

WP/14/90

IMF Working Paper

Optimal Prudential Regulation of Banks and the Political Economy
of Supervision

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EUR

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May 2014

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Abstract

We consider a moral hazard economy in banks and production to study how incentives for risk taking are affected by the quality of supervision. We show that low interest rates may generate excessive risk taking. Because of a pecuniary externality, the market equilibrium may not be optimal and there is a need for prudential regulation. We show that the optimal capital ratio depends on the macro-financial cycle, and that, in presence of production externalities, it should be complemented by a constraint on asset allocation. We show that the political process tends to exacerbate excessive risk taking and credit cycles.

JEL Classification Numbers: G2, E44, D8.

Keywords: Banking Regulation, Regulatory Forbearance, Political Economy.

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¹Respectively International Monetary Fund, and Paris School of Economics-ENPC and CEPR. This paper was written with financial support from the PEGGED (Politics, Economic and Global Governance, the European Dimension) program. The paper benefited from comments of seminar participants at University Paris Sorbonne, Puc-Rio (Brazil), and at the seminar on the Political Economy of Crisis-Induced Reform organized by the Chaire Banque de France of PSE-Ecole d'Économie de Paris.

Contents

I.	Introduction	3
II.	Literature	5
III.	A Model of Bank Finance	7
	A. Production and External Financing Technologies	7
	B. Collusion and the Quality of Banking Supervision	8
IV.	Firms' Financial Contracts	9
	A. Incentives and Participation Constraints:	9
	B. The Borrower's Maximization Program	11
V.	Market Equilibrium	11
	A. Choice of Financial Contracts	11
	B. Decentralized Market Equilibrium	15
VI.	Optimal Regulation of Bank Capital	16
	A. Social Optimum	17
	B. Fixed Capital Adequacy Rule	18
	C. Optimal Capital Adequacy Rule	21
VII.	Optimal Financial Regulation with Productive Externalities	22
	A. An Economy with Externalities	22
	B. Optimal Capital Adequacy Ratio	24
VIII.	Political Economy of Banking Supervision	26
IX.	Conclusion	33
	Appendices	35
	References	50

I. Introduction

The financial crisis has ignited an intense policy debate on the determinants of incentives in the financial industry, and has resulted in substantial efforts to improve financial regulations to tame risk taking during booms and build capital buffers for downturns. There is now a consensus among policy-makers and economists that the prudential regulation of banks should be envisaged from a systemic, macro-prudential perspective, and not only from a traditional microprudential approach.¹ The Basel III framework has introduced the Countercyclical Cyclical Buffer, which is calibrated to mitigate credit cycles over time, and the systemic buffer aimed at improving the resilience of global systemically important financial institutions. Policy-makers have also established bodies tasked with the design and operationalization of macro-prudential policies, while best practises are being crafted in international fora (IMF, 2011, 2013; European Systemic Risk Board, 2013). In parallel, the crisis led to a debate on the role played by low interest rates in fueling asset bubbles and excessive risk taking by financial intermediaries (Taylor, 2010). In his address at the 2010 Annual meeting of the American Economic Association, Fed Chairman Ben Bernanke argued instead that, based on evidence of declining lending standards during the boom, “stronger regulation and supervision aimed at problems with underwriting practices and lenders’ risk management would have been a more effective and surgical approach to constraining the housing bubble than a general increase in interest rates”.

We develop a model to study the incentives of financial intermediaries and borrowers to take excessive risks. We aim at understanding the interplay between the prudential regulation of banks, the quality of bank supervision and the role of the political economy in exacerbating financial cycles.² There are two main features of our analysis. First, we develop a theory of (macro-prudential) bank regulation based on the presence of pecuniary externalities in a model with credit frictions. A novelty of our model is the possibility of regulatory forbearance by the supervisor which allows negative net present value projects to be undertaken in equilibrium. This justifies ex-ante policy interventions to constrain the leverage of financial institutions. Second, we highlight the interplay between the quality of banking supervision and optimal prudential regulations. We also show that when the quality of supervision can be influenced by the political economy, credit cycles are exacerbated: when interest rates or expected returns on projects are low, agents’ prefer weak supervision to maximize leverage but this tends to exacerbate risk taking and results in lower average return on projects ex-posts. In contrast, when interest rates are high, borrowers and uninformed investors prefer high quality supervision to constrain the rents left to banks.

Following Holmstrom and Tirole (1997), we consider a moral hazard economy in which banks monitor borrowers’ efforts, but must be incentivized by investing their own capital in the project, in addition to the entrepreneur’s capital. There are two incentive problems: first, banks must monitor projects; second, they must be prevented from colluding with borrowers – which they do at the expense of uninformed investors by (sometimes)

¹The term "macro-prudential" was first coined at the BIS and in the early work of Borio (2003). See also Borio (2011) for a discussion of policy issues.

²We abstract from maturity mismatches in bank balance sheet, hence we do not analyze funding liquidity issues, even if those have played a central role in the propagation of the financial crisis.

investing in non-productive projects which only generate non-verifiable benefits.³ Collusion can be prevented by supervision and audits of bank accounts. However, assuming that bank audits are imperfect and stochastic, preventing collusion requires promising higher financial returns to the bank to ensure it will not collude with the borrower in the event the audit quality turns out to be poor. If however, audit quality is high ex-post, the bank enjoys a pure rent equal to the private benefit of control necessary to incentivize to monitor when audit quality is poor.

Because bank capital is more costly than uninformed capital, financial contracts that prevent collusion are not always in the best advantage of borrowers because they require leaving a rent to the banks. To maximize leverage, it is in the borrower's interest to minimize the share of investment financed out of bank capital. When the differential between the cost of bank capital and interest rates is large enough, private agents may prefer a contract relaxing the incentive constraint of the bank, by ensuring monitoring only when the audit by the supervisor is of good quality. The benefit is that a larger share of the financial return can be pledged to uninformed investors. This enhances the borrowing capacity ex-ante, and increases the leverage of the borrower and of the bank. The cost of such contracts is that bad projects are sometimes undertaken when the quality of supervision turns out to be low, which tends to reduce the average expected return on projects. In these cases, there is "excessive risk taking" by a subset of financial intermediaries.

The market outcome is not necessarily optimal because agents do not internalize the impact of their actions on market prices (there is a pecuniary externality). For example, when choosing collusion contracts, borrowers do not internalize the general equilibrium effect on the return on bank capital which is depressed when more and more agents turn to collusion contracts. This provides a rationale for a capital adequacy rule (which is equivalent to a leverage constraint in our framework) that would maximize welfare subject to the existing frictions. We show that a fixed capital adequacy rule may be sufficient to rule out equilibria with collusion. However, such a rule is generally not socially optimal. It risks being excessively tight when interest rates or the return on projects are high, or ineffective in ruling out collusion when interest rates are low. We then characterize the optimal capital adequacy rule. We show that it should depend *pro-cyclically* on interest rates (because some increase in leverage is optimal when the cost of capital falls), even if the rule should become more binding for low interest rates. But it depends *counter-cyclically* on investment opportunities (e.g. the profitability of projects): when expected returns increase, the capital adequacy rules should be relaxed. This is the outcome of a standard effect in moral hazard economies: incentives to choose good projects are higher when interest rates are low and the return on investment is high. The possibility of collusion under imperfect supervision introduces an offsetting effect: as the interest rate declines, bank capital becomes relatively more expensive than uninformed finance, which creates incentives to collude to increase leverage further. As a result, the market equilibrium is further away from the socially optimal leverage. This suggests that, in periods of low interest rates, the case for regulation becomes stronger, even if some increase in leverage is desirable. We also find that the optimal capital rule also depends on institutional characteristics: it should be tighter if banks are less efficient, if supervision quality is lower, and if corporate governance is of worse quality.

³Uninformed investors can be interpreted as being either depositors or any holder of debt claims on banks.

We consider two extensions of the model and study the implications for risk taking and optimal financial regulation. In the first extension, we introduce productive externalities across projects, by assuming that the return on individual projects depends positively on the proportion of successful projects. With such a production externality, multiple equilibria become possible and investment in bad projects are more likely to take place. We show that, in this context, the optimal macroprudential capital adequacy rule described above becomes either ineffective or excessively tight. We show that optimality can be restored by combining the macroprudential capital adequacy rule with an asset allocation constraint.

In the second extension, we endogenize the quality of banking supervision. We show that, during periods of low interest rates or low return on productive investments, there is pressure from financial intermediaries to worsen the quality of bank audits. This makes collusion less costly, and raises the rent received by the bank. We show that investors and borrowers do not oppose such pressure because a lower cost of collusion tends to increase the borrowing capacity in the partial equilibrium (in the general equilibrium, this beneficial effect of lower supervision quality is partly offset by the increase in the cost of bank capital). In contrast, during periods of high interest rates and high return on investment, investors and borrowers unambiguously prefer high supervision quality to reduce the bank's economic rent under collusion-proof contracts. The political pendulum is reversed to high quality supervision. Hence, we show that the political process tends to exacerbate excessive risk taking by weakening banking supervision precisely when instead it should be strengthened. The implication for regulation is that the optimal capital adequacy rule will need to be further tightened during the boom, relative to the situation in which the quality of supervision is immune to political pressures and does not worsen when interest rates fall.

The paper is organized as follows. Section 2 discusses the literature. Section 3 presents the basic model. Section 4 characterizes financial contracts while the market equilibrium is solved in section 5. Section 6 solves the optimal capital regulation. Section 7 considers an economy with productive externalities. In section 8, we endogenize the political process through which banking supervision quality is chosen. Section 9 concludes.

II. Literature

Our paper is related to several strands of the literature.

First, it is closely related to the emerging theoretical literature that justifies the need for pigouvian taxes or macroprudential policies by the presence of "pecuniary externalities" in presence of a credit market friction or market incompleteness. The literature builds on the financial accelerator models (Bernanke and Gertler, 1989) and models with shocks to asset value (Kiyotaki and Moore, 1997). A number of recent papers have focused on interventions that correct externalities generated by boom and busts of capital flows (Jeanne and Korinek, 2010; Farhi and Werning, 2013) or by the existence of a wedge between the pledgeability of domestic and international collateral (Caballero and Krishnamurthy, 2001). Close to our paper is the theory of macroprudential buffers by Gersbach and Rochet (2012), or earlier work by Lorenzoni (2008), or Korinek (2011)

considering policies to tame excessive risk taking and credit cycles. Jeanne and Korinek (2013) characterize optimal combinations of ex-ante regulations and ex-post bailouts. Our paper differs from these models as we highlight a new credit friction arising from the possibility of collusive behaviors between banks and borrowers. As discussed in the introduction, this mechanism generates both optimal procyclical leverage but also a greater need for regulations in low interest rate environments. Recent empirical work at the BIS suggests that a deviation of the credit-to-GDP ratio from its trend may be a good indicator to calibrate a countercyclical capital buffer (Drehman et al. (2010)).

