-asset ratios so as to reduce the probability of bank failures and avoid government compensation of depositors or bank bailouts more generally. The banks do not care about this social loss when selecting their capital-asset ratios.

3.4 Parametric Example

Finally, we use a simple parametric example to highlight the most important results. Let

$$(9) \qquad \begin{aligned} &R(k-k^*,k^*) = a0 - a1\langle (k-k^*) - a2\langle k^* \\ &c(k) = \frac{1}{2}k^2, \quad L(k) = b0 - b1\langle n\langle m\langle k \end{aligned}$$

[17] This result is due to the assumption that q is fixed. It would still obtain, however, if the total quantity of *uninsured* deposits, q-m, did not increase much with the introduction of deposit insurance. This seems plausible: even if q increased when bank deposits become safer, the increase would probably be directed into investments that have now become more attractive, namely insured accounts.

Where a1 and a2 are related to the depositors' evaluation of idiosyncratic and systemic bank risk respectively. n is the number of banks.

Using (9) and the fact that in a symmetric equilibrium k* = k, equations (6) and (8) are written as

$$(10) \qquad k^p = R^L + (q-m)\langle a1$$

$$(11) \qquad k^s = R^L + (q-m)\langle a1 - (a1-a2)\langle (q-m) + n\langle m\langle b1$$

A necessary condition for banks to hold at least as much capital as the social planner would require is that the depositors care more about idiosyncratic than about systemic bank risk (a1 > a2). A sufficient condition is that n•m•b1-(a1-a2)(q-m) < 0 or, equivalently, (n•m•b1)/(q-m) < a1-a2.

4. Empirical Analysis

Our model suggests that banks may use their capital-asset ratios as a means of gaining a cost advantage vis-à-vis their competitors. This behavior may, in principle, lead to capital-asset ratios that do not - even in the absence of capital adequacy regulations - fall short of the socially optimal ratios. In this section we examine whether the borrowing costs of banks are affected by idiosyncratic and banking sector-wide capital-asset ratios. In particular, we test the relevance of equation (9) above[18], which is the main building block of our theory.

$$R_{it} = a1\bullet (k_{it} - k_t^*) + a2\bullet k_t^* + a3\bullet x_{it} + u_{it}$$

R_{it} measures the funding costs of bank i in period t; k_{it} is that bank's capital-asset ratio; k_t^* is the average capital-asset ratio within the group that includes the bank's competitors (for instance, other banks within the same state); and x_{it} is a set of other bank characteristics that may affect bank i's funding costs (e.g., bank size, bank performance). If a1 is negative (and statistically significant), a bank can lower its funding costs by increasing its capital-asset ratio. If a2 is negative, bank competition is not strong enough to overcome the free-riding problems associated with systemic risk. If a2 is positive, bank competition can reduce or even eliminate the free-riding problem; consequently, the banking system would be sufficiently capitalized in the absence of capital adequacy regulation. A large, positive value for a2 would suggest that this might be true even in the presence of deposit insurance (recall from (10) and (11) that we need n•m•b1 < (a1-a2)(q-m)).

[18] In the theoretical part of the paper we assumed that all banks were identical. As a result, all of them ended up selecting the same capital-asset ratio and paying the same interest rate on deposits. It is straightforward to allow for differences across banks (for instance in the c function). This would produce a non degenerate distribution of capital-asset ratios and interest rates and would hence justify the use of this regression specification.

The variables k_{it} and x_{it} are easier to define than k_t^*. The construction of k_t^* requires some subjective judgment because it is not obvious, on empirical grounds, what constitutes the relevant reference group for each individual bank. We postpone dealing with this issue and first estimate the following equation without the average capital-asset ratio:

$$R_{it} = w1 \bullet k_{it} + w2 \bullet x_{it} + u_{it}$$

We test the hypothesis that $w1 < 0$. If we can reject this hypothesis there is no reason to proceed any further. If an individual bank can not reduce its borrowing costs by raising its capital-asset ratio, then the principal mechanism identified in our model – that competition may drive CAR upward – will not be relevant from an empirical standpoint.

