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Working Paper

Does Competition make Banks more Risk-seeking?

Tinbergen Institute Discussion Paper, No. 14-059/IV

Provided in Cooperation with:

Tinbergen Institute, Amsterdam and Rotterdam

Suggested Citation: Arping, Stefan (2014) : Does Competition make Banks more Risk-seeking?, Tinbergen Institute Discussion Paper, No. 14-059/IV, Tinbergen Institute, Amsterdam and Rotterdam

This Version is available at:

<https://hdl.handle.net/10419/98916>

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TI 2014-059/IV
Tinbergen Institute Discussion Paper



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Does Competition Make Banks More Risk-Seeking?

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December 2013

Revised: May 2014

Abstract

This article presents a model in which, contrary to conventional wisdom, competition can make banks more *reluctant* to take excessive risks: As competition intensifies and margins decline, banks face more-binding threats of failure, to which they may respond by reducing their risk-taking. Yet, at the same time, banks become riskier. This is because the direct, destabilizing effect of lower margins outweighs the disciplining effect of competition; moreover, a substantial rise in competition reduces banks' incentive to build precautionary capital buffers. A key implication is that the effects of competition on *risk-taking* and on *failure risk* can move in opposite directions.

Keywords: Charter Value Hypothesis; Bank Franchise Value; Bank Competition; Financial Stability; Capital Requirements

JEL Classification: G2, G3

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1 Introduction

Greater competition in the banking sector is traditionally believed to make banks more eager to take high risks. As competition intensifies, so one prominent argument goes, the present value of banks' future rents (their charter or franchise value) declines, making failure less costly and inducing banks to take on more risk.¹ The charter value hypothesis and its variants have a firm place in the banking literature,² and they underpin the widely held view among policy makers that competition in banking should be restrained.

Yet, to a banker, the perceived academic wisdom may seem puzzling. Would a decline in margins caused by heightened competition not call for a more conservative stance and *less* aggressive risk-taking? Conversely, would the high profits that can be reaped in less-competitive environments not allow for *more* risk-taking? Viewed through the lens of the banker, the conventional view in the literature seems far less obvious. But, then, would the banker's view not be at odds with the historical experience that episodes of financial deregulation are periodically followed by banking crises (e.g., Keeley 1990; Kaminsky and Reinhart 1999; Demirgüç-Kunt and Detragiache 2006; Reinhart and Rogoff 2009)?

This article presents a dynamic model of banking in which, consistent with the banker's intuition, fiercer competition for deposits can cause banks to become more *conservative* in their risk-taking. This puts the charter value hypothesis on its head. Yet, at the same

¹As eloquently put by Gorton (2012, pp. 126-127):

“The history of banking in the United States implicitly revolves around a conflict between charter value, which creates an incentive for banks not to become too risky, and competition, which creates risks. If a bank is deemed insolvent, it loses its charter [...], so the higher a bank's charter value, the higher the incentive it has to avoid risk. But as companies without bank charters compete with banks by offering the same services, the value to a bank of having a charter decreases, and to compete and stay afloat, a bank must take on more risk.”

²See, among others, Keeley (1990); Suarez (1994); Allen and Gale (2000, 2004); Hellmann, Murdock, and Stiglitz (2000); Matutes and Vives (2000); and Repullo (2004). This literature focuses on the effects of competition on *banks'* risk-shifting incentive, and so does our article. Another literature, pioneered by Boyd and De Nicolo (2005), puts the focus on *borrowers'* risk-taking behavior: In their model, fiercer competition for loans leads to lower loan rates; this mitigates borrowers' risk-shifting incentive, making loans safer.

time, and consistent with the historical experience, competition makes banks riskier, leading to higher failure rates. The intuition behind this result has to do with the observation that competition affects bank failure rates not only indirectly, through its effect on asset risk-taking, but also *directly*, through the effect of lower margins on default risk. It is precisely because of the latter effect that competition can reduce banks' risk appetite: As competition becomes fiercer, default risk rises; this exposes banks to more-binding threats of failure, to which banks may respond by adjusting their risk policies and *reducing* their risk-taking. However, competition also erodes charter values, which has the opposite effect on risk-taking. The overall effect of competition on risk-taking is, then, ambiguous.

The key takeaway from an empirical perspective is that the effects of competition on bank risk-taking and on failure risk can move in *opposite* directions. Although a *ceteris paribus* decrease in asset risk-taking would improve bank financial stability, lower risk-taking can be caused by an increase in competition, the overall effect of which is destabilizing in our model. Observing a decline in, say, loan portfolio risk, a regulator may, then, erroneously infer that banks became safer, too. Conversely, lower bank failure rates are not necessarily proof of more-prudent lending practices. In either case, the inference would suffer from an omitted-variables bias—the omitted variable being competition.³

The model has the following features: A bank collects deposits to fund a portfolio of assets. It derives market power from the fact that depositors find it costly to access the money market—their outside option. The risk profile of the bank's asset portfolio is shaped by the banker's prudence in "monitoring" assets: Less-diligent monitoring effort entails higher asset risk. The choice of "prudence" is, then, driven by a classic trade-off between, among other things, the short-term gains from shifting risk to bank liability-holders and minimizing the

³Yet another reason why the difference between risk-taking and failure risk matters is that the welfare effects of excessive risk-taking may differ from those of heightened failure risk. While less-fierce competition makes banks more stable, it can come at the expense of imprudent risk-taking, e.g., in the form of lower lending standards. This introduces a *trade-off* between financial stability and prudent banking.

risk of failure and losing the charter (e.g., Keeley 1990). The main question of interest is how a rise in market power affects the banker's choice of asset risk (or "imprudence").

The model is similar in spirit to the dynamic frameworks of Hellmann, Murdock, and Stiglitz (2000) and Repullo (2004),⁴ but it differs from these models in a key respect: Returns of risky assets do not follow a two-state distribution but are continuously distributed. This has the important consequence that heightened market power affects failure rates not only indirectly, through its effect on prudence, but also directly, through the effect of higher margins on default risk. A key insight is that, because of the reduction in default risk caused by a reduction in deposit rates, an increase in market power can undermine prudence.

More specifically, heightened market power can have three effects on bank prudence in our model. The first effect is the standard moral-hazard-reducing effect of lower deposit rates that also occurs in static models: Lower deposit rates reduce banks' deposit-repayment burdens, mitigating risk-shifting incentives. The other two effects are unique to a dynamic setting. The first is the classic charter value effect: An increase in market power raises the present value of future profits, making failure more costly. The second effect goes in the opposite direction: As deposit-market power rises, the bank's debt-repayment burden and, thus, default risk decline; this reduces the risk of losing the charter, which, in turn, gives the bank additional room to behave recklessly. Thus, the overall impact of market power on asset risk-taking is ambiguous. However, it also turns out that the potentially adverse prudence effect never outweighs the direct, stabilizing effect of lower funding costs, so enhanced market power always entails lower bank *failure risk* in our setting.

In an additional step, we explore the effect of market power on banks' incentive to build precautionary equity capital buffers. Our analysis draws heavily on Marcus's (1984) observation that poorly-capitalized banks aim to weaken their balance sheets to maximize

⁴Cf., also, Suarez (1994). He has a model with mean-preserving spreads in which the bank's risk-taking problem has a corner solution. In our model, the risk-taking problem has an interior solution.

the value of their deposit insurance “put options” (Merton 1977), whereas well-capitalized banks aim to strengthen their balance sheets to protect their charter values. Similarly, in our model, highly profitable banks optimally build equity capital buffers to guard against failure, whereas banks operating in more-competitive environments seek to minimize their capital. And, interestingly, as banks are *required* to “hold” more capital, they eventually overcome their aversion to capital. The intuition is simple: Banks that are required to hold a lot of capital have a lot to lose from failing—namely, their capital—and, consequently, they have an incentive to hold *even more* capital to guard against failure.