Second, our paper provides some insight to the recent debate about the risk taking consequences of loose monetary policy, as argued in Taylor (2010) and Diamond and Rajan (2009), and documented by Adrian and Shin (2008) in the case of investment banks. In a recent paper, Dell'Ariccia, Laeven and Marquez (2010) provide a framework to study the risk taking channels of monetary policy, and find that when bank capital is allowed to adjust endogenously, banks tend to increase leverage and risk taking when interest rates are low.⁴ Our model shares their predictions but they do not derive optimal macro-prudential policies. Rajan (2005) identified a mechanism through which monetary policy changes may create risk taking by affecting the return on financial institutions' short-term assets. Recent notable papers include Diamond and Rajan (2010) and Farhi and Tirole (2012) who analyze the implications of "macro" bailouts for risk taking and risk correlations. Other recent papers studying bailout guarantees and financial regulation include Chari and Kehoe (2009) and Ranciere and Tornell (2010). Evidence on risk taking in low interest environments is provided in Lown and Morgan (2006) who show that credit standards in the U.S. tend to tighten following a monetary contraction. Dell'Ariccia, Laeven and Suarez (2013) provide additional supportive evidence of a risk taking channel of monetary policy in the US. Evidence on euro area countries is provided by Maddaloni and Peydró (2010).

Third, the microeconomic literature has analyzed the role of regulations in enhancing the quality and size of the financial system in presence of moral hazard and asymmetric information, as well as the trade-offs associated with the internationalization of banking supervision and regulations (see for instance recent contributions by Morrison and White, 2005, 2009; Acharya, 2003; Dell'Ariccia and Marquez, 2005). Morrison and White (2005) study the role of capital adequacy rule as a substitute to screening of bank applications when the supervisor has low reputation, and Morrison and White (2010) shows, as we do, that some regulatory forbearance may be optimal, but with a motive to prevent contagion. Hellmann, Murdoch and Stiglitz (2000) show, in a model where capital regulation reduce risk taking incentives but may harm the franchise value of a bank, that controls on prices may complement the capital adequacy ratio.

Fourth, our theory provides new insights on the political economy of the financial crisis in the US, by characterizing how the political pendulum may oscillate with credit conditions. Johnson and Kwak (2010) document how the political influence of the financial industry contributed in creating an environment conducive to the accumulation of risks. Igan, Mishra and Tressel (2012) show that lobbying activity to loosen regulations of credit standards were closely associated with more risky portfolio choices during the boom and with the likelihood of a bailout in 2008. Rajan (2010) argues that incentives were

⁴See Dell'Ariccia and Marquez (2005).

distorted and points at the role of politicians and of the government in pushing credit to low income households who could not afford it. To the best of our knowledge, our paper is the first to provide a theory of the political economy of bank supervision and of how it is shaped by credit cycles, and exacerbates them. An early theory of capture of government decision-making is provided by Laffont and Tirole (1991).

III. A Model of Bank Finance

We consider a single good economy with four types of risk neutral agents, with unit mass each: (a) investors, who supply capital elastically; (b) bankers who have the ability to monitor borrowers; (c) entrepreneurs who have investment opportunities and are endowed with an aggregate capital stock normalized to one; and (d) a banking supervisor who audits banks and enforces regulations. Both bankers and entrepreneurs' actions are subject to moral hazard as in Holmstrom and Tirole (1997) and Tressel and Verdier (2011).

The economy lasts for three periods and there is no aggregate uncertainty. In period 1, agents write financial contracts. In period 2, agents discover the extent to which individual banks are audited, audits take place and projects are undertaken. In period 3, outcomes are realized, and the payments to financiers, investors and entrepreneurs. Investment I in the first period is financed by a combination of internal funds (the entrepreneur's endowment 1), bank loans and direct borrowing from uninformed investors.

A. Production and External Financing Technologies

All agents have access to a storage technology with a rate of return γ .⁵ There are two types of projects that can be undertaken by entrepreneurs only. A good project generates a verifiable financial return equal to R per unit of capital invested (if it succeeds) or to 0 (if it fails). A bad project yields only a non pledgeable private benefit (not verifiable) with probability 1 and whose value is determined by bankers' monitoring.

Formally, the return per unit of capital invested is given by:

$$\begin{aligned} \text{Good project: } & \begin{cases} Y = R \text{ with probability } p \\ Y = 0 \text{ with probability } 1 - p \end{cases} \\ \text{Bad project: } & \begin{cases} Y = B \text{ with probability } 1 \text{ if the banker does not monitor} \\ Y = b \text{ with probability } 1 \text{ if the banker monitors} \end{cases} \end{aligned}$$

with $\Delta B = B - b > 0$. We assume that only good projects are socially efficient:

$$\textbf{Assumption A: } pR - c - \gamma > 0 > B - \gamma > b - \gamma$$

⁵This exogenous rate of return could be interpreted as a short-term risk free market interest rate, or as the policy rate of the central bank.

The banking sector consists of many competitive intermediaries who monitor firms by paying a non verifiable cost c per unit of capital invested in the project. The aggregate stock of capital K_B is exogenously given and β is the equilibrium market rate of return on bank capital is. Monitoring reduces the entrepreneur's private benefit from B to b when choosing bad projects. This reduces moral hazard in production, and thus enhances the entrepreneur's borrowing capacity. We assume that each bank finances only one project⁶.

Investors do not monitor firms to which they lend, and supply capital elastically at the rate of return γ .⁷ Uninformed investors can also be interpreted as bank depositors or bank creditors.

B. Collusion and the Quality of Banking Supervision

As we shall see in the following section, an entrepreneur and a bank may have an incentive to collude after signature of the financial contract so that monitoring does not take place.⁸ The bank has all the bargaining power: if a bribe is paid to her, the benefits of collusion are transferred in the form of a non-verifiable side payment S that leaves the entrepreneur indifferent between colluding and not colluding⁹. Collusion requires a costly non-verifiable transfer from the former to the latter: the benefit to the bank of a side payment of 1 takes only a value k_C , with $0 \leq k_C < 1$.

The cost of the illicit transfer k_C is determined by the audit technology of the banking supervisor and is subject to *idiosyncratic* uncertainty which is revealed *after* the financial contract is signed, but *before* the entrepreneur's choice of project. Specifically, the supervisor can audit banks in period 2 and impose sanctions if banks and entrepreneurs are investing in bad projects. However, because the supervisor cannot audit all banks or all projects perfectly, the technology of the banking supervisor is stochastic. With probability q , the audit is perfect and collusion becomes verifiable by a court. As a result, the bank cannot extract collusive rents from the borrower and $k_C = 0$. However, with probability $1 - q$, the audit is not perfect and a fraction $k > 0$ of the collusive rent of the bank is not observed by the bank supervisor. Hence $k_C = k$. Therefore, $1 - k$ represents the strength or quality of the banking supervisor, measured by the fraction of the collusive rent that is lost when an audit takes place.

There are two justifications for the stochastic auditing technology which introduces relationship-specific uncertainty in the contracting environment. First, cost effectiveness limits the capacity of supervisory agencies, they select and focus their auditing efforts on a subset of banks only. If a bank is selected for an audit, parties involved in a loan contract are then likely to be under close scrutiny, and therefore subject to high costs of hiding

⁶In practise, banks often have large exposures to a small numbers of borrowers. La Porta, Lopez-de-Silanes and Zamarripa (2003) provide evidence of large related lending exposures in Mexico. Acharya, Hasan and Saunders (2006) evidence of undiversified bank portfolios in Italy, and Dahiya, Saunders and Srinivasan (2003) on the sharp negative effects of defaults by major corporate borrowers in the U.S. on their lead lending bank.

⁷A possible justification for the fact that uninformed investors do not monitor is that they are atomistic and therefore do not have the monetary incentives to incur the cost of monitoring.

⁸See Tirole (1992) and Tirole (1986) for the theory of collusion.

⁹We assume that firms cannot default on promised side payments to banks contingent on the state of nature realized.

illicit transactions. Second, even if audits are not stochastic, there may be a relationship-specific component in the effectiveness of bank inspections and controls. This component will depend on the extent to which banking supervisors they are susceptible to political influence or mere corruption. For instance, it is well known that, in weak institutional environments, political connections facilitate bank regulatory forbearance, increase connected lending, and provide politically connected firms easier access to domestic bank credit.¹⁰ We shall initially take the quality of banking supervision as a given. Next, we will endogenize the political economy of the quality of banking supervision.

IV. Firms' Financial Contracts

For a project of total size I , financial contracts specify the maximum borrowing capacity of the entrepreneur ($I - 1$), the amount borrowed from bankers (I_B) from uninformed lenders (I_I), as well as the payments to each party if the project succeeds: the return $R \cdot I$ is shared between the bank (R_B), the uninformed investors (R_I) and the entrepreneur (R_E): $R \cdot I = R_E + R_B + R_I$.

Given that internal funds of the entrepreneur are equal to 1, I also measures entrepreneurial leverage, and I/I_B measures the leverage of banks. Two types of financial contracts are possible, depending on whether they allow for collusion or not between the entrepreneur and a bank. We first write the incentive and participation constraints for each of these contracts before laying out the maximization problem in the decentralized economy.

A. Incentives and Participation Constraints:

(1) Collusion-Proof Contract

Let us start with the contract that prevents any investment in bad projects.

- Incentive compatibility constraints:

The entrepreneur must obtain an expected return equal to his private benefits:

$$pR_E \geq bI \tag{1}$$

Given a transaction cost of collusion k , and a potential bribe SI , the bank's net expected return in absence of collusion must be greater or equal to the expected bailout payment plus the bribe if collusion occurs:

$$pR_B - cI \geq kSI \tag{2}$$

¹⁰As suggested by Fisman (2001), the value and effectiveness of these political connections may also change over time, hence generating some relation-specific uncertainty on the feasibility and costs of illicit transactions.

where the maximum side payment SI that the entrepreneur is willing to transfer to the bank is equal to ΔBI , under the assumption that the bank has all the bargaining power and appropriate the full rent from collusion.