The data set we use consists of yearly observations on the entire population of US banks in the period 1990 - 2000.[19] It was constructed from data provided by the US FDIC[20]. We lack detailed information on interest rates offered by each bank on the various types of deposits. We therefore use a measure of banks' individual "average" interest rate (see Table A1 in the Appendix for variable definitions). The $\mathbf{R_{it}}$ variable is measured in terms of the *average cost of deposits* and is defined as the ratio of banks' interest expense on deposits to the value of total deposits. For $\mathbf{k_{it}}$ we have used *Tier 1 capital* (Tier 1 capital divided by total risk weighted assets, K)[21]. $\mathbf{x_{it}}$ consists of various *control variables* pertaining to the size (*number of employees*, **EMPL**; *total value of assets*, **ASSET**) and other characteristics of banks (*return on equity*, **ROE**; and *non-performing loans*, **NONP**). Because some of the data are probably reported with error, we purged the sample from a small number of outliers.[22] Specifically, we included only those banks with a Tier 1 capital-asset ratio between 0 and 100%, and an average, annual, interest rate on deposits that ranged from 0 to 30%. Tables A2 and A3 in the Appendix report the summary statistics for the original data set – with the outliers – and for the data set actually used in the analysis respectively.

To estimate the above equation (as well as the other equations below) we ran pooled cross-section times series regressions with a fixed-effects procedure[23]. Using random-effects specifications did not lead to different results (see, for instance, Table A4 in the Appendix). We also include *quadratic terms* in the regressions to capture possible non-linearities in the relationship between capital-asset ratios and banks' borrowing costs.

Table 1 reports the estimation results without control variables. Table 2 includes control variables.

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[19] This time period was chosen because capital-asset ratios (calculated according to BIS standards) are available only from 1990 on.

[20] We are extremely grateful to the FDIC, and particularly to Pat Relich, for making this data available.

[21] Using other measures of the capital-asset ratio (such as total capital ratio, that is, risk based capital divided by total risk weighted assets) does not matter for the results.

[22] For instance, the raw data set contained a few large negative values for tier 1 capital and for interest expenses, as well as some implausibly large positive values for the same variables.

[23] Estimates were obtained using the xtreg procedures in STATA.

Table 1
Dependent variable: Interest expense ratio (R)

	Coef.	Std. Err.	t	P>t
k_i	-.0011195	.0000194	-57.597	0.000
k_i^2	.0000108	2.63e-07	41.074	0.000
Constant	.053119	.0002468	215.259	0.000
N = 132340 R-sq = 0.0330 Prob > F = 0.000				

Table 2
Dependent variable: Interest expense ratio (R)

	Coef.	Std. Err.	t	P>t
k_i	-.0009453	.0000218	-43.311	0.000
k_i^2	9.08e-06	3.24e-07	27.993	0.000
asset	-1.08e-10	3.05e-11	-3.536	0.000
empl	-3.07e-07	1.39e-07	-2.218	0.027
roe	-.0001329	5.05e-06	-26.307	0.000
nonp	.2204094	.0034358	64.151	0.000
Constant	.0428308	.0001443	296.868	0.000
N = 124274 R-sq = 0.0931 Prob > F = 0.000				

The results reported in Tables 1 and 2 indicate that well capitalized banks face lower average interest expenses on their deposits. This finding validates an important premise of the model, namely, that market forces influence banks' choices of individual capital-asset ratios. Moreover, this function is convex: the coefficient for the quadratic term, k_i^2, is positive. This means that while additional capital lowers borrowing costs, it does so at a decreasing rate. Well-capitalized banks benefit less than poorly capitalized banks when they increase their capital-asset ratios.

The results shown in Table 2 also suggest that large banks – either in terms of number of employees (EMPL) or value of assets (ASSET) – face lower borrowing costs, and so do banks that are more successful in terms of higher returns on equity (ROE). On the other hand, banks with a larger share of non-performing loans (NONP) face higher interest expense ratios. The latter finding provides additional evidence that depositors are concerned about the riskiness of their investments. Banks that are perceived as riskier – because they hold larger amounts of non-performing loans – are "punished" by the market with higher borrowing costs.[24]

[24] Interestingly, this penalty might imply a further deterioration of the balance sheet of troubled banks.