Overall, the analysis proposed here suggests that even though market power can spur more-aggressive risk-taking, it tends to make banks safer. Market power is stabilizing for two reasons. First, holding capital constant, the stability-enhancing effect of lower funding costs (higher margins) outweighs the potentially adverse prudence effect. And, second, heightened market power can induce banks to hold more capital, which reinforces the previous effect. These predictions are largely consistent with the empirical evidence reported in Berger, Klapper, and Turk-Ariss (2009). They document that, while market power can entail riskier asset portfolios, it also tends to make banks less fragile—one reason being that banks operating in less-competitive environments tend to hold more capital.

2 Related Theoretical Literature

Much of the extant literature on the link between bank competition and financial stability focuses on the deposit market (e.g., Suarez 1994; Allen and Gale 2000, 2004; Hellmann et al. 2000; Matutes and Vives 2000; Repullo 2004; and many more). The common theme of this literature is that fiercer competition for deposits tends to make banks more fragile by encouraging them to take high asset risks. As banks pay higher deposit rates, they face higher deposit-repayment burdens, which exacerbates risk-shifting moral hazard (cf., Jensen

and Meckling 1976). This static effect is, then, reinforced by the charter (or franchise) value effect that arises in dynamic models in which banks have charter values to lose (e.g., Suarez 1994; Hellmann et al. 2000; Repullo 2004). Our article contributes to this literature by showing that there can be a third—and thus far neglected—effect: As banks face less-fierce competition, deposit-repayment burdens decline; this reduces default risk and, thus, the risk of losing the charter, which, in turn, gives banks more room for risk-taking. Perotti and Suarez (2002) develop a model in which failure of a bank leads to a temporary rise in concentration; this can aggravate risk-shifting since the rise in the market shares of the surviving banks increases the scale of the short-term gains from risk-taking. The effect proposed in our article is different from and complementary to this effect.

Another channel through which competition can reduce asset risk is proposed by Boyd and De Nicolo (2005). In their model, fiercer competition in loan markets entails lower loan rates; this reduces *borrowers'* risk-shifting incentive, making loans and, ultimately, banks safer. A key feature that distinguishes their approach from the aforementioned literature is that, in their setting, the riskiness of bank assets is shaped by borrowers' risk-shifting incentive, whereas in the deposit-market literature—and in our model—asset risk is under the direct control of *banks*. This difference is crucial since Wagner (2010) shows that the risk-reducing effect of loan competition in the Boyd and De Nicolo framework may reverse sign when banks control loan risk, too (cf., also, Hakenes and Schnabel 2011).

Martinez-Miera and Repullo (2010) present a model in which the relationship between loan-market power and bank failure risk is non-monotonic:⁵ Higher loan rates provide a buffer against losses from defaulting borrowers; however, they also lead to higher loan default rates, so the overall effect on loan *portfolio* risk is ambiguous. In other words, heightened loan-market power can make loans riskier but loan portfolios—and banks—safer. In our model, deposit-market power makes banks safer, yet it can lead to riskier asset portfolios.

⁵Caminal and Matutes (2002), too, show that the stability aspects of loan competition can be subtle.

Lastly, the mechanism by which market power can undermine bank prudence in our model is akin to the notion that product-market power can make firms more complacent by insulating them from the threat of liquidation—the “quiet-life” hypothesis; see Schmidt (1997) for a model. This, in turn, is related to the idea that “fragile” capital structures can have desirable commitment effects by making firms or banks vulnerable to the threat of liquidation or runs (e.g., Calomiris and Khan 1991; Dewatripont and Tirole 1994; Bolton and Scharfstein 1996; Diamond and Rajan 2000).⁶ Thus, the observation that competition can have a disciplining effect by making failure threats more binding is not novel. Our contribution is to show that accounting for this effect in the context of a model of bank risk-taking can have profound implications for the debate on the effects of competition on bank prudence. Notably, it can put the charter value hypothesis on its head.

The article proceeds as follows. Section 3 presents the model. Sections 4 and 5 analyze the effects of market power on bank prudence and capital, respectively. Section 6 provides a discussion of welfare, and Section 7 concludes. Proofs are relegated to the Appendix.

3 The Model

There is an infinite number of periods, $t = 1, \dots, \infty$.

We consider a bank that is owned and run by infinitively lived shareholders with deep pockets (the “banker”). The bank funds itself with deposits and inside equity. At the beginning of each period, a unit mass of one-period depositors is born, each with an endowment of \$1. There also is a regulator who insures deposits and sets bank capital requirements.⁷ Finally, there is a competitive money market in which agents can invest funds at the riskless

⁶The notion that capital (requirements) can, in some cases, *aggravate* moral hazard in banking is central to a number of papers. See, among others, Kim and Santomero (1988), Besanko and Kanatas (1996), Blum (1999), Calem and Rob (1999), Hellmann et al. (2000), and Perotti, Ratnovski, and Vlahu (2011).

⁷Deposit insurance is a realistic model ingredient and simplifies the exposition; however, it is not crucial. In particular, as is well known, it is not required for a risk-shifting moral-hazard problem to occur.

rate $r > 0$. All parties are risk-neutral and protected by limited liability.

Assets. At the beginning of period t , the bank collects funds to invest in two types of one-period assets: a scalable safe asset (e.g., T-bills) yielding the riskless return r with certainty, and a positive-NPV risky asset. The risky asset is non-scalable and requires an investment of \$1. Thus, if the bank raises \$1 of deposits, chooses equity capital K (through retaining earnings or issuing new equity), and invests in the risky asset (\$1), then K dollars are mechanically invested in the safe asset. Table 1 illustrates the bank’s balance sheet.

| Assets | Equity & Liabilities |
|-----------------|----------------------|
| Safe asset K | Deposits \$1 |
| Risky asset \$1 | Equity K |

Table 1: Bank Balance Sheet

The risk-return profile of the risky asset is shaped by the banker’s prudence in “monitoring” the asset:⁸ If the banker chooses a monitoring intensity $m_t \in [0, 1]$, then the gross return of the risky asset is $m_t \tilde{\theta}_t R$, where $\tilde{\theta}_t \in [0, 1]$ is a (non-verifiable) random variable representing exogenous (“macroeconomic”) uncertainty, and $R > 0$ is a constant. The per-period states of the economy $\tilde{\theta}_t$ are identically and independently distributed according to a smooth c.d.f. $F(\theta)$ with density $f(\theta)$ and mean μ . For the sake of simplicity, we take f to be uniform, $\tilde{\theta}_t \sim U(0, 1)$ (i.e., $\mu = 1/2$). Thus, the probability that the risky asset will generate revenue $Z \geq 0$ or less is

$$\text{Prob} \left[m_t \tilde{\theta}_t R \leq Z \right] = F \left(\frac{Z}{m_t R} \right) = \begin{cases} \frac{Z}{m_t R} & \text{for } Z \leq m_t R, \\ 1 & \text{for } Z > m_t R. \end{cases}$$

⁸“Monitoring” should be interpreted broadly. For example, it can refer to monitoring the performance of borrowers and/or asset/loan managers and preventing them from pursuing harmful private benefit objectives; conducting proper deal due diligence (including loan screening); putting appropriate risk mitigants in place (and negotiating them with counterparties); maintaining “safe and sound” lending standards, etc. In any case, the monitoring modeling approach adopted here is not crucial. A classical, appropriately specified risk-shifting setting in the spirit of Stiglitz and Weiss (1981) would yield similar insights. What is crucial is that the bank’s asset risk-taking problem has an interior solution, as opposed to a corner solution.

In other words, by acting more prudently—monitoring more intensively—the banker can reduce the likelihood that portfolio revenue will fall below a certain threshold. There is a private monitoring cost $\psi(m)$, which is increasing and strictly convex and satisfies $\psi(0) = \psi'(0) = 0$, and $\psi'(1) = \infty$. The monitoring intensity is unobservable and chosen by the banker right after investment. Throughout the analysis, we assume that the underlying parameter values and functional forms are such that, in equilibrium, it is optimal for the bank and efficient for society to invest in the risky asset (clearly, this must be the case for, e.g., R sufficiently large). Thus, in this setup, the welfare distortion of interest stems from the bankers' incentive to deviate from the efficient level of prudence/monitoring.