- Participation constraints:

The bank expected return net of monitoring cost must exceed the expected return on bank capital β :

$$pR_B - cI \geq \beta I_B \quad (3)$$

while investors must break even on average:

$$pR_I \geq \gamma I_I \quad (4)$$

(2) Contract allowing for some collusion

Consider now a contract that allows for partial collusion. Such a contract is possible because, in a collusion-proof contract, the incentive constraint of the bank is too tight if the audit technology turns out to be perfect with probability q , and it leaves an "excessive" rent to the bank equal to $k\Delta BI$. A partial collusion contract aims at eliminating this rent, and does so by incentivizing the bank only when the audit technology is perfect. The cost is that, when the audit technology is not perfect, the bank is not incentivized to monitor and a bad project is undertaken.

- Incentive compatibility constraints:

The bank must be incentivized to monitor when the bank supervisor has perfect audit capacity, but is not incentivized when collusion is feasible:

$$pR_B - cI \geq 0 \quad (5a)$$

The incentive compatibility constraint of the entrepreneur remains the same: he must choose the good project when the bank supervisor has perfect audit capacity.

- Participation constraints:

The bank must now break even if collusion occurs when auditing is imperfect. The overall bank return now includes the net financial payment if audit is perfect (with probability q), and the expected bailout and bribe when audit is imperfect (with probability $1 - q$): $q \cdot (pR_B - cI) + (1 - q) \cdot (kSI) \geq \beta I_B$. Hence the condition:

$$\tilde{p}R_B - qcI + (1 - q)k\Delta BI \geq \beta I_B \quad (6)$$

where $\tilde{p} = qp$ is the probability of a repayment. The constraint shows that the bank saves on monitoring costs cI which are paid only with probability q , enjoys a bribe $k\Delta BI$ with probability $1 - q$ (this replaces the same face value financial payment received with probability one to always ensure monitoring in a collusion-proof contract), but receives the financial return R_B with a lower probability $\tilde{p} = qp < p$.

Finally, uninformed investors must also break even on average, but with a lower probability of payment \tilde{p} :

$$\tilde{p}R_I \geq \gamma I_I \tag{7}$$

B. The Borrower's Maximization Program

Given rates of return γ and β , the collusion-proof contract or the partial collusion contract chosen by an entrepreneur with initial internal funds 1 is then the solution of the following maximization program:

Maximize: $U_E = pR_E$

subject to: - $1 + I_B + I_I = I$ (resource constraint);

- $R \cdot I = R_E + R_B + R_I$ (profit sharing rule);

- Incentive constraints (1) and (2), or (1) and (5a), and participation constraints (3) and (4), or (6) and (7)

V. Market Equilibrium

We are now ready to characterize the market equilibrium under various parameters. The incentive constraint of the bank is binding because bank capital is more costly than uninformed investors capital, hence the entrepreneur will minimize both the share of bank capital in external finance and the amount repaid to the bank for a given project size. The incentive constraint of the entrepreneur is binding because, to achieve maximum leverage, the entrepreneur will maximize the share of profits pledged to external providers of finance, and retain the minimum share of profits necessary to have incentives to choose the productive project (the "non-pledgeable income", as defined by Holmstrom and Tirole, 1997). We assume the following:

$$\textbf{Assumption B : } R - \frac{b}{p} - \frac{c + k\Delta B}{p} \geq 0 \text{ and } c < k\Delta B$$

The first part of Assumption B states that the project's return is large enough so that the pledgeable income that uninformed investors get in case of success is positive, ensuring therefore the existence of an active credit market in the economy. The second part of assumption B follows Holmstrom and Tirole (1997) and ensures that monitoring by banks is socially valuable.

A. Choice of Financial Contracts

The optimal project size in collusion-proof contracts, and in partial-collusion contracts are characterized in the following proposition.

Proposition 1 Consider an entrepreneur with initial internal funds 1.

(1) Define $\Phi_{NC} = \gamma \cdot \frac{I}{I}$, and $\Lambda_{NC} = \beta \cdot \frac{I_B}{I}$ the net expected return to investors and to the bank per unit of capital invested in the project in a collusion-proof contract. The project size I_{NC} in a collusion-proof contract is given by:

$$I_{NC} = \frac{1}{1 - \frac{\Phi_{NC}}{\gamma} - \frac{\Lambda_{NC}}{\beta}} \equiv \frac{1}{V_{NC}(\gamma, \beta)} \quad (8)$$

(2) Similarly, define $\Phi_C = \gamma \cdot \frac{I}{I}$, and $\Lambda_C = \beta \cdot \frac{I_B}{I}$ the net expected return the expected return to investors and to the bank per unit of capital invested in the project in a partial collusion contract. The project size I_C of the optimal partial collusion contract is given by:

$$I_C = \frac{1}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C}{\beta}} \equiv \frac{1}{V_C(\gamma, \beta)} \quad (9)$$

Proof. See the appendix ■

The parameters Λ_{NC} and Φ_{NC} for the collusion-proof contract, and of Λ_C and Φ_C for the partial-collusion contract can be interpreted as follows. The minimum expected return per unit of investment and *net* of monitoring costs provided to the bank to ensure monitoring and collusion proofness must compensate for not engaging in collusion:

$$\Lambda_{NC} = k\Delta B$$

The expected pledgeable income per unit of investment that is left to uninformed investors in the collusion-proof contract is:

$$\Phi_{NC} = p \left(R - \frac{b}{p} - \frac{c + k\Delta B}{p} \right)$$

Assumption B ensures that it is positive and therefore that there is an active credit market in this economy. Φ_{NC} depends positively on the profitability of investment projects R , and negatively on the extend of the moral hazard problem in production b . Because of moral hazard and collusion in banking, Φ_{NC} also depends negatively on the monitoring cost c and on the potential for collusion $k\Delta B$.

Similar comparative statics can be realized for Λ_C and Φ_C in the case of the partial collusion contract.

A comparison between Λ_{NC} and Λ_C on the one hand, and between Φ_{NC} and Φ_C on the other hand, illustrates the basic trade-offs associated with collusion. The expected return to the bank is *lower* when the contract allows for some collusion:

$$\Lambda_C - \Lambda_{NC} = -qk\Delta B < 0 \quad (10)$$

With a partial-collusion contract, the bank receives a collusion rent with probability $1 - q$ but does not receive the equivalent financial rent if the quality of supervision is high. In contrast, in the collusion-proof contract, the financial rent equivalent to the private

benefits is received in both states of nature to always incentivize the bank irrespective of the quality of the audit. Hence, allowing for some collusion generates a savings equal to the financial rent $k\Delta B$ that is received with probability q when the quality of supervision is high.

The flipside of the lower expected financial return left to the bank is that the expected financial return to the investors may in some circumstances increase if a partial collusion contract is signed. This defines the condition under which the decentralized market equilibrium will result in the choice of contracts allowing for some collusion:

$$\Phi_C - \Phi_{NC} = \underbrace{(\Lambda_{NC} - \Lambda_C)}_+ - \underbrace{(p - \tilde{p}) \left(R - \frac{b}{p} - \frac{c + k\Delta B}{p} \right)}_- > 0 \quad (11)$$

The first term is positive and represents the financial savings in the payment to the bank that can be transferred to the investor. The second (negative) term is the expected reduction in the financial payment resulting from lower probability of generating a return associated with the project, net of the monitoring costs of the bank and income of the entrepreneur.

To summarize, allowing for partial collusion lowers the financial return promised to banks in case of success and it reduces the monitoring intensity by relaxing the incentive constraint of banks. As a result, the optimal partial-collusion contract leaves a lower expected pledgeable income per unit of investment to the bank compared to the situation without collusion (ie. $\Lambda_C < \Lambda_{NC}$). This allows the expected pledgeable income of uninformed investors to increase by a corresponding amount (the positive term on the LHS of (11), and therefore tends to improve the borrowing capacity of the entrepreneur. Second, with partial collusion, the probability of success of the project falls from p to $\tilde{p} = qp$. This in turn leads to a reduced profitability of projects and a negative effect on the expected pledgeable income that uninformed investors can get (the negative term on the LHS of (11)). This tends to reduce the borrowing capacity of the entrepreneur.

If observed in equilibrium, collusion must thus improve the borrowing capacity of the entrepreneur. This is possible if and only if partial-collusion increases the financial return to uninformed investors (e.g. $\Phi_C \geq \Phi_{NC}$) who require a lower return on capital than banks ($\gamma < \beta$). As we shall see in the next section, a necessary condition for this to happen is that the probability of collusion is not too high (assumption C):

$$\mathbf{Assumption\ C:} \quad \Phi_C \geq \Phi_{NC} \Leftrightarrow \frac{\tilde{p}}{p} = q \geq 1 - \frac{\frac{k\Delta B}{p}}{R - \frac{b}{p} - \frac{c}{p}}$$

The overall effect of collusion on the entrepreneur's borrowing capacity depends on parameters' values and on the relative opportunity cost β/γ of "banking finance" instead of "market finance". We now turn to this choice.

The contract chosen ex-ante is the contract that maximizes the expected utility of the entrepreneur per unit of capital invested $U_E = \frac{b}{V_j(\gamma, \beta)}$ with $j \in \{NC, C\}$, conditional on the participation and incentive constraints of the bank and the uninformed investors, given

the return on bank capital β and the cost of funds γ . This is equivalent to maximizing the total present value of external financiers' expected returns – discounted with the correct interest rates:

$$\frac{\Phi_j}{\gamma} + \frac{\Lambda_j}{\beta} \quad (12)$$

We derive the following proposition:

Proposition 2 *Under Assumptions A-C, partial collusion occurs if and only if the cost of bank capital β exceeds the return on investors capital γ by a margin Ψ , that is if and only if $\beta \geq \gamma \cdot \Psi$ where $\Psi = \frac{\Lambda_{NC} - \Lambda_C}{\Phi_C - \Phi_{NC}}$. This margin Ψ is increasing in the quality of bank supervision ($\frac{\partial \Psi}{\partial k} < 0$), decreasing in the private benefits of control ($\frac{\partial \Psi}{\partial \Delta B} < 0$) and increasing in the efficiency of bank monitoring ($\frac{\partial \Psi}{\partial c} < 0$).*

Proof. See the Appendix. ■

This conditions states that the contract allowing for collusion is chosen if the present value of the increased payment to the uninformed investors $\frac{\Phi_C - \Phi_{NC}}{\gamma}$ exceeds the present value of the reduction $\frac{\Lambda_{NC} - \Lambda_C}{\beta}$ in the expected return to the bank.

