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How banking regulation affects collusion sustainability: A multimarket contact approach☆

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ABSTRACT

This paper investigates how regulatory instruments affect collusion sustainability in banking within a theoretical framework where: (i) banks compete simultaneously in loan and deposit markets characterized by different degrees of product differentiation; (ii) strategic interaction occurs through an infinitely repeated game with Nash reversion strategies; and (iii) capital requirements, reserve ratios, and interbank rates alter the relative profitability of each market. We show that the impact of these instruments on collusion depends critically on relative market differentiation: the same regulatory instrument can either facilitate or hinder coordination depending on which market exhibits greater product homogeneity. This non-monotonicity implies that regulators must account for market structure when calibrating policy instruments to avoid unintended effects on competitive intensity.

1. Introduction

The ability of banks to sustain collusive practices constitutes a central concern for competition authorities and banking regulators. This concern is particularly salient in the banking sector, where institutions operate simultaneously in multiple interlinked markets (deposit taking and loan granting) thereby creating multimarket contact dynamics that may facilitate tacit coordination. Understanding how regulatory instruments interact with these dynamics is therefore central to assessing the competitive consequences of banking regulation.

This paper examines how prudential regulation affects the sustainability of collusion in the banking industry. Specifically, we analyze how capital requirements, reserve ratios, and the interbank interest rate influence the feasibility of collusive outcomes when banks interact repeatedly in both loan and deposit markets. While the classic literature on multimarket contact shows that operating across multiple markets can either facilitate or hinder collusion depending on market characteristics (Bernheim and Whinston, 1990), comparatively little is known about how this logic applies to regulated banking environments.

Existing work applying industrial organization models to banking (such as Dalla, 2023 and Dalla and Varelas, 2019, Dalla et al., 2014, Banal-Estañol and Ottaviani, 2007) has provided important insights into competitive behavior under asymmetric conduct, the comparative statics of regulatory parameters or the effects of bank mergers. However, most this literature has largely focused on static competition. Our contribution is to extend this framework to an infinitely repeated setting and to study collusion sustainability using Nash reversion (grim trigger) strategies. This approach allows us to characterize how banking-specific regulatory instruments affect the incentives to deviate from, and to punish deviations from, collusive agreements. In terms of objectives, our work is closely related to Bagliano et al. (2000),who discussed how monetary policy affects credit market competition, but the modeling set up is significantly different. Bagliano et al. (2000) assumes that loans are homogeneous and that banks do not compete for deposits.

Our analysis reveals that the effect of banking regulation on collusion sustainability is fundamentally non-monotonic and hinges on the relative degree of differentiation between loan and deposit markets. When loans are more differentiated than deposits, increases in capital or reserve requirements, as well as reductions in the interbank rate, tend to facilitate collusion by shifting profits toward the market in which coordination is easier to sustain. By contrast, when deposits are more differentiated than loans, the same regulatory interventions make collusion more difficult to sustain. In this case, regulation shifts

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profits toward the loan market, where collusion is intrinsically harder to sustain and deviation incentives are stronger, thereby weakening overall collusive stability.

These findings carry important policy implications. Regulatory measures designed to enhance financial stability may unintentionally facilitate or hinder anticompetitive outcomes, depending on the underlying structure of banking markets. As a result, competition authorities and prudential regulators should account explicitly for multimarket interactions when calibrating regulatory instruments, recognizing that identical policies can have markedly different competitive effects across banking systems

2. The model

To model the banking industry, we use an Industrial Organization oligopoly model based in Freixas and Rochet (2008) in which there is imperfect (Cournot) competition for loans and deposits. This type of model has been used in the literature with different configurations. We follow the model specification and notation in Dalla (2023) (see also Mathis, 2025), where a duopoly model in which one bank chooses quantities and another one chooses prices is presented. We differ from Dalla (2023) solely by assuming that both banks are price setters and that the game is infinitely repeated.

As far as loans are concerned, we assume that the inverse demand for loans faced by bank i is given by

$$r_{Li} = m - b_1 L_i - b_2 L_j$$

where L_i denotes the loans granted by bank i, r_{Li} the corresponding loan interest rate. m, b_1 and b_2 are positive parameters with $b_1 > b_2$. The ratio $b_2/b_1 \in (0,1)$ captures the degree of differentiation between the loans of the two banks, with $b_2/b_1 \to 1$ representing homogeneous products and $b_2/b_1 \to 0$ indicating that the two banks operate in independent loan markets.