Deposits. At the beginning of period t , a unit mass of one-period depositors is born. Depositors are each endowed with \$1, which they need to store for later consumption (depositors value consumption only at period-end). They can deposit cash in the bank or in a money market fund, but they cannot safely store cash “at home.” The bank derives market power from the fact that depositors are price-takers and have an intrinsic preference to do business with the bank (say, because they find it cumbersome to access the money market). Formally, if a depositor accesses the money market, she incurs a transaction cost (or disutility) $s \in (0, 1)$. Since depositors are insured, they do not demand compensation for bank default risk. Thus, in equilibrium, the bank offers a gross deposit rate of $D = (1 - s)(1 + r)$, and depositors accept. To simplify the exposition, following Hellmann et al. (2000) and Repullo (2004), we normalize deposit insurance premia to zero.

In this setting, the parameter s measures the bank's pricing power in the deposit market. Presumably, as money markets become more developed (e.g., through technological progress) or depositors become more financially literate (e.g., because they become wealthier and better educated), depositors find it less costly to access the money market. This, in turn, raises competitive pressure in the deposit market, leading to higher deposit rates. The main comparative statics exercise of interest is to vary the pricing-power parameter s and

to explore its effect on bank prudence. Section 6 provides a discussion of how the analysis could be extended to the asset (“loan”) market by varying the asset return R .

Capital. At the beginning of period t , the bank chooses its equity capital K_t (through its dividend and equity-issuance policy). The bank faces a regulatory capital requirement: For each dollar of risky assets, it must “hold” at least K^{\min} dollars of equity capital. We assume that the bank can adjust its equity capital only at the beginning of each period. Thus, in the event of a cash shortfall at the end of the period, the bank cannot cover the loss and avoid failure by raising additional capital. The underlying premise is that, when failure is imminent, there is just insufficient time for a quick recapitalization.

As is standard in models such as ours, if equity markets were completely frictionless, then first-best capital requirements would be such that banks never default. To avoid this uninteresting outcome—and for the sake of realism—we need to introduce equity frictions. We do so in the simplest possible manner by assuming that “drastic” capital requirements are not feasible.⁹ Formally, feasible capital requirements must satisfy $K^{\min} \leq \bar{K}$, where \bar{K} is the bank’s “equity capacity” (all that is required here is that holding “a lot” of capital is prohibitively costly or infeasible). For simplicity, we assume that for $K_t \leq \bar{K}$, the equity cost of capital is no different from the frictionless cost of capital—here, the riskless rate—but we relax this assumption later. To make the analysis interesting, we posit that $\bar{K} < 1 - s$, so that *net* debt is always positive and there is some risk of default.

The Banker’s Problem. At the beginning of period t , the banker collects \$1 of deposits, chooses the bank’s equity capital $K_t \in [K^{\min}, \bar{K}]$, and invests \$1 in the risky asset and K_t dollars in the safe asset. At the end of the period, the risky asset returns $m_t \tilde{\theta}_t R$ and the safe

⁹Such a constraint could stem from, e.g., issuance costs; supply-side frictions causing equity capital to be scarce (Gorton and Winton 2000; Repullo 2013); market pressure to pay dividends; or agency costs of equity à la Diamond and Rajan (2000). And, of course, drastic capital requirements may not be politically feasible due to bankers’ lobbying against them—an important, real-world friction.

asset $K_t(1+r)$. Thus, the bank fails—defaults on its debt—if and only if

$$m_t\theta_t R + K_t(1+r) < D = (1-s)(1+r),$$

or $\theta_t < (1-s-K_t)/(\beta m_t R) \equiv \hat{\theta}_t$, where $\beta = (1+r)^{-1}$ is the discount factor. If the bank does not fail, it continues to the next period. If it fails, the regulator is assumed to take over the bank and expropriate shareholders. Let $\phi_t = 1 - F(\hat{\theta}_t)$ denote the probability that the bank survives period t . Thus, the banker's problem is to

$$\begin{aligned} \max_{(m_t, K_t)} \quad & U(m_t, K_t) = \mathbb{E}_\theta \max \left[0, \beta m_t \tilde{\theta}_t R + K_t - (1-s) \right] - \psi(m_t) - K_t + \phi_t \beta V_{t+1}, \\ \text{s.t.} \quad & \\ & K_t \in [K^{\min}, \bar{K}], \end{aligned}$$

where V_{t+1} is the bank's *charter value*—i.e., the present value of future profits—at the beginning of period $t+1$. We restrict attention to Markov-perfect equilibria. By stationarity, $(m_t, K_t) = (m_{t+1}, K_{t+1})$, and, dropping subscripts, $V = \max_{m, K} \{U(m, K)\}$.

3.1 Static Benchmark Equilibrium

As a useful point of reference, let us first derive the equilibrium of the static game that would prevail in a one-period economy. The bank's payoff function can be rewritten as

$$U(m, K) = \underbrace{\beta m \mu R - \psi(m)}_{\text{asset PV}} - \left[\int_0^{\hat{\theta}} (\beta m \theta R + K) dF(\theta) + \int_{\hat{\theta}}^1 (1-s) dF(\theta) \right],$$

where, recall, $\hat{\theta} = (1-s-K)/(\beta m R)$, and the first term is the present value of assets (net of monitoring costs) and the term inside the square brackets is the present value of liabilities. Thus, the bank faces the usual trade-off between maximizing the value of its assets and

minimizing the value of its liabilities. Clearly, the bank's payoff is decreasing in K through its effect on the value of liabilities, so capital requirements are binding,¹⁰ $K = K^{\min}$. The bank's problem boils down to maximizing $U(m, K^{\min})$ with respect to m .

Note that we must have $\hat{\theta} < 1$ in an equilibrium with risky investment; otherwise, the bank would fail with probability one, derive a payoff of $-\psi(m) - K^{\min}$, and be worse off relative to its outside option of investing in safe assets, which would have secured the bank a profit of $1 - (1 - s) = s > 0$. Consequently, we must have $m > \underline{m}$, where \underline{m} solves $\hat{\theta} = 1$. Furthermore, by $\psi'(1) = \infty$, we must have $m < 1$. Thus, we know that a monitoring optimum m^* exists and lies in the interval $(\underline{m}, 1)$. However, in the absence of further regularity assumptions, the optimum is not necessarily unique—i.e., it could occur that the objective function has multiple global maxima. To ensure uniqueness, we are going to assume that the underlying parameter values and functional forms are such that $U(m, K)$ is strictly concave in m over the relevant range for which risky investment is optimal.¹¹

By Leibniz's rule, the first-order condition for a monitoring optimum is

$$\frac{\partial U(m, K^{\min})}{\partial m} = \underbrace{\beta\mu R - \psi'(m)}_{\text{marginal asset PV}} - \int_0^{\hat{\theta}} \beta\theta R dF(\theta) = 0. \quad (1)$$

Thus, since the second term is positive (by $K^{\min} < 1 - s$), the bank acts too imprudently relative to the social optimum (even abstracting from social costs of bank failure). This, of course, is the standard risk-shifting effect from limited liability (e.g., Jensen and Meckling 1976): Since the bank internalizes only part of the cost of an increase in default risk but bears the full cost of acting more prudently, it shows too little prudence.

¹⁰It is worth noting that this result is not driven by deposit insurance, unless one adopts the (somewhat implausible) assumption that (i) depositors can observe bank capital structure *and* (ii) banks cannot alter their capital structures once having collected deposits. This is because (in a static setting) banks would always undo excess capital holdings through their dividend policy once having collected deposits.

¹¹Assuming concavity to ensure that optimization problems are well-behaved is very common in the literature. See, e.g., Martinez-Miera and Repullo (2010) and, in a different context, Schmidt (1997).