The basic trade-off involved in the contract choice can be obtained from the following equation derived from (11) and (12):

$$(\Lambda_{NC} - \Lambda_C) \left(1 - \frac{\gamma}{\beta}\right) \geq (p - \tilde{p}) \left(R - \frac{b}{p} - \frac{c + k\Delta B}{p}\right) \quad (13)$$

The LHS of (13) reflects the gain in financial leverage obtained of switching from a collusion-proof contract to a partial-collusion contract, if projects were equally successful under partial-collusion contracts. As said, with collusion the expected pledgeable income per unit of investment to the bank is reduced by $\Lambda_{NC} - \Lambda_C$ while that to uninformed investors is increased by the same amount. The larger the wedge between the "banking finance" cost and the "uninformed finance" cost β/γ (since $\gamma < \beta$), the higher is the leverage gain and increase in investment from shifting one unit of pledgeable income from bankers to nonbankers. The RHS side of (13) is the cost of switching to a partial-collusion contract. As bad projects get implemented in some states of nature, the average profitability of projects is reduced by $p - \tilde{p}$. Consequently, the expected pledgeable income of uninformed investors is also smaller. This in turn makes it more difficult to get cheaper loans from this "uninformed finance". It follows that, when bank capital becomes relatively expensive relative to uninformed capital and condition (13) is met, an entrepreneur can increase his expected utility by substituting away from bank capital towards uninformed capital. This is more likely to happen the larger β/γ is relative to the threshold Ψ .

Inspection of the threshold Ψ provides the comparative statics.

A lower quality of bank supervision (ie larger value of k) and a larger value of the potential private benefits of collusion ΔB , increase the pledgeable income $\Lambda_{NC} - \Lambda_C$ that

can be shifted from the bank to uninformed investors by having a collusion contract, increasing therefore the LHS of (13). Such changes reduce $(p - \tilde{p}) \left(R - \frac{b}{p} - \frac{c+k\Delta B}{p} \right)$, the loss of expected pledgeable income of uninformed investors that is induced by collusion (ie. the RHS of (13)). At a given value of β/γ , both effects make it easier to have an equilibrium collusion contract (and therefore a lower value of the threshold Ψ).

A reduced efficiency of bank monitoring (larger value of c) reduce the pledgeable income $R - \frac{b}{p} - \frac{c+k\Delta B}{p}$ that can be left to uninformed investors under the collusion proof contract. This reduces the RHS of (13) and leads to a lower threshold level Ψ above which collusion is chosen in the decentralized equilibrium.

B. Decentralized Market Equilibrium

The equilibrium return on bank capital $\beta^*(\gamma)$ is given by $K_B = I_B(\beta, \gamma)$, where the aggregate demand of bank capital $I_B(\beta, \gamma)$ depends on the type of financial contracts chosen by entrepreneurs:

$$\begin{aligned} I_B(\beta, \gamma) &= I_B^{NC}(\beta, \gamma) = \frac{1}{\beta} \frac{\Lambda_{NC}}{V_{NC}(\gamma, \beta)} \quad \text{when } \beta < \gamma \cdot \Psi \\ &= I_B^C(\beta, \gamma) = \frac{1}{\beta} \frac{\Lambda_C}{V_C(\gamma, \beta)} \quad \text{when } \beta > \gamma \cdot \Psi \\ &= \nu I_B^{NC}(\beta, \gamma) + (1 - \nu) I_B^C(\beta, \gamma) \quad \text{with } \nu \in [0, 1] \quad \text{when } \beta = \gamma \cdot \Psi \end{aligned}$$

When $\beta = \gamma \cdot \Psi$, the two types of contracts can be chosen. We should therefore consider a mixed equilibrium with $\nu \in [0, 1]$, the (endogenous) fraction of contracts which are collusion-proof.

Conditions (8) and (9) provides that in regime $j \in \{NC, C\}$, the return on bank capital $\beta_j(\gamma)$ is given by:

$$\beta_j(\gamma) = \frac{\Lambda_j}{1 - \frac{\Phi_j}{\gamma}} \left[1 + \frac{1}{K_B} \right]$$

Comparative statics. The return on bank capital (i) decreases with the return on the storage technology: a lower γ improves the borrowing capacity of the entrepreneur, and therefore increases the demand for bank capital; (ii) increases with the expected payment Λ_j to the bank per unit of capital invested; (iii) increases with the expected payment Φ_j to uninformed investors (because a higher expected payment improves the borrowing capacity of the entrepreneur, and therefore raises the demand for bank capital); (iv) decreases with the supply of bank capital.

In equilibrium, some or all firms will prefer partial-collusion contracts if and only if the cost of bank capital relative to uninformed capital is high enough: $\frac{\beta}{\gamma} \geq \Psi$. To characterize the equilibrium, it is useful to define two thresholds $\bar{\gamma}$ and $\underline{\gamma}$ given respectively by

$$\begin{aligned} \beta_{NC}(\bar{\gamma}) &= \bar{\gamma} \cdot \Psi \\ \beta_C(\underline{\gamma}) &= \underline{\gamma} \cdot \Psi \end{aligned}$$

$\bar{\gamma}$ is the cost of uninformed capital below which, starting from an equilibrium without collusion, some firms will start accepting contracts with collusion. Similarly, $\underline{\gamma}$ is the cost of uninformed capital above which some firms accept contracts that are collusion-proof. Note that there exists $\hat{\gamma} < \underline{\gamma}$ such that for all $\gamma > \hat{\gamma}$ ¹¹, the return on bank capital is lower in a partial-collusion regime than in a collusion-proof regime: $\beta_C(\gamma) < \beta_{NC}(\gamma)$. The following proposition characterizes the bank capital equilibrium.

Proposition 3 *Decentralized market equilibrium.* *There exist $\bar{\gamma}, \underline{\gamma}$, with $\hat{\gamma} < \underline{\gamma} < \bar{\gamma}$ such that: (1) if $\gamma > \bar{\gamma}$, all credit contracts are collusion-proof contracts; (2) if $\gamma < \underline{\gamma}$, all credit contracts are partial-collusion contracts; (3) if $\gamma \in [\underline{\gamma}, \bar{\gamma}]$, a unique mixed equilibrium exists in which a proportion ν of firms chooses contracts that are collusion-proof, and a proportion $1 - \nu^*(\gamma)$ chooses partial-collusion contracts, where $\nu^*(\gamma)$ is an increasing function of γ with $\nu^*(\bar{\gamma}) = 1$, and $\nu^*(\underline{\gamma}) = 0$. In the mixed equilibrium region, domestic bank capital and uninformed capital become substitutes: the return on bank capital β falls as the cost of uninformed finance γ goes down.*

Proof. See the Appendix. ■

Corollary 4 *(1) For all $\gamma > \bar{\gamma}$, or $\gamma < \underline{\gamma}$, the cost of bank capital β is a decreasing function of the cost of external finance γ . (2) For all $\gamma \in [\underline{\gamma}, \bar{\gamma}]$, the cost of capital is an increasing function of the cost of external finance γ .*

Proof. See the appendix ■

This property of the equilibrium return on bank capital β is interesting (Figure 1). Contrary to what intuition would suggest, it is not positively correlated with the cost of external finance. This is because, in the short-run, the overall supply of bank capital is fixed. As the cost of external finance decreases (for example, when the policy rate of the central bank declines), the required return on bank capital increases, as entrepreneurs desire and can achieve higher leverage. Banks become more leveraged as a result. This property that entrepreneur and bank leverage should increase when interest rates decline is a very general property of models of banking based on moral hazard, as noted earlier. We are now equipped to characterize the social optimum and optimal financial regulations.

(Figure 1 about here)

VI. Optimal Regulation of Bank Capital

The market imposes a capital ratio to ensure incentive compatibility. The need for regulation of bank capital ratio under imperfect supervision derives from a pecuniary

¹¹The value of $\hat{\gamma}$ is given by :

$$\hat{\gamma} = \frac{\Phi_C \Lambda_{NC} - \Phi_{NC} \Lambda_C}{\Lambda_{NC} - \Lambda_C}$$

which is positive under assumption C.

externality: individual agents do not internalize the impact of contract choices on the equilibrium return on bank capital.¹²

We first characterize a fixed capital adequacy ratio, and show that it is in general not the optimal one. The optimal rule implies a capital adequacy ratio that is *pro-cyclical* with respect to the interest rate but is *countercyclical* with respect to the return R on projects. However, the wedge between the ratio imposed by the market to ensure incentive compatibility and the optimal one instead increases as the interest rate γ falls, as more and more agents choose financial contracts that leave some room for collusion.

A. Social Optimum

The constrained efficient socially optimal contract is the one that maximizes the sum of agents' expected utilities :

$$\max_{j \in \{C, NC\}} \left[bI_j + \beta_j K_B + \gamma I_I^j \right]$$

under the incentives constraints and participation constraints associated with each contract, and given the market condition that determines the return on bank capital.

From section III, the maximization program above can be simplified into:

$$\max_{j \in \{C, NC\}} [b + \Lambda_j + \Phi_j] I_j(\gamma, \beta_j(\gamma))$$

with $I_j(\gamma, \beta_j(\gamma))$ the equilibrium level of project size under regime j and the equilibrium return on bank capital given by $\beta_j(\gamma) = \frac{\Lambda_j}{1 - \frac{\Phi_j}{\gamma}} \left[1 + \frac{1}{K_B} \right]$.

We then have

Proposition 5 *Social Optimality:* *Under Assumptions A-C: i) social optimality implies that contracts allowing some collusion should be adopted if and only if the interest rate γ is below a threshold $\gamma^* > 0$. ii) This threshold γ^* is strictly below $\underline{\gamma}$ when K_B is not too large.*

Proof. See the appendix ■

When assumption C holds, proposition C says that there exists a rate of return below which collusion is socially optimal. In such a case, the increase in leverage that is allowed by collusion more than outweighs the lower social rate of return associated to these contracts. The social optimum differs from the decentralized equilibrium because of a pecuniary externality: when switching to collusion contracts, agents do not internalize the fact that the return on bank capital is going to fall and this is not internalized by the entrepreneur who maximizes leverage.¹³

¹²In this model, the capital ratio is a leverage ratio I/K_B because the probability of success of a project cannot be observed.

¹³which is equivalent to maximizing the present value of financiers' expected return at *given* rates of return γ and β : see condition 12.

In what follows, we shall assume that $\gamma > \gamma^*$ and that partial collusion contracts are not socially optimal.