How important are these results from a quantitative point of view? The elasticity[25] of the interest rate ratio with regard to the capital-asset ratio is around –0.5. That is, an increase in the capital-asset ratio by 10% lowers the average interest rate paid on bank deposits by 5%. In other words, the effect of capital-asset ratios on borrowing costs is surprisingly strong.

We have shown that competition among banks contributes to higher levels of bank capitalization. We still do not know, however, whether the desire to lower borrowing costs is strong enough to override the tendency for undercapitalization that arises from free riding and moral hazard. To assess this proposition we return to our original specification and estimate equation (9) directly

$$R_{it} = a1 \bullet (k_{it} - k_t^*) + a2 \bullet k_t^* + w \bullet x_{it} + u_{it}$$

where $\mathbf{k_t^*}$ is the *average capital-asset ratio at time t in the state where the bank is located*. Table 3 reports the results.

Table 3
Dependent variable: Interest expense ratio (R)

	Coef.	Std. Err.	t	P>t
$k_i - k^*$	-.0000302	7.27e-06	-4.156	0.000
k^*	-.0159864	.0001984	-80.557	0.000
$(k^*)^2$	.0003363	5.82e-06	57.763	0.000
asset	-2.71e-11	2.65e-11	-1.022	0.307
numemp	-1.48e-07	1.20e-07	-1.228	0.219
roe	-.0000447	4.26e-06	-10.513	0.000
nonp	.1089001	.0029854	36.478	0.000
constant	.211112	.0016895	124.953	0.000
N = 131982 R-sq = 0.3164 Prob > F = 0.000				

Both a1 and a2 (the coefficients for variables ($k_i - k^*$) and k^*) are statistically significant and negative. This result implies that if a bank increases its capital-asset ratio relative to the U.S. state average, it reduces its borrowing costs. On the other hand, an increase in the industry-wide capital-asset ratio – holding individual bank capital constant – also reduces the bank's borrowing costs. Given that the coefficient for the average capital-asset ratio, k^*, is much larger than that

[25] Given the form of the regression equation, $R = b1*k_i + b2*k_i^2$, the elasticity, e, is defined as $e = (b1+b2*k_i)*(k_i/R_i)$. Using the values of the estimated coefficients b1 and b2 at the mean values k =17.1 and R =0.038 results in e = –0.491.

for the individual capital-asset ratio ($k_i - k^*$), the latter effect dominates. That is, competition among banks is not sufficient to eliminate the free-rider problem.

We have also examined the relationship between capital-asset ratios and other types of borrowing cost, including the interest expense ratios for liabilities as a whole (ratio of total interest expense and total liabilities), and subordinate debt (ratio of interest expense on subordinate debt and value of subordinate debt). In the case of subordinate debt, for example, the estimated coefficients were statistically insignificant (see Table A5 in the Appendix). It should be noted, however, that the number of observations in this regression was very small – very few banks issue subordinated debt.

5. Conclusions

This paper demonstrates that in order to understand the extent and form as well as the effectiveness and efficiency of government regulation, particularly in economic policy, it is essential to understand the behavior of the relevant firms and markets. We did so in the context of the US banking sector in the 1990s. While political science research to date has examined regulatory policy with respect to financial markets chiefly by studying the behavior of policy-makers, we complement this research by developing and testing a model of bank behavior to shed additional light on regulatory policy in this key area of the US economy.

The theoretical model and the empirical analysis concentrate on two main questions: Would banks be undercapitalized relative to the social optimum in the absence of capital adequacy regulation? Would they also be undercapitalized relative to existing official capital adequacy requirements (which do not necessarily coincide with the socially optimum) if no such regulation existed?

The theoretical analysis shows that there is no presumption in favor of an affirmative answer to these questions. Competitive forces may, in principle, motivate banks to select high capital-asset ratios as a means of lowering their borrowing costs. If the effect of competition among banks is strong, then it may overcome the tendency for bank undercapitalization that arises from systemic effects (free riding, moral hazard). If systemic effects are strong, capital adequacy regulation is required.