With respect to deposits, the assumptions are similar. The inverse supply of deposits is

$$r_{Di} = \beta + \gamma_1 D_i + \gamma_2 D_j$$

where D_i denotes the deposits collected by bank i, r_{Di} the corresponding deposit interest rate. β, γ_1 and γ_2 are positive parameters with the ratio $\gamma_2/\gamma_1 \in (0,1)$ capturing the degree of differentiation between the deposits offered by both banks. The net position of each bank, M_i, is reflected by its balance sheet constraint:

$$M_i = K_i + (1-\alpha) D_i - L_i$$

where K_i represents bank i equity and α the required reserve ratio. Bank capital ratios must meet some regulatory requirements: at least a certain part of risky assets must be covered by equity (Dalla and Varelas, 2019; Schaeck and Cihák, 2012; Freixas and Rochet, 2008). Assuming the capital requirement ratio $\rho = K_i/L_i$, the net position simplifies to

$$M_i = (1-\alpha) D_i - (1-\rho) L_i \tag{1}$$

If positive, this is lent at interest rate r and if, it is negative, banks borrow at the same exogenously set rate r.

Both banks have constant symmetric marginal costs of granting more loans or taking deposits. Bank i's cost function is

$$C_i = \theta L_i + \varphi D_i \tag{2}$$

with θ and φ denoting the marginal cost of loans and deposits, respectively.

With respect to all model parameters we make the following assumptions:

Assumption 1.

$$m - \theta - r(1-\rho) > 0$$
$$r(1-\alpha) - \beta - \varphi > 0$$
$$\max\left\{b_2/b_1, g_2/g_1\right\} < 2/(\sqrt{3}+1)$$

This assumption ensures both banks loans and deposits are always positive.

The profit function of bank i is then

$$\Pi_i = r_{Li} L_i + r M_i - r_{Di} D_i - C_i$$

which, after plugging (1) and (2), simplifies to

$$\Pi_i = \left(r_{Li} - r(1-\rho) - \theta\right) L_i + \left(r(1-\alpha) - r_{Di} - \varphi\right) D_i$$

As can bee seen the profit function is separable in loans and deposits, something that would not happen for instance if there were economies of scope.

We want to establish under which conditions banks can sustain the monopoly prices (deposit and loans interest rates) with a Nash reversion strategy, a specific type of (grim) trigger strategy where the punishment involves reverting to the static Nash equilibrium actions forever.

As usual, the critical discount factor above which these strategies implement a Subgame Perfect Nash Equilibrium is given by

$$\delta^* = \frac{\Pi_i^D - \Pi_i^C}{\Pi_i^D - \Pi_i^N}$$

where Π_i^C is the collusive profit, Π_i^D the deviation profit and Π_i^N the Nash equilibrium (punishment) profit. It is straightforward to determine these which can be showed to be

$$\Pi_i^N = \frac{\left(b_1 - b_2\right) b_1}{\left(b_1 + b_2\right)\left(2b_1 - b_2\right)^2}\left(m - \theta - r(1-\rho)\right)^2 + \frac{\gamma_1\left(\gamma_1 - \gamma_2\right)}{\left(\gamma_1 + \gamma_2\right)\left(2\gamma_1 - \gamma_2\right)^2}\left(r(1-\alpha) - \beta - \varphi\right)^2$$

$$\Pi_i^C = \frac{\left(m - \theta - r(1-\rho)\right)^2}{4\left(b_1 + b_2\right)} + \frac{\left(r(1-\alpha) - \beta - \varphi\right)^2}{4\left(\gamma_1 + \gamma_2\right)}$$

$$\Pi_i^D = \frac{\left(2b_1 - b_2\right)^2}{16 b_1\left(b_1 - b_2\right)\left(b_1 + b_2\right)}\left(m - \theta - r(1-\rho)\right)^2 + \frac{\left(2\gamma_1 - \gamma_2\right)^2}{16\left(\gamma_1 - \gamma_2\right)\left(\gamma_1 + \gamma_2\right)\gamma_1}\left(r(1-\alpha) - \beta - \varphi\right)^2$$