B. Fixed Capital Adequacy Rule

First we consider a fixed capital adequacy rule CAR . We shall see that such a rule, when it is binding, is often not socially optimal. The choice of contract is now constrained by the additional condition:

$$\frac{I_B}{I} \geq CAR$$

- Consider a collusion-proof contract. Combining the capital adequacy rule with the participation constraint

$$pR_B - cI \geq \beta I_B$$

implies $pR_B - cI \geq \beta CAR \bullet I$ or that $R_B \geq R_B^1 = \frac{\beta CAR + c}{p} I$. At the same time, the incentive condition ((2)) implied that $R_B \geq R_B^2 = \frac{k\Delta B + c}{p} I$. Hence the payment to the bank must be such that:

$$R_B = \max \left[\frac{k\Delta B + c}{p} I; \frac{\beta CAR + c}{p} I \right]$$

The capital adequacy ratio rule is binding if and only if:

$$CAR \geq \frac{1}{\beta} [k\Delta B] = \frac{1}{\beta} \Lambda_{NC}$$

This implies that the incentive constraint of the bank is not binding, and that the bank receives an additional rent over and above the payment necessary to avoid collusion. Since the return on bank capital β exceeds the cost of funds γ , this implies that the borrowing capacity of the entrepreneur goes down, and that the size of the investment will decline. More precisely an optimal collusion proof contract with a CAR is characterized as follows:

Proposition 6 *Optimal collusion proof contract with a CAR : i) For $\beta \geq \frac{\Lambda_{NC}}{CAR}$, the CAR is binding and the optimal size of investment $I_{CAR}^N(\beta, \gamma)$ for a collusion proof contract is such that:*

$$I_{CAR}^N(\beta, \gamma) < I_{NC}(\beta, \gamma)$$

ii) For $\beta < \frac{\Lambda_{NC}}{CAR}$, the CAR is not binding and the optimal size of investment is $I_{NC}(\beta, \gamma)$

Proof. See the appendix. ■

Consider now a collusion contract. Again combining the capital adequacy rule with the participation constraint

$$\tilde{p}R_B - qcI + (1 - q)k\Delta BI \geq \beta I_B$$

implies $\tilde{p}R_B - qcI + (1 - q)k\Delta BI \geq \beta CAR \bullet I$ or that $R_B \geq R_B^1 = \frac{\beta CAR + qc - (1 - q)k\Delta B}{\tilde{p}}I$. At the same time, the incentive condition ((5a)) implied that $R_B \geq R_B^2 = \frac{c}{p}I$. Hence the payment to the bank must be such that:

$$R_B = \max \left[\frac{c}{p}I; \frac{\beta CAR + qc - (1 - q)k\Delta B}{\tilde{p}}I \right]$$

Hence, the capital adequacy ratio rule is binding if and only if:

$$CAR \geq \frac{1}{\beta}(1 - q)k\Delta B = \frac{1}{\beta}\Lambda_C$$

We have therefore a similar proposition:

Proposition 7 Optimal collusion contract under a CAR: *i) For $\beta \geq \frac{\Lambda_C}{CAR}$, the CAR is binding and the optimal size of investment $I_{CAR}^C(\beta, \gamma)$ for a collusion contract is such that: $I_{CAR}^C(\beta, \gamma) \leq I_C(\beta, \gamma)$; ii) For $\beta < \frac{\Lambda_C}{CAR}$, the CAR is not binding and the optimal size of investment is $I_C(\beta, \gamma)$*

Proof. See the appendix. ■

One may compare now the two types of contracts. For a given value of the return on bank capital β , we have the following proposition :

Proposition 8 *i) When $\beta \geq \frac{\Lambda_{NC}}{CAR}$ the optimal contract is a constrained collusion proof contract.*

ii) When $\beta < \frac{\Lambda_{NC}}{CAR}$ and $\beta < \Psi\gamma$, the optimal contract is a non constrained collusion proof contract

iii) When $\beta < \frac{\Lambda_C}{CAR}$ and $\beta > \Psi\gamma$, the optimal contract is a non constrained collusion contract

iv) When $\beta \in \left] \frac{\Lambda_C}{CAR}; \frac{\Lambda_{NC}}{CAR} \right[$ and $\beta > \Psi\gamma$, the optimal contract is a constrained collusion contract if

$$\frac{(1 - q)p}{\gamma} \left[R - \frac{b}{p} - \frac{(c + k\Delta B)}{p} \right] + \left(CAR - \frac{\Lambda_{NC}}{\beta} \right) \left(\frac{\beta}{\gamma} - 1 \right) < 0 \quad (14)$$

otherwise it is a non constrained collusion proof contract.

Proof. See the appendix. ■

The optimal choice contract structure is depicted in Figure 2 in the space $\{\gamma, \beta\}$. The capital adequacy ratio CAR is binding for both the collusion contract and the collusion

proof contract in region 1 where $\beta \geq \frac{\Lambda_{NC}}{CAR}$. In such a region, collusion is dominated. In region 2 corresponding to $\beta < \frac{\Lambda_{NC}}{CAR}$ and $\beta < \Psi\gamma$, the capital adequacy ratio is not binding for the collusion proof contract, it may or may not be binding for the collusion contract. But as $\beta < \Psi\gamma$ the result of proposition (?) tells us that the collusion proof contract dominates an unconstrained collusion contract. Therefore it should dominate any type of collusion contract (whether it is constrained or not). Region 3 corresponds to the case where $\beta < \frac{\Lambda_C}{CAR}$ and $\beta > \Psi\gamma$. In such a situation, the CAR is binding for neither for the collusion contract nor the collusion proof contract. It follows that because $\beta > \Psi\gamma$ we can be sure that the unconstrained collusion contract dominates the unconstrained collusion proof contract. Finally, there is the last region 4 where $\beta \in \left] \frac{\Lambda_C}{CAR}; \frac{\Lambda_{NC}}{CAR} \right[$ and $\beta > \Psi\gamma$. In such a region the CAR is binding for the collusion contract but not for the collusion proof contract. The determination of the optimal contract hinges therefore on the comparison between $I_{CAR}^C(\beta, \gamma)$ and $I_{NC}^C(\beta, \gamma)$, that is reflected in the condition (14) that characterizes when the constrained collusion contract dominates the collusion proof contract. Note that because we are in a region where $\beta \geq \Psi\gamma$, the unconstrained collusion contract dominates the collusion proof contract and therefore it is also possible for the constrained collusion contract to also eventually dominate a no-collusion contract.

(Figure 2 about here)

• **Characterization of the banking capital market equilibrium:**

We are now in position to characterize the equilibrium on the banking capital market. The following proposition shows that a sufficiently restrictive fixed capital adequacy ratio helps to reduce the likelihood of financial contracts with collusion.

Proposition 9 *Banking capital market equilibrium under a fixed capital adequacy ratio:* Under Assumptions A-C and a given fixed capital adequacy ratio CAR , there exists a threshold $\tilde{\gamma}(CAR)$ such that for $\gamma \geq \tilde{\gamma}(CAR)$, the banking capital market equilibrium is associated with collusion-proof contracts only. This threshold $\tilde{\gamma}(CAR)$ is decreasing in CAR .

Proof. See the appendix ■

A restrictive enough capital adequacy ratio CAR such that $\tilde{\gamma}(CAR) < \underline{\gamma}$ will effectively reduce significantly the likelihood of collusion financial contracts at the equilibrium. It is also going to depress investment as $I_{CAR} = \frac{1}{V_{CAR}(\beta, \gamma)}$ is a declining function of CAR . Hence avoiding collusion may generate high costs in terms of potential output. From a normative point of view, a fixed capital adequacy rule that eliminates collusion depresses total investment and is clearly welfare decreasing relative to the decentralized market equilibrium for high and low external costs of funds. Indeed for $\gamma \geq \bar{\gamma}$, the market would already provide collusion proof contracts without the eventually binding constraint on bank capital. Hence, it is not socially optimal to have a binding CAR for $\gamma \geq \bar{\gamma}$. Moreover, as proposition 5 showed, for $\gamma \leq \gamma^*$, collusion contracts are socially optimal and

therefore one should not eliminate them. For intermediate values of the opportunity cost of funds, (ie. $\gamma^* < \tilde{\gamma}(CAR) < \gamma < \bar{\gamma}$), the previous fixed capital adequacy rule eliminates the contracts with collusion. It has therefore the beneficial effects of reducing excessive risk taking. But this comes at the cost of a reduced size on total investment. The net social value of such regulation depends therefore on which effect dominates in this intermediate range of the interest rate γ (see appendix for precise conditions under which a fixed capital ratio decreases welfare relative to the decentralized market equilibrium). This also implies that such a fixed capital adequacy rule is not socially optimal.

(Figure 3 about here)

C. Optimal Capital Adequacy Rule

The preceding discussion suggests that an optimal capital adequacy rule should be flexible enough to take into account the macro conditions in particular related to the interest rate γ . The optimal capital adequacy rule should be such that, for $\gamma > \gamma^*$, investment is maximized under the constraint that no collusion contracts are signed.

For $\gamma > \gamma^*$, an optimal capital adequacy rule must therefore verify:

$$CAR \leq \frac{\Lambda_{NC}}{\beta_{NC}(\gamma)} = \frac{I_B^{NC}}{I_{NC}}$$

while also satisfying

$$CAR > \frac{\Lambda_C}{\beta_C(\gamma)}$$

(to ensure that there is no market equilibrium consistent with collusion contracts) Note that:

$$\frac{\Lambda_C}{\beta_C(\gamma)} < \frac{\Lambda_{NC}}{\beta_{NC}(\gamma)}$$

is equivalent to $\Phi_C > \Phi_{NC}$ which is true under assumption C. Since the optimal CAR should minimize the distortion of investment size under collusion proofness, the optimal capital adequacy rule must therefore be:

$$CAR = \frac{\Lambda_{NC}}{\beta_{NC}(\gamma)} = \frac{1}{1 + \frac{1}{K_B}} \left(1 - \frac{\Phi_{NC}}{\gamma} \right) \quad \text{for } \gamma > \gamma^* \quad (15)$$

From this we have the following proposition:

Proposition 10 *The optimal capital adequacy rule that prevents collusion (ie; when $\gamma > \gamma^*$) $CAR_{opt} = CAR(\gamma, K_B, R, c, k\Delta B)$ is i) increasing in the cost of external funds γ , and the stock of banking capital K_B , ii) decreasing in the return on investment R , and iii) increasing in the cost of monitoring c , the rent associated with regulatory forbearance $k\Delta B$, and the non-pledgeable income of the entrepreneur b . The wedge $CAR - \frac{\Lambda_C}{\beta_C(\gamma)}$ between the constrained allocation with a binding capital adequacy ratio and the market equilibrium increases as the interest rate γ declines.*

Proof. See the appendix. ■

Hence, the optimal capital adequacy ratio should be procyclical with respect to the interest rate γ but countercyclical with respect to the return R on projects in which banks' invest, and should also depend negatively on the quality of banking supervision, on efficiency of banks, and on the quality of corporate governance. In other words, the extent to which the capital buffers are countercyclical should be evaluated on the basis of the expected return of projects financed, and not on the basis of the monetary policy rate.