We now analyze how the bank's choice of prudence m^* depends on its deposit-market power (s). Totally differentiating (1) with respect to s , we obtain:

$$\text{sign} \left[\frac{dm^*}{ds} \right] = \text{sign} \left[\hat{\theta} f(\hat{\theta})/m \right] \Big|_{m=m^*} > 0.$$

Thus, enhanced deposit-market power entails more prudence. The intuition is standard: As the bank pays lower deposit rates, its deposit-repayment burden declines, thus mitigating risk-shifting moral hazard. The probability of bank failure is

$$\text{Prob} \left[\tilde{\theta} < \hat{\theta}^* \right] = F \left(\frac{1 - s - K^{\min}}{\beta m^* R} \right).$$

Thus, as the bank has more market power, it becomes less fragile. Market power entails higher margins, reducing the risk of failure. The moral-hazard-reducing effect of lower deposit rates, then, reinforces this mechanical balance-sheet effect. The overall takeaway from the static model is standard: Market power enhances bank prudence and stability.

4 Prudence

We now turn to the dynamic model, analyzing in a first step the bank's choice of prudence for given capital. Section 5 analyzes the bank's choice of capital.¹² As we shall see, the prudence-enhancing effect of market power in the static model will also be present in the dynamic model, and it will be reinforced by the charter value effect. However, there also will be a third effect, which goes in the direction of undermining banks' incentive to act prudently. And, crucially, it can dominate the prudence-enhancing effects.

¹²Think of this as a two-stage game in which the bank first chooses its capital and then prudence. We proceed by "backward induction," so we first analyze the choice of prudence for given capital.

The per-period monitoring optimum m^* maximizes the bank's objective function, i.e.,

$$\max_m U(m, K) = \mathbb{E}_\theta \max \left[0, \beta m \tilde{\theta} R + K - (1 - s) \right] - \psi(m) - K + \phi \beta V,$$

where, recall, V is the bank's charter value (at period-end). The first-order condition is

$$\underbrace{\beta \mu R - \psi'(m)}_{\text{marginal asset PV}} - \int_0^{\hat{\theta}} \beta \theta R dF(\theta) + \frac{\partial \phi}{\partial m} \beta V = 0, \quad (2)$$

The first term is the marginal asset value (net of monitoring costs), and the second term captures the moral-hazard effect from limited liability, as in the static model. The third term, which is positive, represents the charter-value effect: The prospect of losing its charter induces the bank to act more prudently, as compared with the static model. Crucially, however, it is no longer the case that enhanced market power always entails more prudence. Indeed, totally differentiating (2) with respect to market power s ,¹³ we obtain

$$\text{sign} \left[\frac{dm^*}{ds} \right] = \text{sign} \left[\hat{\theta} f(\hat{\theta})/m + \frac{\partial \phi}{\partial m} \frac{\partial \beta V}{\partial s} + \frac{\partial^2 \phi}{\partial m \partial s} \beta V \right] \Big|_{m=m^*}. \quad (3)$$

The first term captures the moral-hazard-reducing effect of market power that also occurs in the static model: As the bank pays lower deposit rates, leverage declines, thus mitigating moral hazard. The other two terms are unique to the dynamic setting. The second term embodies the charter-value hypothesis: An increase in (future) market power raises the bank's charter value (clearly, we must have $\partial V/\partial s > 0$), thus making failure more costly for the bank. The third term represents the effect of market power on the *marginal* probability

¹³Section 5 shows that the capital optimization problem has a corner solution at either K^{\min} or \bar{K} , so a small change in s has no effect on capital, except for a range of parameter values that has zero mass.

of survival. Straightforward algebra shows that $\partial\phi/\partial m = \hat{\theta}f(\hat{\theta})/m > 0$ and

$$\frac{\partial^2\phi}{\partial m\partial s} = - \left[f(\hat{\theta}) + \hat{\theta}f'(\hat{\theta}) \right] / (\beta m^2 R) < 0,$$

by $f(\hat{\theta}) = 1$ and $f'(\hat{\theta}) = 0$. Thus, the marginal probability of survival is strictly decreasing in market power.¹⁴ As market power rises, there is less of a need for the banker to behave prudently to avoid failure. This leads to the following result:

Proposition 1 *While the effect of deposit-market power on bank prudence is unambiguously positive in the static model, it is ambiguous in the dynamic model.*

As we move from a static model to a dynamic setting, the effect of market power on prudence may switch direction and become negative. Intuitively, while an increase in market power makes failure more costly to the bank—it has more to lose from having its banking license revoked—higher margins also give the banker more leeway to behave recklessly. The overall effect of market power on prudence is, then, ambiguous in the dynamic model, even though, as seen earlier, it is unambiguously prudence-enhancing in the static model.

While the effect of market power on prudence is, in general, ambiguous, it turns out that the effect is unambiguously negative when leverage $(1 - s - K)$ is sufficiently low. To see this, note that, as leverage goes to zero, the first two terms in expression (3) vanish, whereas the third term remains strictly negative. Thus, the following result:

Proposition 2 *For sufficiently low bank leverage, the prudence-reducing effect of deposit-market power outweighs the traditional prudence-enhancing effects.*

In other words, banks with relatively strong balance sheets respond to an increase in competition by reducing their risk-taking, whereas banks with weaker balance sheets may

¹⁴It is worth emphasizing that this result does not rely on the assumption that f is uniform. In particular, as long as $f(0) > 0$ (and $\lim_{\hat{\theta} \rightarrow 0} \hat{\theta}f'(\hat{\theta}) = 0$), it always holds in the limit, as $\hat{\theta}$ goes to zero.

take on more risk. Since balance-sheet strength (the inverse of $1 - s - K$) depends on the degree of competition, the model's predictions are consistent with a "U-shaped" relationship between competition and bank risk-taking.¹⁵ To see the intuition behind the proposition more clearly, it is useful to rewrite (3) as follows:

$$\text{sign} \left[\frac{dm^*}{ds} \right] = \text{sign} \left[\frac{\partial \phi}{\partial m} \frac{\partial (\beta V + K - (1 - s))}{\partial s} + \frac{\partial^2 \phi}{\partial m \partial s} \beta V \right] \Big|_{m=m^*}.$$

The first term captures the effect of market power on the marginal payoff from exerting effort, disregarding the effect of market power on the marginal survival probability. Here, the term $\beta V + K - (1 - s)$ is simply the NPV from not defaulting: In exchange for paying back depositors at (present) cost $1 - s$, the bank is going to keep its charter, worth βV , and its capital K . Since the marginal survival probability is positive and the gain from not defaulting is increasing in market power, the first term is positive. However, as bank leverage decreases, the first term becomes smaller, and, as bank leverage goes to zero, prudence has no effect on the probability of survival, so the first term vanishes. We are left with the second term, which captures the effect of market power on the marginal survival probability. By $f(0) > 0$, this term is strictly negative even in the limit as leverage goes to zero.

We next analyze the effect of market power s on the bank's failure rate $F(s) \equiv F(\hat{\theta}(s, m^*(s)))$, holding capital constant. Differentiating $F(s)$ with respect to s , we obtain

$$\text{sign} \left[\frac{dF(s)}{ds} \right] = \text{sign} \left[\underbrace{\frac{\partial \hat{\theta}}{\partial s}}_{<0} + \underbrace{\frac{\partial \hat{\theta}}{\partial m}}_{<0} \times \underbrace{\frac{dm^*}{ds}}_{?} \right].$$

The first term captures the mechanical leverage-reducing effect of market power. The second term represents the indirect incentive effect; it is negative if and only if market power enhances prudence. Thus, the overall effect of market power on stability could be ambiguous.

¹⁵See Niu (2012) for empirical evidence that is consistent with such a pattern.

However, we can prove the following result (see the Appendix):

Proposition 3 *Holding capital constant, an increase in deposit-market power enhances bank stability: The direct, stabilizing effect of market power (lower deposit rates and, thus, reduced deposit-repayment burden) outweighs the potentially destabilizing prudence effect.*

Thus, not surprisingly, a reduction in the bank’s deposit-repayment burden does not impair stability, despite the fact that it could have negative implications for prudence. The key takeaway from an empirical perspective is that the effects of market power on bank failure risk and on risk-taking can move in *opposite* directions. To see why the proposition should not be surprising, recall that, following a decline in deposit rates, the bank adjusts its risk-taking in response to the additional breathing space that the reduction in default risk provides. Now, if the increase in asset risk had a stronger effect on default risk than the direct effect of lower deposit rates, default risk would, ultimately, not decrease but increase; this, in turn, would invalidate the bank’s initial reasoning, so the bank should have taken less risk, rather than more. Indeed, the proposition rules out this paradox.