The critical discount factor is then

$$\delta^* = \frac{\frac{b_2^2}{b_1\left(b_1-b_2\right)\left(b_1+b_2\right)}\frac{(m-\theta-r(1-\rho))^2}{(r(1-\alpha)-\beta-\varphi)^2} + \frac{\gamma_2^2}{\gamma_1\left(\gamma_1-\gamma_2\right)\left(\gamma_1+\gamma_2\right)}}{\frac{b_2^2\left(8b_1^2+b_2^2-8b_1 b_2\right)}{b_1\left(b_1-b_2\right)\left(b_1+b_2\right)\left(2b_1-b_2\right)^2}\frac{(m-\theta-r(1-\rho))^2}{(r(1-\alpha)-\beta-\varphi)^2} + \frac{\gamma_2^2\left(8\gamma_1^2+\gamma_2^2-8\gamma_1\gamma_2\right)}{\gamma_1\left(\gamma_1-\gamma_2\right)\left(\gamma_1+\gamma_2\right)\left(2\gamma_1-\gamma_2\right)^2}} = \frac{X_L W + X_D}{Y_L W + Y_D}$$

where X_L and Y_L are a function of loan demand parameters, X_D and Y_D are a function of deposit supply parameters and W is a function of all other model parameter, in particular of the bank industry specific parameters α, ρ and r as well as of the marginal costs θ and φ. To see how these parameters affect collusion, we simply analyze their impact on δ^*. Start by noting that

$$\frac{\partial \delta^*}{\partial W} = \frac{X_L Y_D - Y_L X_D}{\left(Y_L W + Y_D\right)^2}$$

with

$$X_L Y_D - Y_L X_D = \frac{4\gamma_2^2 b_2^2\left(\gamma_1 b_2 + \gamma_2\left(b_1 - b_2\right)\right)\left(\frac{b_2}{b_1} - \frac{\gamma_2}{\gamma_1}\right)}{\left(b_1 - b_2\right)\left(b_1 + b_2\right)\left(2b_1 - b_2\right)^2\left(\gamma_1 - \gamma_2\right)\left(\gamma_1 + \gamma_2\right)\left(2\gamma_1 - \gamma_2\right)^2}$$

Hence, an increase in W may either increase or decrease the critical discount factor, depending on the sign of $\frac{b_2}{b_1} - \frac{\gamma_2}{\gamma_1}$, as all other terms are positive.

To better understand the relevance of the $\frac{b_2}{b_1}$ and $\frac{\gamma_2}{\gamma_1}$ ratios, it is important to look at each market in isolation.

2.1. Single market firms

If each bank only operated in the loan market, for instance, it is straightforward to show that the critical discount factor would be (see e.g. Deneckere, 1983):

$$\delta^* = \frac{\left(2 - \frac{b_2}{b_1}\right)^2}{8 - 8\frac{b_2}{b_1} + (\frac{b_2}{b_1})^2}$$

As all three profit expressions (Nash, collusive, deviation) are proportional to $(m - \theta - r(1-\rho))^2$ this term cancels when the critical discount factor is calculated. As a result, and as highlight in Ross (1992), the critical discount factor only depends on the ratio $\frac{b_2}{b_1}$ which captures the degree of differentiation between bank 1 and bank 2's loans. If this ratio is low, the two banks' loans are highly differentiated. The derivative of δ^* with respect to $\frac{b_2}{b_1}$,

$$\frac{\partial \delta^*}{\partial \frac{b_2}{b_1}} = \frac{4\frac{b_2}{b_1}\left(2 - \frac{b_2}{b_1}\right)}{\left(8 - 8\frac{b_2}{b_1} + (\frac{b_2}{b_1})^2\right)^2},$$

is always positive meaning that collusion becomes harder to sustain as $\frac{b_2}{b_1}$ increases. When products are less differentiated (or more homogeneous, that is, when $\frac{b_2}{b_1}$ is high) collusion is more difficult to sustain: on the one hand, the gains from deviation increase but, on the other hand, the punishment is harsher. With the specific demand and cost structure used in the model, the first effect dominates. The additional gains from deviation make collusion harder to sustain. Exactly the same logic applies to the deposit market: all profits are proportional to $(r(1-\alpha) - \beta - \varphi)^2$ and, hence, if banks only operated in the deposit market, the critical discount factor would now depend on $\frac{\gamma_2}{\gamma_1}$ instead of $\frac{b_2}{b_1}$, with $\frac{\gamma_2}{\gamma_1}$ capturing the degree of differentiation between bank 1 and bank 2's deposits.