VII. Optimal Financial Regulation with Productive Externalities

Because of various macro productive or demand interdependencies, the return to individual projects may depend to some extent on some aggregate measure of aggregate production or demand in the economy.¹⁴ We extend our basic framework to discuss such possibility and analyze how it affects the optimal regulation of the banking sector.

A. An Economy with Externalities

We model these externalities by assuming that the return on a project depends on the number of other successful projects in the economy:

$$R = \tilde{R}(X) = R_0 (\Omega X)^\epsilon \quad \text{with } \epsilon \geq 0 \text{ and } \Omega > 0$$

Note that $\epsilon \geq 0$ parametrizes the degree of productive or demand externalities in the economy (ie. $\epsilon = 0$ corresponds to an economy with no externalities).

where X is the proportion of successful projects. Given our dichotomous outcomes for projects and using the law of large numbers, it follows that

$$\begin{aligned} R &= R_0 (\Omega p)^\epsilon \text{ if there is no collusion} \\ &= R_0 (\Omega pq)^\epsilon \text{ if there is collusion} \\ &= R_0 [\Omega (\nu p + (1 - \nu)qp)]^\epsilon \text{ in a mixed equilibrium} \\ &\quad \text{with } \nu \text{ is the proportion of projects with no collusion} \end{aligned}$$

Define $\bar{R}(\epsilon) = R_0 (\Omega p)^\epsilon$ the return if there is no collusion, $\underline{R}(\epsilon) = R_0 (\Omega pq)^\epsilon$ the return if no collusion, and $\hat{R}(\epsilon, \nu) = R_0 [\Omega (\nu p + (1 - \nu)qp)]^\epsilon$ the return in the mixed region.

We assume $p\Omega > 1 > pq\Omega$, that is an increase in the degree of externality ϵ increases the return to investment in a no collusion regime and decreases it in a collusion regime.

¹⁴ Aggregate demand externalities may arise for instance in economies with monopolistic competition (Blanchard and Kiyotaki, 1987).

For each regime $j \in \{NC, C\}$, we define $\bar{\Lambda}_j, \bar{\Phi}_j, \bar{V}_j$ respectively the return per unit invested for the bank and for the investor, and the investment multiplier if agents anticipate that all other agents will choose non collusion contracts and the return on a successful project will be $\bar{R}(\epsilon)$. Similarly define $\underline{\Lambda}_j, \underline{\Phi}_j, \underline{V}_j$ the returns and investment multiplier if the expectation is that all other projects will be collusive projects with an expected return on a successful project equal to $\underline{R}(\epsilon)$.

- **What is the effect of productive externalities on the likelihood of a market equilibrium with collusion?**

Define $\bar{\gamma}(R^e)$ the cost of uninformed capital below which, starting from an equilibrium without collusion, some firms will start accepting contracts with collusion:

$$\beta_{NC}(\bar{\gamma}, R^e) = \bar{\gamma} \cdot \Psi(R^e)$$

where $\beta_{NC}(\gamma, R^e)$ is the equilibrium return on bank capital, $\Psi(R^e) = \frac{\Lambda_{NC} - \Lambda_C}{\Phi_C(R^e) - \Phi_{NC}(R^e)}$, and R^e is the expected return of successful projects.

Similarly, define $\underline{\gamma}(R^e)$ the cost of uninformed capital above which, starting from an equilibrium with collusion, some firms will start accepting contracts with no collusion. $\underline{\gamma}(R)$ is given by the following condition:

$$\beta_C(\underline{\gamma}, R^e) = \underline{\gamma} \cdot \Psi(R^e)$$

Proposition 11 *Suppose that $q < 1/2$, then there exists a threshold ϵ^* such that for $\epsilon \geq \epsilon^*$ an economy with productive externalities is more likely to generate collusion equilibria than the benchmark economy:*

$$\bar{\gamma}(\bar{R}(\epsilon)) < \underline{\gamma}(\underline{R}(\epsilon))$$

In the region $\gamma \in [\bar{\gamma}(\bar{R}(\epsilon)), \underline{\gamma}(\underline{R}(\epsilon))]$, there are multiple equilibria with possibly both types of regimes (collusion and no collusion regimes) depending on agents' expectations

Proof. See the appendix. ■

Two effects are at play when the economy exhibits productive externalities. First, at a given return on bank capital, the expectation of many failed projects (which is more likely to happen when there are collusion contracts) lowers the expected return on productive projects and therefore worsens the moral hazard problem. It becomes more difficult to incentivize banks who must get a higher share of the pledgeable income to monitor. This in turn makes monitoring more expensive and increases the benefit of collusion contracts that relax the bank incentive constraint and raise the share of the pledgeable income to uninformed investors.

Second, when other contracts are anticipated to be collusion contracts, the overall borrowing capacity of an entrepreneur is lower. This tends to lower the aggregate demand for bank capital, and therefore the equilibrium return on bank capital.

When the equilibrium return on bank capital falls (relative to the situation in which only good projects are expected to be undertaken), the likelihood of observing collusion contracts goes down. This general equilibrium effect tends to offset the first direct effect mentioned above. The proposition shows conditions under which the first effect dominates (ie. when q is smaller than $1/2$).

The situation is illustrated in figure 4 where we show for each value of $R \in \{\underline{R}(\epsilon), \bar{R}(\epsilon)\}$, the value of $\Psi(R)\gamma$ (the value of β above which a collusion contract is chosen) and the equilibrium banking capital rates of returns $\beta_j(\gamma, R)$ for $j \in \{NC, C\}$. The bold lines CC and NN show the equilibrium rates of return on bank finance in the regime with collusion and without collusion. Note that there is also a set of mixed equilibria with a positive fraction of collusive and collusion proof contracts as shown by the dotted line that links the two bold parts CC and NN.

When the productive externality is large enough, there are multiple equilibria for the range of external costs of returns $\gamma \in [\bar{\gamma}(\bar{R}(\epsilon)); \underline{\gamma}(\underline{R}(\epsilon))]$ because it introduces a strategic complementarity in the choice of financial contracts. In an environment with collusive (resp. collusion proof) contracts, the individual incentives to choose a collusive (resp. a collusion proof) contract are enhanced.

(Figure 4 about here)

B. Optimal Capital Adequacy Ratio

How do externalities modify our optimal capital adequacy rule? With externalities, this rule becomes:

$$CAR = \frac{\Lambda_{NC}}{\bar{\beta}_{NC}(\gamma)}$$

where $\bar{\beta}_{NC}(\gamma) = \beta_{NC}(\gamma, \bar{R}(\epsilon))$.

The optimal capital adequacy ratio must be equal to the share of bank finance in total investment under a collusion-proof contract if agents anticipate that other agents will choose the collusion-proof contract and that the return on projects will be high.

The optimal capital adequacy rule will prevent collusion if and only if the required capital ratio is above the share of bank capital under a collusion contracts if all other projects are expected to be non-productive:

$$\frac{\Lambda_{NC}}{\bar{\beta}_{NC}(\gamma)} > \frac{\Lambda_C}{\underline{\beta}_C(\gamma)}$$

where $\underline{\beta}_C(\gamma) = \beta_C(\gamma, \underline{R}(\epsilon))$

This condition is equivalent to:

$$\Phi_{NC}(\bar{R}(\epsilon)) < \Phi_C(\underline{R}(\epsilon))$$

i.e. the collusion contract must still be such that it allows to raise the financial return to investors even when bad projects are expected to be undertaken. It is obvious then, that when externalities are large enough, this condition will not hold, therefore the optimal capital adequacy rule will not be sufficient to prevent collusion to occur.

The key problem is that, with lower expected return on projects, the borrowing capacity of entrepreneurs falls, total investment falls, and as the return on bank capital is depressed, this tends to increase the proportion of investment that is, in equilibrium, financed by the bank. If this effect is large enough, we may observe in equilibrium a higher share of investment financed by banks *and* the choice of collusion contracts. If this happens, the CAR rule becomes consistent with the presence of collusion contracts, and is therefore ineffective.

Formally, this happens if and only if:

$$\Phi_C(\underline{R}(\epsilon)) - \Phi_{NC}(\bar{R}(\epsilon)) = -(1-q)p \left[\bar{R}(\epsilon) - \frac{b+c}{p} \right] + pq [\underline{R}(\epsilon) - \bar{R}(\epsilon)] + k\Delta B < 0 \quad (16)$$

This is possible and not inconsistent with the condition:

$$\Phi_C(\bar{R}(\epsilon)) - \Phi_{NC}(\bar{R}(\epsilon)) = -(1-q)p \left[\bar{R}(\epsilon) - \frac{b+c}{p} \right] + k\Delta B > 0$$

as $\underline{R}(\epsilon) - \bar{R}(\epsilon) < 0$.

The first and the last term of (16) were present before: the first term is the reduction in the expected pledgeable income net of monitoring costs resulting from collusion. the last term is the gain resulting from lower financial return to the bank. The middle term is the externality effect which tends to lower the expected pledgeable income further. If this term is large enough, the CAR becomes ineffective, and does not prevent collusion.

- **What are the possible solutions?**

A first option is to make collusion contract infeasible with good quality audits by the supervisor ($k = 0$). However one can argue that the quality of audit and forbearance of the regulator may be endogenous and determined by political considerations that prevent the possibility for a value of k close to 0 (see more on this in the following section).

A second option is to make the CAR rule tighter when $\gamma \leq \underline{\gamma}(\underline{R}(\epsilon))$ (ie that is in the region multiple equilibria start to be possible). Typically a rule such that:

$$CAR = \frac{\Lambda_{NC}}{\underline{\beta}_{NC}(\gamma)}$$

where

$$\underline{\beta}_{NC}(\gamma) = \beta_{NC}(\gamma, \underline{R}(\epsilon))$$

will deter collusion. This rule is however excessively tight if all agents choose the right project (and expect others to do so), and therefore is not optimal.

A third option would be to extend the flexibility of the CAR rule to make it explicitly conditional on the average return on capital (if the latter can be estimated). Define the estimated return on capital \widehat{R} and consider the following "extended" flexible CAR rule:

$$\begin{aligned} \text{if } \widehat{R} &\approx \overline{R}(\epsilon) \text{ use } CAR = \frac{\Lambda_{NC}}{\overline{\beta}_{NC}(\gamma)} \\ \text{if } \widehat{R} &\approx \underline{R}(\epsilon) \text{ use } CAR = \frac{\Lambda_{NC}}{\underline{\beta}_{NC}(\gamma)} \end{aligned}$$

This rule will deter the collusion equilibrium and will not be excessively restrictive. Indeed it makes the capital adequacy requirement tighter when the return on capital is lower (which may happen towards the end of a boom). The fundamental reason for making the capital regulation conditional on the return on capital is general in moral hazard economies. Indeed, moral hazard is higher when the return on capital is lower, making it more likely to generate collusive contracts. This depresses further the return to capital when productive externalities are present in the economy, leading to an even more severe moral hazard problem at the level of individual contracts and therefore the necessity of tighter constraints on banks to eliminate the collusive behaviors. In the economy with externalities, this dependence becomes even stronger. It may however not be practical to do so, as the expected return on future projects may not be measured credibly.