5 Capital

The next step in our analysis is to characterize the bank’s choice of capital. Let $U(K) \equiv U(m^*(K), K)$ denote the bank’s reduced-form payoff as a function of capital K —i.e.,

$$U(K) = \mathbb{E}_\theta \max \left[0, \beta m^* \tilde{\theta} R + K - (1 - s) \right] - \psi(m^*) - K + \phi^* \beta V.$$

The banker’s problem is to maximize $U(K)$ subject to the regulatory capital constraint, $K \geq K^{\min}$, and the equity capacity constraint, $K \leq \bar{K}$. By the envelope theorem, the first

derivative of $U(K)$ with respect to K is

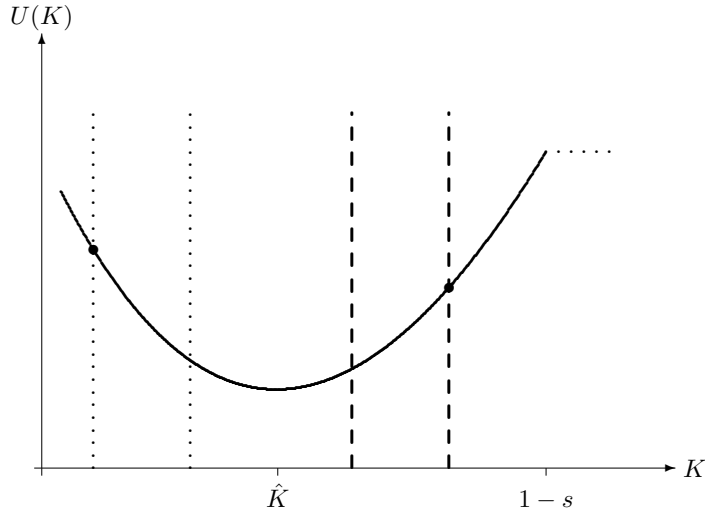
$$\begin{aligned} U'(K) &= \left[-F(\hat{\theta}) + \frac{\partial \phi}{\partial K} \beta V \right] \Big|_{m=m^*}, \\ &= \underbrace{-F(\hat{\theta}^*)}_{<0} + \underbrace{\frac{f(\hat{\theta}^*)}{\beta m^* R} \beta V}_{>0}, \end{aligned} \quad (4)$$

where $\hat{\theta}^* = (1 - s - K)/(\beta m^* R)$. Thus, mirroring Marcus (1984), the bank's choice of capital solves a trade-off between the short-term costs of a rise in capital (wealth transfer to bank liability-holders) and the long-term benefits (protecting its charter value). Since f is uniform, (4) reduces to

$$U'(K) = \frac{\beta V + K - (1 - s)}{\beta m^* R},$$

where the term in the nominator is, again, the NPV from not defaulting: In exchange for paying back depositors at present cost $1 - s$, the bank keeps its capital, worth K , and its charter, worth βV . Thus, the lower the net debt and the higher the charter value, the stronger is the bank's incentive to build precautionary capital buffers. By inspection, we have $U'(K) = 0$ if and only if $K = 1 - s - \beta V \equiv \hat{K}$. Furthermore, $U'(K) > 0$ for $K > \hat{K}$ and $U'(K) < 0$ for $K < \hat{K}$. In fact, as we show in the Appendix, $U(K)$ is strictly convex in K , and, hence, the maximization problem has a corner solution at either K^{\min} and \bar{K} .

Figure 1 provides an illustration. The dashed lines depict K^{\min} and $\bar{K} > K^{\min}$ for a scenario in which $U'(K^{\min}) > 0$ or, equivalently, $\beta V > 1 - s - K^{\min}$. The dotted lines depict K^{\min} and \bar{K} for a different scenario, in which $U'(\bar{K}) < 0$ or $\beta V < 1 - s - \bar{K}$. In the former case, the regulatory capital constraint is (*locally*) slack and the equity capacity constraint is binding, so the optimum is attained at $K = \bar{K}$. In the latter case, the reverse holds, so the regulatory capital constraint is binding, $K = K^{\min}$. In the remaining case, $U'(K^{\min}) < 0 < U'(\bar{K})$, the bank chooses $K = \bar{K}$ if and only if $U(\bar{K}) \geq U(K^{\min})$. Thus, banks with strong balance sheets operating in low-competition environments tend to hold capital in



The solid line depicts the bank's reduced-form payoff $U(K)$. The dashed lines depict K^{\min} and \bar{K} for a scenario in which $U'(K^{\min}) > 0$, and the dotted lines depict K^{\min} and \bar{K} for a different scenario, in which $U'(\bar{K}) < 0$. In the former case, the equity capacity constraint is binding, whereas in the latter case, the regulatory capital constraint is binding.

Figure 1: Choice of Capital

excess of the regulatory minimum, whereas banks with weak balance sheets operating in high-competition environments aim to hold as little capital as possible.

And, interestingly, as capital requirements become tighter, regulatory capital constraints eventually become slack. To see this, turn to Figure 1 and consider a scenario in which the dotted line to the far left depicts K^{\min} , and the dashed line to the far right depicts \bar{K} . In this example, $U(K^{\min})$ exceeds $U(\bar{K})$, so the regulatory capital constraint is binding. Following a small increase in K^{\min} , the regulatory capital constraint remains binding. However, following a more substantial increase in K^{\min} , the regulatory capital constraint eventually becomes slack. In other words, as banks are *required* to hold more equity capital, they eventually overcome their aversion to capital and seek to hold *even more* capital.

In an additional step, we explore the effects of an increase in capital requirements (K^{\min}) and in the bank's equity capacity (\bar{K}) on its choice of prudence. By stationarity, if the

regulatory capital constraint, $K \geq K^{\min}$, is binding in period t , then it must also be binding in all future periods. Similarly, if the equity capacity constraint, $K \leq \bar{K}$, is binding in period t , then the equity capacity constraint will be binding in future periods. Suppose that the regulatory capital constraint is binding, and let $U(K^{\min}) = U(m^*(K^{\min}), K^{\min})$ denote the bank's reduced-form payoff. By the envelope theorem,

$$\frac{dU(K^{\min})}{dK^{\min}} = \phi^* \beta \frac{\partial V}{\partial K^{\min}} + \left[-F(\hat{\theta}) + \frac{\partial \phi}{\partial K} \beta V \right] \Big|_{(m,K)=(m^*,K^{\min})}.$$

However, $V = U(K^{\min})$ and, hence,

$$\frac{\partial V}{\partial K^{\min}} = \frac{1}{1 - \phi^* \beta} \underbrace{\left[-F(\hat{\theta}) + \frac{\partial \phi}{\partial K} \beta V \right]}_{U_K(K) < 0} \Big|_{(m,K)=(m^*,K^{\min})} < 0,$$

where we use the fact that if the regulatory capital constraint is binding, then the term inside the square brackets must be negative. Thus, not surprisingly, if the regulatory capital constraint are binding, then a tightening in capital requirements reduces bank charter values. Consider, now, the effect of higher capital requirements on prudence when the regulatory capital constraint is binding. By implicit differentiation of (2),

$$\text{sign} \left[\frac{dm^*}{dK^{\min}} \right] = \text{sign} \left[\underbrace{\frac{\partial \phi}{\partial m}}_{>0} + \underbrace{\frac{\partial \phi}{\partial m} \beta \frac{\partial V}{\partial K^{\min}}}_{<0} + \underbrace{\frac{\partial^2 \phi}{\partial m \partial K} \beta V}_{<0} \right] \Big|_{(m,K)=(m^*,K^{\min})}.$$