We then examined the behavior of US banks in the 1990s. Two main findings emerged. Better-capitalized banks experienced lower borrowing costs. And bank competition does not seem to perfectly substitute for capital adequacy regulation because of substantial systemic effects (free riding). These findings offer an explanation for overcompliance with official requirements, a puzzling observation that has indeed motivated our analysis. Namely, overcompliance is likely to have resulted from the fact that competition has motivated banks to select higher capital-asset ratios than they otherwise would have.

Our analysis offers a fundamental building block for explaining more systematically how and why market forces have contributed to capital-asset ratios that, in most OECD countries, are on average well above regulatory floor standards. It also contributes towards more systematic explanations of the rapid international diffusion of the Basle capital adequacy standards to ever more countries despite widespread complaints by banks about such regulatory burdens. Our results suggest that market pressure has facilitated the implementation of capital adequacy requirements and the adoption of the Basle standards by a growing number of countries – it is

obviously easier for regulators to request higher capital-asset ratios from banks when financial markets are driving banks in that same direction. Moreover, our analysis shows that recent US and international (Basel Accord) regulatory reform efforts, which are designed to increase transparency and enhance competition in the banking sector, can be interpreted as an effort to align market forces and regulation in ways that minimize the need for costly government enforcement or bailouts. Indeed, the analysis confirms that an important effect of prudential regulations, such as those of the Basle Accord and Basle II, is to strengthen competition among banks by generating simple benchmarks for comparing the riskiness of banks as well as more data on bank performance.

More generally, the analysis in this paper demonstrates that modelling the behavior of firms and markets is instrumental for understanding whether complementarities exist between government policy and market forces. The extent to and forms in which such complementarities exist beyond the banking sector is obviously a matter for further research. However, it is very likely that interactions between regulatory processes and market forces play an important role also in a variety of other national and international policy areas, for example environmental policy, corporate governance, and labor standards. Studying whether and how firms and markets affect political processes and how policies can be designed so as to create synergies among regulation and markets that help in reaching political goals is much too important to be left to economists alone.

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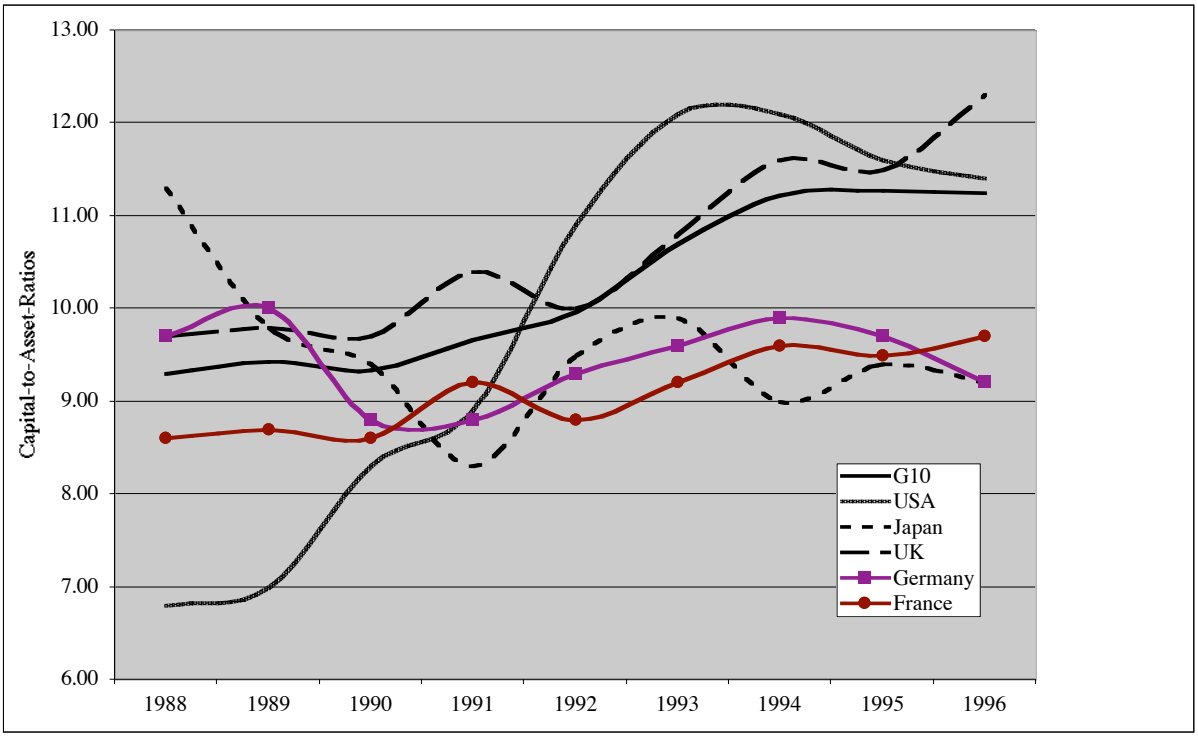
APPENDIX