A fourth option could be to keep the initial capital requirement, but to impose that a portion μ of bank capital is invested in an alternative technology such as T bills if $\widehat{R} \approx \underline{R}(\epsilon)$. Indeed, taking explicitly the dependence of the equilibrium banking rates on the stock of bank capital K_B consider the portion $\bar{\mu}$ of bank capital invested in T bills is such that

$$\frac{\Lambda_C}{\underline{\beta}_C(\gamma, (1 - \bar{\mu})K_B)} = \frac{\Lambda_{NC}}{\overline{\beta}_{NC}(\gamma, K_B)}$$

Then the flexible CAR rule:

$$CAR = \frac{\Lambda_{NC}}{\overline{\beta}_{NC}(\gamma, K_B)}$$

plus the imposition of a portion $\mu > \bar{\mu}$ of bank capital is invested in T bills if $\widehat{R} \approx \underline{R}(\epsilon)$, will also deter the collusive equilibria. Hence the rule would specify investments in Treasury bills when there is a presumption of excessive investments in non-productive projects.

VIII. Political Economy of Banking Supervision

An important element of the previous discussion relates to the importance of regulatory forbearance and the rent $k\Delta B$ that the banking sector derives from it. So far we assumed that the quality of banking supervision as summarized by the parameter k was exogenous. As discussed in the introduction and in section II, the efficiency of banking supervision is however likely to depend on political economy considerations. In this section, we extend our analysis and characterize the agents' preferences over the quality of banking supervision.

For this, let us return to an economy with no externalities (ie. $\epsilon = 0$). Assume that the quality of banking supervision $1 - k$ is constrained to be in an interval $[1 - k_{\max}, 1 - k_{\min}]$, or alternatively, that the degree of regulatory forbearance $k \in [k_{\min}, k_{\max}]$. We then characterize the equilibrium utility of each type of agents: $U_E(k)$ for entrepreneurs, $U_B(k)$ for banks and $U_I(k)$ for the uninformed investors as function of k (the degree of regulatory forbearance). The structure of preferences depends on the type of market equilibria that agents anticipate. To understand the basic intuition, notice that:

$$\frac{\partial \Lambda_{NC}}{\partial k} = -\frac{\partial \Phi_{NC}}{\partial k} = \Delta B > 0 \quad (17)$$

When contracts are collusion-proof, a higher degree of regulatory forbearance redistributes the financial return from uninformed investors to the bank. Furthermore, in a partial equilibrium at a given β , a higher financial return for the bank reduces the borrowing capacity of the entrepreneur (because the cost of bank capital β exceeds the market cost of capital γ):

$$\frac{\partial V_{NC}}{\partial k} = \frac{\partial \Lambda_{NC}}{\partial k} \cdot \left(\frac{1}{\gamma} - \frac{1}{\beta} \right) > 0$$

Consider now a collusion contract. A higher degree of regulatory forbearance increases the private benefits of undertaking the bad project received by the bank. This has however no impact on the financial return received by uninformed investors:

$$\frac{\partial \Lambda_C}{\partial k} = (1 - q)\Delta B > 0 \text{ and } \frac{\partial \Phi_C}{\partial k} = 0 \quad (18)$$

The partial equilibrium effect is thus to increase the borrowing capacity of the entrepreneur: $I_C = \frac{1}{V_C}$

$$\frac{\partial V_C}{\partial k} = -\frac{1}{\beta} \cdot \frac{\partial \Lambda_C}{\partial k} < 0$$

Finally, we also know from proposition 2 that a lower quality of supervision makes collusion more likely:

$$\Psi'(k) < 0$$

We now have the main ingredients to solve the political general equilibrium, where

$$\beta_j(\gamma, k) = \frac{\Lambda_j(k)}{1 - \frac{\Phi_j(k)}{\gamma}} \left[1 + \frac{1}{K_B} \right].$$

- *Collusion proof market equilibrium regime*

Consider first the case where agents anticipate to be in a collusion-proof regime. This will occur when the cost of funds γ is high and that all financial contracts are collusion proof.

This will occur indeed when $\gamma \geq \bar{\gamma}(k)$ with $\bar{\gamma}(k)$ the lowest cost of funds such that an equilibrium with collusion proof contracts prevails:

$$\Psi \cdot \bar{\gamma}(k) = \beta_{NC}(\bar{\gamma}(k), k)$$

It is possible to show that, for a given value of γ , a collusion proof regime occurs when (see appendix for a formal proof):

$$k < \bar{k}(\gamma) \quad \text{with } \bar{k}'(\gamma) > 0$$

Hence, when the cost of capital is higher, a collusion-proof regime can be sustained for a higher degree of regulatory forbearance.

Taking into account the general equilibrium effect on the cost of bank capital, the utilities of each category of agents become:

$$\begin{aligned} U_E(k) &= b \cdot I_{NC}(k) = \frac{b}{1 - \frac{\Phi_{NC}(k)}{\gamma}} [K_B + 1] \\ U_B(k) &= \Lambda_{NC}(k) \cdot I_{NC}(k) = \frac{\Lambda_{NC}(k)}{1 - \frac{\Phi_{NC}(k)}{\gamma}} [K_B + 1] \\ U_I(k) &= \Phi_{NC}(k) \cdot I_{NC}(k) = \frac{\Phi_{NC}(k)}{1 - \frac{\Phi_{NC}(k)}{\gamma}} [K_B + 1] \end{aligned} \quad (19)$$

Using (19), and (17) simple differentiation immediately implies that $\frac{U'_E(k)}{U_E(k)} < 0$, $\frac{U'_B(k)}{U_B(k)} \geq 0$, and $\frac{U'_I(k)}{U_I(k)} < 0$ (see appendix for a formal proof).

Typically better supervision quality (ie. a lower value of k) unambiguously improves the borrowing capacity I_{NC} of the entrepreneur by reducing the rent that must be left to the bank.

Indeed

$$\frac{1}{I_{NC}} \frac{\partial I_{NC}}{\partial k} = \frac{\frac{1}{\gamma} \frac{\partial \Phi_{NC}}{\partial k}}{1 - \frac{\Phi_{NC}}{\gamma}} < 0$$

Hence entrepreneurs unambiguously prefer a higher supervision quality.

Investors also prefer a higher supervision quality, because better supervision, besides increasing total investment, also improves the proportion of profits pledged to uninformed investors as:

$$\frac{\partial \Phi_{NC}}{\partial k} = -\Delta B < 0$$

In the case of banks, the overall effect of better supervision is ambiguous:

$$\frac{U'_B(k)}{U_B(k)} = \underbrace{\frac{\frac{\partial \Lambda_{NC}}{\partial k}}{\Lambda_{NC}}}_{+} + \underbrace{\frac{\frac{1}{\gamma} \frac{\partial \Phi_{NC}}{\partial k}}{1 - \frac{\Phi_{NC}}{\gamma}}}_{-} \quad (20)$$

Higher supervision (associated to a lower value of k) first reduces the rents left to banks to prevent collusion (the first term in (20)). This has a negative effect on the banking sector payoff. On the other hand, higher supervision also increases the borrowing capacity of entrepreneurs, leading to a higher demand for banking capital and a positive effect on the equilibrium return $\beta_{NC}(\gamma)$ for banks (the second term in (20)). This second effect therefore increases the banking sector payoff.

When the return on physical capital R is large enough, the expected pledgeable return on the project net of monitoring cost $\Lambda_{NC} + \Phi_{NC}$ exceeds the opportunity cost of funds γ and the positive effect of supervision quality on overall investment (which is positively related to the return on bank capital) outweighs the negative effect on the share of profits pledged to the bank. In such a case banks also prefer a high supervision quality.

- *Collusion contracts market equilibrium regime:*

Consider now the case where agents anticipate to be in a collusion regime. This will occur when the cost of funds γ is relatively low and collusion-contracts may enhance the borrowing capacity.

More specifically, this will occur when the cost of funds γ is such that $\gamma \leq \underline{\gamma}(k)$ with $\underline{\gamma}(k)$ the highest cost of funds such that an equilibrium with collusion contracts prevails:

$$\Psi \cdot \underline{\gamma}(k) = \beta^C(\underline{\gamma}(k), k)$$

It follows that for a given value of γ , a collusion regime occurs when (see appendix for a formal proof):

$$k > \underline{k}(\gamma) \quad \text{with } \underline{k}'(\gamma) > 0$$

Consider again the utility of each group of agents as function of k (the degree of regulatory forbearance) when taking into account the equilibrium return on bank capital $\beta_C(\gamma)$:

$$\begin{aligned} U_E(k) &= bI_C = \frac{b}{1 - \frac{\Phi_C}{\gamma}} \cdot [K_B + 1] \\ U_B(k) &= \Lambda_C I_C = \frac{\Lambda_C}{1 - \frac{\Phi_C}{\gamma}} \cdot [K_B + 1] \\ U_I(k) &= \Phi_{NC} I_{NC} = \frac{\Phi_C}{1 - \frac{\Phi_C}{\gamma}} \cdot [K_B + 1] \end{aligned} \tag{21}$$

It follows immediately from (21) that: $\frac{U'_E(k)}{U_E(k)} = 0$, $\frac{U'_B(k)}{U_B(k)} = \frac{\frac{\partial \Lambda_C}{\partial k}}{\Lambda_C} > 0$, and: $\frac{U'_I(k)}{U_I(k)} = 0$ (see appendix for a formal proof).

In the general equilibrium, entrepreneurs and uniformed investors are indifferent with respect to the quality of banking supervision while banks are opposed to better supervision.

As already discussed, conditional on a collusion contract, an entrepreneur would like to reduce the costs of adopting collusion contracts, including the cost of a bank audit, at a given cost of banking capital. This indeed allows more financial leverage and a higher borrowing capacity. In equilibrium though, the higher investment capacity leads to a higher demand for banking capital which in turn leads to an increase in the return to banking capital. Given a fixed supply of banking capital, this general equilibrium effect exactly offsets the benefit of higher financial leverage, and entrepreneurs are indifferent about the quality of banking supervision.

Similarly, in the case of uninformed investors, these higher private benefits of banks associated with a higher k do not lower their expected financial return as the bank is incentivized only when the quality of supervision is high. Hence the financial return of external finance Φ_C per unit of investment is not affected.