The first term is positive and captures the prudence-enhancing effect of capital. This is the standard “capital-at-risk” effect (e.g., Hellmann et al. 2000). The second term represents what Hellmann et al. (2000) coined the “franchise value” effect: Capital requirements reduce charter values, making failure less costly. The last term captures what may be referred to as the “capital-buffer-complacency” channel: As capital rises, default risk declines; thus, there is less of a need to reduce default risk by acting more prudently. Thus, the effect of

capital requirements on prudence could be ambiguous. However, given that f is uniform, it is straightforward to show that

$$\text{sign} \left[\frac{dm^*}{dK^{\min}} \right] = \text{sign} \left[- \underbrace{U_K(K^{\min})}_{<0} \frac{1 - \beta}{1 - \phi^* \beta} \right] > 0.$$

Thus, if regulatory capital constraints are binding, then tighter capital regulation has positive implications for bank prudence and, thus, financial stability in our model.¹⁶

Crucially, however, in our setting, regulatory capital constraints are not necessarily binding. As seen earlier, as capital requirements increase, the regulatory capital constraint eventually becomes non-binding, and the equity capacity constraint becomes binding. Going through the same steps as above, one can show that if the equity capacity constraint is binding, $K = \bar{K}$, then $\partial V / \partial \bar{K} > 0$, and

$$\text{sign} \left[\frac{dm^*}{d\bar{K}} \right] = \text{sign} \left[\underbrace{\frac{\partial \phi}{\partial m}}_{>0} + \underbrace{\frac{\partial \phi}{\partial m} \beta \frac{\partial V}{\partial \bar{K}}}_{>0} + \underbrace{\frac{\partial^2 \phi}{\partial m \partial K} \beta V}_{<0} \right] \Big|_{(m,K)=(m^*,\bar{K})}.$$

Since f is uniform, we can simplify to

$$\text{sign} \left[\frac{dm^*}{d\bar{K}} \right] = \text{sign} \left[- \underbrace{U_K(\bar{K})}_{>0} \frac{1 - \beta}{1 - \phi^* \beta} \right] < 0.$$

Thus, if the equity capacity constraint is binding (and, hence, the regulatory capital constraint is slack), then an increase in the bank's equity capacity will have *negative* implications for prudence. However, as in our analysis of the effect of market power on stability, this effect never outweighs the direct, stability-enhancing effect of capital, so the net effect of less-tight equity capacity constraints on bank financial *stability* is positive.

¹⁶However, this result may be driven by our simplifying assumption that f is uniform. Thus, the key takeaway is not so much that tighter regulation is unambiguously prudence-enhancing, but that, consistent with Hellmann et al. (2000), the effect is in general ambiguous.

6 Discussion

This section provides a discussion of welfare. Furthermore, we briefly discuss how the analysis could be extended to the loan market, and how it would be altered if the equity cost of capital differed from the frictionless cost of capital.

6.1 Welfare

As mentioned, in the event of failure, the regulator takes over the bank and shareholders are expropriated. Let us assume, then, that the bank is restructured and continues operating. However, there is a restructuring cost and, in addition, there could be other social costs of bank failure, such as systemic costs. Denoting the total cost of bank failure by S , total welfare at the beginning of period t , net of investment costs, is

$$W = \beta m \mu R - \psi(m) - 1 + \phi \beta W + (1 - \phi) \beta (W - S).$$

This is the sum of investment NPV in period t and continuation welfare. We assume that $W > S$. With probability ϕ , the bank continues to the next period, and welfare is again W . With probability $1 - \phi$, the bank fails and is restructured, so continuation welfare is $W - S$. Solving for W gives

$$W = \frac{1}{1 - \beta} \left[\beta m \mu R - \psi(m) - 1 - (1 - \phi) \beta S \right].$$

Thus, total welfare equals the discounted sum of the per-period investment NPVs, less the discounted sum of expected social costs of failure. The first derivative with respect to m is

$$\partial W / \partial m = \frac{1}{1 - \beta} \left[\beta \mu R - \psi'(m) + \frac{\partial \phi}{\partial m} \beta S \right].$$

Comparing this expression with the first-order condition (2), we conclude that the equilibrium level of prudence can be below, at, or above the socially efficient level.

Indeed, for S close to zero and sufficiently low leverage, equilibrium prudence may be *too high* relative to the social optimum. Intuitively, while the leverage-moral-hazard effect goes in the direction of reducing prudence, the threat-of-liquidation effect (losing the charter) works in the opposite direction. As leverage declines, the threat-of-liquidation effect eventually becomes so strong relative to the leverage-moral-hazard effect that the banker acts too prudently. There are three caveats, though. First, prudence (monitoring) could entail positive externalities not accounted for in our setting. For example, if the bank’s assets were loans to firms, monitoring might generate efficiency gains above and beyond those internalized by banks (e.g., Allen, Carletti, and Marquez 2011). Second, in our formulation above, bank rents have a weight of one in the social welfare function. If we excluded bankers’ private effort costs from the welfare function,¹⁷ then prudence would never be excessive in our model. Third, and most importantly, as bank failure becomes more costly to society, equilibrium prudence eventually becomes unambiguously inferior to the socially efficient level.¹⁸

As seen earlier, in our model, it is not necessarily the case that heightened competition undermines prudence; on the contrary, it can enhance prudence. At the same time, competition always has negative implications for bank stability. This provides an interesting perspective on the notion that, in banking, there can be a trade-off between “competition” and “stability.” In our setup, of course, competition is potentially welfare-enhancing not because of its effect on consumer (depositor) surplus, but its effect on bank prudence.

¹⁷For instance, one might argue that bankers’ rents are “too high” anyway—e.g., for the reasons outlined in Bolton, Santos, and Scheinkman (2012)—and that reducing such rents should be welcomed. Or one might argue that society should simply not care about bankers’ private benefits from acting less prudently.

¹⁸Conversely, if risk-taking is indeed too conservative from a welfare perspective, then the question arises whether the assumed bank closure policy—failing banks are taken into receivership by the regulator—is optimal. As in the literature on the impact of failure threats on innovation (e.g., Manso 2011), tough failure penalties can deter valuable risk-taking and, thus, be costly. For analyses of closure rules in banking, which is beyond the scope of this article, see, among others, Mailath and Mester (1994) and Suarez (1994).

Depending on the level of competition, there can be a “trade-off” between prudence and stability in our model. In particular, when the degree of competition is low, a reduction in the intensity of competition *reduces* banks’ incentive to act prudently but, simultaneously, *improves* stability. By contrast, when competition is more intense, no such trade-off may occur, and reduced competition can be both prudence- and stability-enhancing.

6.2 Market Power in Asset Markets

In our previous analysis, we have focused on the economic effects of changes in banks’ deposit-market power. How would the analysis extend to the loan market? While the model is too simplistic for a full-fledged analysis of competition in the loan market—it abstracts from the effect of higher loan rates on the risk-shifting incentives of borrowers (cf., Boyd and De Nicolo 2005)—let us provide some insight into this question by exploring the effects of a change in the asset return parameter R on prudence. Straightforward algebra shows

$$\text{sign} \left[\frac{dm^*}{dR} \right] = \text{sign} \left[\underbrace{\int_{\hat{\theta}}^1 \beta \theta dF(\theta)}_{>0} + \underbrace{\frac{\partial \phi}{\partial m} \beta \hat{\theta} m}_{>0} + \underbrace{\frac{\partial \phi}{\partial m} \frac{\partial \beta V}{\partial R}}_{>0} + \underbrace{\frac{\partial^2 \phi}{\partial m \partial R} \beta V}_{<0} \right] \Big|_{m=m^*}.$$

The first two terms capture the effect of the asset return R on the marginal short-term profit, and the last two terms capture the effect on the marginal continuation value. Thus, as in our analysis of the deposit market, an increase in “loan-market” power (R up) can have an ambiguous effect on prudence. The logic is similar: Holding prudence constant, an increase in loan-market power (higher margins) reduces default risk; this reduces the risk of losing the charter, so there is less of a need to behave prudently. And, as above, this effect needs to be traded off against the “traditional” prudence-enhancing effects of market power.