2.2. Multi-market firms

With markets taken in isolation, collusion would be easier to sustain in the loan market than in the deposit market if and only if $\frac{b_2}{b_1} < \frac{\gamma_2}{\gamma_1}$. When banks operate in both markets, the critical insight is about the relative weight of each market in the overall collusion calculus. As loan and deposit profits are, respectively, proportional to $(m - \theta - r(1-\rho))^2$ and $(r(1-\alpha) - \beta - \varphi)^2$ the ratio W captures the relative importance, in terms of profits, of the loan market when compared to the deposit market. An increase in W means that the loan market became relatively more important than the deposit market. If this is the market in which collusion is easier to sustain (that is, if $\frac{b_2}{b_1} < \frac{\gamma_2}{\gamma_1}$), then an increase in its weight will make collusion overall easier to sustain. If the loan market is the market in which collusion is harder to sustain (that is, $\frac{b_2}{b_1} > \frac{\gamma_2}{\gamma_1}$) then an increase in its relevance will have the opposite effect. When the loan market (the more homogeneous one) becomes relatively more important, since it is in this market that competition is tougher (higher $\frac{b_2}{b_1}$), and deviation incentives are stronger, the overall agreement becomes more fragile.

We now discuss how the different model parameters affect the relative importance (or weight) of each market. It is clear from the profit function above that a higher reserve ratio α reduces the profits from deposits whereas a higher capital requirement ρ increases the profit from loans. A higher r, however, affects both profits, decreasing loan profits and increasing deposit profits. Hence, a higher α, a higher ρ and a lower r increase the relative importance of profit from loans when compared to deposit profits. The impact of the marginal costs and demand/supply intercepts are obvious.

The following result presents our finding:

Proposition. *Let loan differentiation be larger than deposit differentiation: $\frac{b_2}{b_1} < \frac{\gamma_2}{\gamma_1}$. Then, an increase in the reserve ratio α, an increase in the capital requirements ρ or a decrease in the interbank rate r make collusion easier to sustain. Otherwise, when loan differentiation be lower than deposit differentiation ($\frac{b_2}{b_1} > \frac{\gamma_2}{\gamma_1}$), an increase in the reserve ratio α, an increase in the capital requirements ρ or a decrease in the interbank rate r make collusion harder to sustain.*

Proof. It follows directly from the sign of $\frac{\partial \delta^*}{\partial W}$, which is equal to the sign of $\frac{b_2}{b_1} - \frac{\gamma_2}{\gamma_1}$, plus the fact that $\frac{\partial W}{\partial \alpha} = 2r\frac{(m-\theta-r(1-\rho))^2}{(r(1-\alpha)-\beta-\varphi)^3} > 0$, $\frac{\partial W}{\partial \rho} = 2r\frac{m-\theta-r(1-\rho)}{(r(1-\alpha)-\beta-\varphi)^2} > 0$ and $\frac{\partial W}{\partial r} = -2\frac{(m-\theta-r(1-\rho))((1-\alpha)(m-\theta-r(1-\rho))+(1-\rho)(r(1-\alpha)-\beta-\varphi))}{(r(1-\alpha)-\beta-\varphi)^3} < 0$. ■

The following table summarizes these results:

	$\frac{\partial \delta^*}{\partial \alpha}$	$\frac{\partial \delta^*}{\partial \rho}$	$\frac{\partial \delta^*}{\partial r}$
Loans are more differentiated than deposits: $\frac{b_2}{b_1} < \frac{\gamma_2}{\gamma_1}$	< 0	< 0	> 0
Loans are less differentiated than deposits: $\frac{b_2}{b_1} > \frac{\gamma_2}{\gamma_1}$	> 0	> 0	< 0

3. Conclusions

This paper shows that the sustainability of collusion in the banking industry depends on the interaction between market structure in loan and deposit markets and the design of prudential regulation. Modeling banks as playing an infinitely repeated game with Nash reversion strategies, we characterize how regulatory parameters affect the critical discount factor required to sustain collusive interest rates when banks operate simultaneously in both markets.

Our main result is that prudential regulatory instruments such as capital requirements, reserve ratios and the interbank interest rate have non-monotonic effects on collusion sustainability, depending on the relative degree of differentiation across markets. When the loan market is more differentiated than the deposit market, increases in capital or reserve requirements, as well as reductions in the interbank rate, tend to facilitate collusion by increasing the weight of the market in which coordination is easier to sustain. When deposits are relatively more differentiated, the same regulatory interventions make collusion more difficult to sustain by shifting incentives toward the market where deviation gains are large.

These findings imply that the competitive effects of prudential regulation depend on how regulatory instruments shift the relative importance of loan and deposit markets in banks' collusion incentives. Consequently, coordination between competition authorities and prudential regulators is essential to avoid unintended anticompetitive effects.

Possible extensions include alternative punishment strategies, bank asymmetries, or the inclusion of additional markets in which banks compete.

Data availability

No data was used for the research described in the article.

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