Figure A1: Average capital-asset-ratios of banking sectors in selected G-10 countries[26]



[26] Source: Dutch National Bank. The indicator is defined as the total (Tier 1+2) BIS risk-weighted capital-asset ratio. The Tier 1+2 ratios for the US in Figure 1A is not identical to the US Tier 1+2 ratios in Figure 1. The differences are due to a smaller sample of banks covered by Figure 1A and differences in the definition of capital and risk-weighted assets.

Table A1: Variables

Name	*Description*	*US Federal Deposit Insurance code*
R	Ratio of interest expense on deposits to total amount of deposits	EDEP/ DEP
K_I	Ratio of tier 1 capital to total risk-weighted assets	RBC1RWAJ
K*	Average tier 1 capital of the banking sector in the (US) state where the bank is located	Own calculation, based on FDIC data (RBC1RWAJ; STALP)
EMPL	Total number of full time equivalent employees	NUMEMP
ASSET	Total assets	ASSET
ROE	Return on equity	ROE
NONP	Share of non-performing loans in total assets	NPER/ASSET

Table A2: Summary statistics for data used in the regressions

Variable	Obs	Mean	Std.Dev.	Min.	Max.
R	133446	.0382643	.0152153	.0050003	.293571
k_i	133264	17.13009	9.873385	.01	99.7
k*	134909	17.11774	2.131589	7.31	33.47
asset	134909	452471.1	5109305	1	5.85e+08
empl	134909	147.8086	1351.593	0	149800
roe	125085	10.62806	10.76819	-99.51	99.44
nonp	125085	.0118683	.0179961	7.44e-07	.6304279

Note: Restrictions imposed: 0<R<0.3, 0<k<100, -100<roe<100, 0<nonp<1

Table A3: Summary statistics for the raw data

Variable	Obs	Mean	Std.Dev.	Min.	Max.
R	134738	.0440636	.9774424	0	319
k_i	134907	21.59145	764.2705	-1148.02	274636.4
asset	134909	452471.1	5109305	1	5.85e+08
empl	134909	147.8086	1351.593	0	149800
roe	134433	8.727576	213.8381	-73954.55	2246.27
nonp	134909	.0119307	.0228489	-.0478782	1.131936

Table A4: Dependent variable: interest expense ratio (R)

Random-effects GLS regression

	Coef.	Std. Err.	z	P>z
k_i	-.000859	.0000155	-55.383	0.000
k_i^2	8.44e-06	2.19e-07	38.599	0.000
cons	.0502516	.0002066	243.181	0.000
N = 132340 R-sq = 0.0330 Prob > F = 0.000				

Table A5: Dependent variable: Interest expense ratio for subordinate debt (SUB)

Fixed-effects regression

	Coef.	Std. Err.	t	P>t
k_i	.0101416	.0128265	0.791	0.429
k_i^2	-.000216	.0003138	-0.688	0.491
Constant	.1091088	.0009965	109.490	0.000
N = 4146 R-sq = 0.0002 Prob > F = 0.0027				