The key difference between the two settings is that, now, an increase in asset-market power *directly* reduces asset portfolio risk, which, in turn, reduces default risk (of course,

as Boyd and De Nicolo (2005) and Martinez-Miera and Repullo (2010) show, this might be different if higher loan rates stifled loan performance through their effect on borrower incentives). In our previous analysis, an increase in deposit-market power *directly* reduces default risk through its effect on deposit rates, but it has no *direct* effect on asset risk. Rather, deposit-market power affects asset risk indirectly through its effect on risk-taking. Thus, the interpretation is somewhat different: In the loan-market setting, a rise in market power can stifle monitoring incentives, but it will always reduce asset portfolio risk and, consequently, bank failure risk. In this setting, asset portfolio risk and bank failure risk are positively correlated. In the deposit-market setting, asset portfolio risk and bank failure risk can be *negatively* correlated: A rise in market power always entails lower failure risk, but it can, through its potentially adverse effect on prudence, lead to higher asset portfolio risk.

6.3 Equity Cost of Capital

Thus far, we have assumed that the equity cost of capital coincides with the frictionless cost of capital, which, in our setting with universal risk-neutrality, is the riskless rate. This differs from much of the related literature, which often assumes that (risk-neutral) equity investors' opportunity cost of capital exceeds the riskless rate. An important reason why such an assumption may be warranted is that, in practice, debt finance has a tax advantage over equity finance—implying that equity capital is relatively more expensive than debt (holding other factors constant). Thus, there is some practical interest in exploring the robustness of our results with respect to changing the equity cost of capital.

Suppose that shareholders' cost of capital is $r_E = r + \epsilon$, where $\epsilon > 0$ but small. Thus, their discount factor is $\rho = (1 + r_E)^{-1} < \beta$. Shareholders' discounted payoff is

$$U(m, K) = \rho/\beta \times \mathbb{E}_\theta \max \left[0, \beta m \tilde{\theta} R + K - (1 - s) \right] - \psi(m) - K + \phi \rho V.$$

The prudence optimization problem is similar to the above, so let us focus on the question of how much capital the bank will hold. As above, the bank's capital choice maximizes $U(K) \equiv U(m^*, K)$, subject to the regulatory capital and equity capacity constraints. By the envelope theorem, the first derivative of the reduced-form payoff function is

$$U'(K) = \rho/\beta \times \frac{\beta V + K - (1 - s)}{\beta m^* R} - \left(1 - \rho/\beta\right).$$

This is similar to the previous expression (see Section 5). The difference is that, now, we have the scaling factor ρ/β to account for the fact that shareholders' cost of capital exceeds the riskless rate. This, then, also explains the second term. Thus, trivially, an increase in the equity cost of capital (ρ down) makes it less worthwhile for shareholders to inject capital to guard against failure. Obviously, therefore, for ρ very low, the regulatory capital constraint cannot possibly be slack. Conversely, for higher values of ρ , it must be the case that, as capital increases, the regulatory capital constraint eventually becomes slack.

The question of interest pertains to the robustness of our analysis in Section 5. We show in the Appendix that the reduced-form payoff function $U(K)$ remains strictly convex when shareholders' cost of capital differs from the frictionless cost of capital. Consequently, the capital-optimization problem has a corner solution. We conclude that the key insights of our preceding analysis continue to hold. In particular, banks with relatively strong balance sheets will seek to hold excess capital (provided that ρ is not too low), whereas relatively fragile banks will seek to hold as little capital as possible. Furthermore, as capital requirements become tighter, regulatory capital constraints may eventually become slack.

7 Conclusion

Conventional wisdom in the banking literature holds that heightened market power causes banks to become more conservative in their risk-taking. The goal of this article is to revisit this proposition in the context of a dynamic model in which deposit-market power affects failure rates not only indirectly, through its effect on risk-taking, but also directly, through the effect of higher margins on default risk. The main finding is that, because of the latter effect, enhanced market power can spur more-aggressive risk-taking—i.e., increase, rather than decrease, banks’ appetite for risk. Intuitively, while heightened market power raises the value of banks’ charters—making failure more costly—it also gives them additional leeway to take high risks. The overall effect of market power on prudence is, then, ambiguous.

However, while heightened market power can undermine prudence, it does not need to make banks more fragile. This is because the direct, stabilizing effect of higher margins outweighs the potentially destabilizing effect on prudence, and, moreover, a substantial rise in bank profitability can help banks to overcome their aversion to capital, inducing them to build precautionary capital buffers. These predictions are largely consistent with the empirical evidence reported in Berger et al. (2009). They document that, while market power can entail riskier asset portfolios, it also tends to make banks less fragile—one reason being that banks operating in less-competitive markets hold more capital.

The key takeaway from our analysis is that the effects of competition on bank *risk-taking* and on *failure risk* can move in opposite directions. As competition declines, banks may become *more* inclined to take high asset risks. Yet, at the same time, they become safer. Thus, heightened asset portfolio risk does not necessarily allow regulators (or empiricists) to infer that banks became riskier, too; conversely, lower bank failure rates are not necessarily proof of more-prudent lending practices. Put differently, bank risk-taking and failure risk are different concepts—and should be treated as such in empirical settings. Furthermore, to

the extent that the additional risk-taking brought in by less-fierce competition is inefficient for society, there is a “trade-off” between prudence and stability, and the welfare merits of competition are ambiguous—not only because of its effects on consumer surplus, but also because it can serve as a disciplining device for banks to behave more prudently.

References

Allen, F., Carletti, E., and R. Marquez, 2011, Credit market competition and capital regulation, *Review of Financial Studies* 24, 938-1018.

Allen, F., and D. Gale, 2000, *Comparing Financial Systems*, MIT Press, Cambridge.

Allen, F., and D. Gale, 2004, Competition and financial stability, *Journal of Money, Credit, and Banking* 36, 452-480.

Beck, T., De Jonghe, O., and G. Schepens, 2012, Bank competition and stability: Cross-country heterogeneity, *Journal of Financial Intermediation* 22, 218-244.

Berger, A., Klapper, L., and R. Turk-Ariss, 2009, Bank competition and financial stability, *Journal of Financial Services Research* 35, 99-118.

Besanko, D., and G. Kanatas, 1996, The regulation of bank capital: Do capital standards promote bank safety?, *Journal of Financial Intermediation*, 5, 160-183.

Blum, J., 1999, Do capital adequacy requirements reduce risk in banking?, *Journal of Banking and Finance* 23, 755-771.

Bolton, P., Santos, T., and J. Scheinkman, 2012, Cream skimming in financial markets, Mimeo, Columbia University.

Bolton, P., and D. Scharfstein, 1996, Optimal debt structure and the number of creditors, *Journal of Political Economy* 104, 1–25.

Boyd, J., and G. De Nicolo, 2005, The theory of bank risk-taking and competition revisited, *Journal of Finance* 60, 1329-1343.

Calem, P., and R. Rob, 1999, The impact of capital-based regulation on bank risk-taking, *Journal of Financial Intermediation* 8, 317-352.

Calomiris, C., and C. Kahn, 1991. The role of demandable debt in structuring optimal banking relationships, *American Economic Review* 81, 497-513.

Caminal, R., and C. Matutes, 2002, Market power and banking failures, *International Journal of Industrial Organization* 9, 1341-1361.

Demirgüç-Kunt, A., and E. Detragiache, 2006, Financial liberalization and financial fragility, In: Caprio, G., Hohohan, P., and J. Stiglitz (Eds.), *Financial Liberalization: How Far, How Fast?*, Cambridge University Press, 96-124.

Dewatripont, M., and J. Tirole, 1994, A theory of debt and equity: Diversity of securities and manager–shareholder congruence, *Quarterly Journal of Economics* 109, 1027–1054.

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

Diamond, D., and R. Rajan, 2000, A theory of bank capital, *Journal of Finance* 55, 2431-2465.

Gorton, G., 2012, *Misunderstanding Financial Crises: Why We Don't See Them Coming*, Oxford University Press.

Gorton, G., and A. Winton, 2000, Liquidity provision, bank capital, and the macroeconomy, Mimeo, Yale School of Management.

Hakenes, H., and I. Schnabel, 2011, Capital regulation, bank competition, and financial stability, *Economics Letters* 113, 256-258.

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

Kaminsky, G., and C. Reinhart, 1999, The Twin Crises: The causes of banking and balance-of-payments problems, *American Economic Review* 89, 473-500.

- Keeley, M., 1990, Deposit insurance, risk, and market power in banking, *American Economic Review* 80, 1183–1200.
- Kim, D., and A. Santomero, 1988, Risk in banking and capital regulation, *Journal of Finance* 43, 1219-1233.
- Mailath, G., and L. Mester, 1994, A positive analysis of bank closure, *Journal of Financial Intermediation* 3, 272-299.
- Manso, G., 2011, Motivating innovation, *Journal of Finance* 66, 1823-1860.
- Marcus, A., 1984, Deregulation and bank financial policy, *Journal of Banking and Finance* 8, 557-565.
- Martinez-Miera, D., and R. Repullo, 2010, Does competition reduce the risk of bank failure?, *Review of Financial Studies* 23, 3638-3664.
- Matutes, C., and X. Vives, 2000, Imperfect competition, risk, and regulation in banking, *European Economic Review* 44, 1-34.
- Merton, R., 1977, An analytic derivation of the cost of deposit insurance and loan guarantees: An application of modern option pricing theory, *Journal of Banking and Finance* 1, 3-11.
- Niu, J., 2012, An empirical analysis of the relation between bank charter value and risk taking, *Quarterly Review of Economics and Finance* 52, 298-304.
- Perotti, E., and J. Suarez, 2002, Last bank standing: What do I gain if you fail?, *European Economic Review* 46, 1599-1622.
- Perotti, E., Ratnovski, L., and R. Vlahu, 2011, Capital regulation and tail risk, *International Journal of Central Banking* 7, 123-163.
- Reinhart, C., and K. Rogoff, 2011, *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press.

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

Repullo, R., 2013, Cyclical adjustment of capital requirements: A simple framework, *Journal of Financial Intermediation* 22, 608-626.

Schmidt, K., 1997, Managerial incentives and product market competition, *Review of Economic Studies* 64, 191-213.

Stiglitz, J., and A. Weiss, 1981, Credit rationing in markets with imperfect information, *American Economic Review* 71, 393-410.

Suarez, J., 1994, Closure rules, market power, and risk-taking in a dynamic model of bank behaviour, Mimeo, CEMFI.

Wagner, W., 2010, Loan market competition and bank risk-taking, *Journal of Financial Services Research* 37, 71-81.

Appendix

Comparative Statics of Failure Risk

Here, we explore the effect of a small change in market power s on the failure rate $F(s) = F(\hat{\theta}(s, m^*(s)))$, holding capital K constant. Note that, since the capital optimization problem has a corner solution (see below), a small change in s has no effect on capital, and, hence, it is valid to take K as given. We have

$$\frac{dF(s)}{ds} = -\hat{\theta}^* f(\hat{\theta}^*)/m^* \left[\frac{1}{\beta \hat{\theta}^* R} + \frac{dm^*}{ds} \right].$$

Thus, $F(s)$ is strictly decreasing in s if and only if the term inside the square brackets is strictly positive—i.e.,

$$\frac{dm^*}{ds} > -\frac{1}{\beta \hat{\theta}^* R}. \quad (5)$$

Now, by implicit differentiation of (2),

$$\frac{dm^*}{ds} = -\frac{\partial^2 U(m, K)/(\partial m \partial s)}{\partial^2 U(m, K)/\partial m^2} \Big|_{m=m^*} = -\frac{\frac{\partial \phi}{\partial m} (\beta \frac{\partial V}{\partial s} + 1) + \frac{\partial^2 \phi}{\partial m \partial s} \beta V}{-\psi''(m) + \beta \hat{\theta} R \frac{\partial \phi}{\partial m} + \frac{\partial^2 \phi}{\partial m^2} \beta V} \Big|_{m=m^*},$$

where, by concavity, the denominator is strictly negative. Thus, expression (5) reduces to (all evaluated at $m = m^*$)

$$\frac{\partial \phi}{\partial m} \left(\beta \frac{\partial V}{\partial s} + 1 \right) + \frac{\partial^2 \phi}{\partial m \partial s} \beta V > -\frac{1}{\beta \hat{\theta} R} \left[\psi''(m) - \beta \hat{\theta} R \frac{\partial \phi}{\partial m} - \frac{\partial^2 \phi}{\partial m^2} \beta V \right],$$

which can be rewritten as

$$\underbrace{\frac{\partial \phi}{\partial m} \beta \frac{\partial V}{\partial s}}_{>0} + \beta V \underbrace{\left[\frac{\partial^2 \phi}{\partial m \partial s} - \frac{\partial^2 \phi}{\partial m^2} \frac{1}{\beta \hat{\theta} R} \right]}_{\equiv \Omega} > \underbrace{-\frac{\psi''(m)}{\beta \hat{\theta} R}}_{<0}.$$

We now show that the term inside the square brackets, denoted by Ω , is positive, which completes the proof. We have

$$\frac{\partial^2 \phi}{\partial m \partial s} = -\frac{f'(\hat{\theta})\hat{\theta} + f(\hat{\theta})}{\beta m^2 R},$$

and

$$\frac{\partial^2 \phi}{\partial m^2} \frac{1}{\beta \hat{\theta} R} = -\left[f'(\hat{\theta})\hat{\theta} + 2f(\hat{\theta}) \right] \frac{\hat{\theta}}{m^2} \frac{1}{\beta \hat{\theta} R} = -\frac{f'(\hat{\theta})\hat{\theta} + 2f(\hat{\theta})}{\beta m^2 R}.$$

Thus, $\Omega = f(\hat{\theta})/(\beta m^2 R) > 0$, and, consequently, $dF(s)/ds < 0$.

Convexity of $U(K)$

Here, we show that the bank's reduced-form payoff function $U(K) \equiv U(m^*(K), K)$ is strictly convex in K . We allow the equity cost of capital to differ from the frictionless cost of capital (see Section 6.2). Let $0 < \rho \leq \beta = (1+r)^{-1}$ denote shareholders' discount factor. Shareholders' discounted payoff is

$$U(m, K) = \rho/\beta \times \int_{\hat{\theta}}^1 (\beta m \theta R + K - (1-s)) dF(\theta) - \psi(m) - K + \phi \rho V,$$

where $\hat{\theta} = (1-s-K)/(\beta m R)$. The monitoring optimum m^* is characterized by the first-order condition

$$\partial U(m, K)/\partial m = \int_{\hat{\theta}}^1 \rho \theta R dF(\theta) - \psi'(m) + \frac{\partial \phi}{\partial m} \rho V = 0.$$

By implicit differentiation,

$$\frac{dm^*}{dK} = \frac{\rho/\beta \frac{\partial \phi}{\partial m} + \frac{\partial^2 \phi}{\partial m \partial K} \rho V}{-\partial^2 U(m, K)/\partial m^2} \Big|_{m=m^*}.$$

Since f is uniform, this reduces to

$$\frac{dm^*}{dK} = \frac{\rho/\beta (\beta V + K - (1-s))}{\beta m^2 R \times \partial^2 U(m, K)/\partial m^2} \Big|_{m=m^*}. \quad (6)$$

Next, by the envelope theorem, the first derivative of $U(K)$ is

$$U'(K) = \rho/\beta \times \frac{\beta V + K - (1-s)}{\beta m^* R} - (1 - \rho/\beta).$$

Furthermore,

$$U''(K) = \rho/\beta \times \frac{\beta m^* R - \beta R(\beta V + K - (1-s)) \frac{dm^*}{dK}}{(\beta m^* R)^2}.$$

Substituting for (6), this expression reduces to

$$U''(K) = \rho/\beta \times \frac{\beta m^* R - \beta R \frac{\rho/\beta (\beta V + K - (1-s))^2}{(\beta m^2 R \times \partial^2 U(m, K) / \partial m^2) |_{m=m^*}}}{(\beta m^* R)^2} > 0$$

since $\partial^2 U(m, K) / \partial m^2 |_{m=m^*} < 0$. Thus, $U(K)$ is globally convex.