Finally, it is clear that banks will prefer a low quality of supervision as they obtain larger private benefits while the total investment is unchanged.

- *Mixed market equilibrium regime:*

When $k \in [\underline{k}(\gamma); \bar{k}(\gamma)]$, the banking market equilibrium is such that $\gamma \in [\underline{\gamma}(k), \bar{\gamma}(k)]$, and a unique mixed equilibrium exists in which a proportion $\nu(k)$ of firms chooses contracts that are collusion-proof, and a proportion $1 - \nu(k)$ chooses partial-collusion contracts. In such an equilibrium the equilibrium rate of return of banks is $\beta = \Psi(k)\gamma$ and $\nu(k)$ is given by the banking capital market equilibrium :

$$\frac{\nu\Lambda_{NC}(k) + (1 - \nu)\Lambda_C(k)}{\beta}I(k) = K_B, \text{ with } I(k) = \frac{1}{1 - \frac{\Phi_{NC}(k)}{\gamma} - \frac{\Lambda_{NC}(k)}{\beta}}$$

and $\beta = \Psi(k)\gamma$

¹⁵. It is then immediate to see that

$$\begin{aligned} U_E(k) &= bI(k) = \frac{b}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C(k)}{\Psi(k)\gamma}} \\ U_B(k) &= \beta K_B = \Psi(k)\gamma K_B \\ U_I(k) &= \frac{\nu(k)\Phi_{NC}(k) + (1 - \nu(k))\Phi_C}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C(k)}{\Psi(k)\gamma}} \end{aligned} \tag{22}$$

Note that

$$\begin{aligned} \frac{1}{I(k)} &= 1 - \frac{1}{\gamma} \left[\Phi_{NC}(k) + \frac{\Lambda_{NC}(k)}{\Psi(k)} \right] \\ &= 1 - \frac{1}{\gamma} \frac{\Lambda_{NC}(k)\Phi_C - \Lambda_C(k)\Phi_{NC}(k)}{\Lambda_{NC}(k) - \Lambda_C(k)} \end{aligned}$$

¹⁵Note that by definition of $\Psi(k)$, at $\beta = \Psi(k)\gamma$ one has also

$$\begin{aligned} I(k) &= \frac{1}{1 - \frac{\Phi_{NC}(k)}{\gamma} - \frac{\Lambda_{NC}(k)}{\beta}} \\ &= \frac{1}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C(k)}{\beta}} \end{aligned}$$

Therefore $I(k)$ is increasing in k . It follows that

$$U'_E(k) = bI'(k) > 0$$

In the mixed regime, entrepreneurs are in favor of more relaxed banking supervision (ie. larger values of k) as this increases their financial leverage.

For banks, we immediately have

$$U'_B(k) = \Psi'(k) \gamma K_B < 0$$

Interestingly, in the mixed equilibrium, banks are in favor of better banking supervision. To get an intuition of this result, it is interesting to rewrite the banks' payoffs as

$$U_B(k) = [\nu(k)\Lambda_{NC}(k) + (1 - \nu(k))\Lambda_C(k)]I(k) = \beta(k)K_B$$

In this regime, a reduction of k associated to better banking supervision has three effects on banks' payoffs. First, better supervision reduces the financial leverage and scale of investment $I(k)$ and therefore leads to a reduced payoff to the banks. Also increased costs of audits reduce the private benefits of banks both for collusion proof contracts $\Lambda_{NC}(k)$ and for collusion contracts $\Lambda_C(k)$. Finally, better banking supervision leads also to a larger proportion of collusion proof contracts $\nu(k)$ which provide in turn higher pledgeable income per unit of investment to the banks than under collusion contracts (as $\Lambda_{NC}(k) - \Lambda_C(k) > 0$). Indeed, it is simple to see that $\nu(k)$ is decreasing in k (see the appendix) It turns out that in the mixed regime, conditions are such that this last compositional effect more than offset the first two effects and banks are in favour of better supervision in this regime.

Finally, consider the position of uniformed investors in the mixed regime. One gets

$$U_I(k) = [\nu(k)\Phi_{NC}(k) + (1 - \nu(k))\Phi_C] I(k)$$

It can be shown that in the mixed regime $U_I(k)$ is increasing in k and uniformed investors are in favor of relaxed supervision on banks (see the appendix). The intuition for this is again the fact that a better quality in banking supervision (ie. a reduced value of k) again has three effects on the investor's payoff. First, there is the positive effect that it increases the return to investment $\Phi_{NC}(k)$ for collusion proof contracts. Second however, there is the negative effect that it reduces the financial leverage and the scale of investment $I(k)$. Finally there is the composition effect that it increases the proportion of collusion proof contracts. As $\Phi_{NC}(k) < \Phi_C(k)$, this compositional effect also affects negatively the utility of the investor. It turns out that the two negative effects (scale and compositional) offset the first positive return effect. Investors are therefore in favor of relaxed banking supervision and a larger value of k .

Taking together the previous discussion, one has the following proposition on the different groups political preferences for the quality of banking regulation.

Proposition 12 *The political preferences of agents for the quality of banking regulation are the following:*

- For entrepreneurs:

$$\begin{aligned} & \text{collusion proof regime (ie. } k < \bar{k}(\gamma) \text{): } U'_E(k) \leq 0 \\ & \text{mixed equilibrium regime (ie. } k \in [\bar{k}(\gamma); \underline{k}(\gamma)] \text{): } U'_E(k) \geq 0 \\ & \text{collusion regime (ie. } k > \underline{k}(\gamma) \text{): } U'_E(k) = 0 \end{aligned}$$

- For uniformed investors:

$$\begin{aligned} & \text{collusion proof regime (ie. } k < \bar{k}(\gamma) \text{): } U'_I(k) \leq 0 \\ & \text{mixed equilibrium regime (ie. } k \in [\bar{k}(\gamma); \underline{k}(\gamma)] \text{): } U'_I(k) \geq 0 \\ & \text{collusion regime (ie. } k > \underline{k}(\gamma) \text{): } U'_I(k) = 0 \end{aligned}$$

- For banks :

$$\begin{aligned} & \text{collusion proof regime (ie. } k < \bar{k}(\gamma) \text{): } U'_B(k) < 0 \text{ when } R > R^* \\ & \text{mixed equilibrium regime (ie. } k \in [\bar{k}(\gamma); \underline{k}(\gamma)] \text{): } U'_B(k) \leq 0 \\ & \text{collusion regime (ie. } k > \underline{k}(\gamma) \text{): } U'_B(k) > 0 \end{aligned}$$

The different preferences are depicted in Figures (5a) (5b) and (5c). It follows that agents do not have unimodal preferences about the quality of banking regulation. An interesting implication of this is the fact that depending on the structure of the audit technology $[k_{\min}, k_{\max}]$ and the value of the cost of funds γ , one may end up with very different political support for or against better quality of banking supervision.

(Figures 5a, 5b, and 5c about here)

For instance when $k_{\min} > \underline{k}(\gamma)$, the political incentives in the economy are strongly in favor of relaxed banking auditing, as two groups of agents(entrepreneurs and investors) are indifferent and banks are in favor of the minimum possible cost of auditing $1 - k_{\max}$. Note that such situation can also occur when $k_{\min} > \bar{k}(\gamma)$ and that entrepreneurs and investors have enough political power to impose their political positions. In such a case again, the political outcome is likely to be a weak quality of banking supervision k_{\max} . The economy will end up in a market equilibrium with collusion financial contracts (full or partial).

On the opposite if $k_{\max} < \bar{k}(\gamma)$, and the return to physical capital R is large enough, there is again a consensus in society to pick the most stringent banking supervision level k_{\min} . In such an economy the market equilibrium will only have collusion proof contracts.

Whether we end up in a situation with political support for relaxed banking supervision or a situation with stricter financial supervision, depends on the level of the interest rate γ .

For low interest rates $\gamma < \underline{k}^{-1}(k_{\min})$, the political equilibrium is likely to support weak banking supervision and a collusive equilibrium. On the opposite, for high interest rates $\gamma > \bar{k}^{-1}(k_{\max})$, the economy will be in favor of stricter banking supervision and the

banking capital market is characterized by collusion proof contracts. These political economy forces reinforce the effect of lower interest rates on risk taking discussed in the sections I and II, and is consistent with the existing empirical evidence presented in section II. When interest rates are low, incentives for risk taking are stronger, In such environments, the political economy tends to weaken the quality of supervision. This, in turn, favors more risk taking, and tends to reduce the effectiveness of a given capital adequacy ratios in mitigating risk taking as demonstrated in proposition 10.

What are the implications for financial regulation? We have shown that, in absence of productive externalities, the optimal capital adequacy rule is given by $CAR^* = \frac{\Lambda_{NC}}{\beta_{NC}(\gamma, K_B)}$ which depends positively on k . Since the political process will tend to weaken the quality of supervision when interest rates are low, this implies that the optimal capital adequacy rule will have to be tightened as supervision quality worsens during the boom.

IX. Conclusion

The global financial crisis that started as a consequence of the subprime crisis in the US has heightened the importance of high quality banking supervision and adequate regulation. This paper develops a theory of risk taking by financial institutions and of collusive behaviors in presence of imperfect banking supervision to study the interplay between capital regulations, their optimal macroprudential characteristics, and the quality of bank supervision. When the interest rate and/or the return on investment are low, financial institutions and borrowers have stronger incentives to undertake projects with negative net present value. Because banking supervision is imperfect, the market equilibrium does not rule out the choice of such projects if it maximizes expected returns ex-ante. There is a need to regulate bank capital because of a pecuniary externality - the market outcome is not necessarily efficient as individual agents do not take into account the effect on the equilibrium return on bank capital of the choice of non productive projects and its impact on collusion between bankers and borrowers.

We show that, in this economy: (i) a fixed capital adequacy rule is often not socially optimal (because it is either ineffective or too tight); (ii) the optimal capital adequacy rule is *pro-cyclical* with respect to the interest rate (a robust consequences of moral hazard models of banking) but *counter-cyclical* with respect to the return on investment, and should be tighter the lower the efficiency of the banking system and the lower the quality of supervision. However, even though capitalization should optimally decrease (or leverage increase) as interest rates decline, the wedge between the market equilibrium leverage of banks and the socially optimal one becomes wider (and excessive risk taking rises), calling for stronger scrutiny of capital adequacy ratios in low interest rate environment.

We consider several extensions of our model. First, we allow for the possibility of productive or aggregate demand externalities. If these externalities are strong enough, the regulation of capital may become ineffective in mitigating excessive risk taking by bankers. This is because (self-fulfilling) expectations play a crucial role in determining investment choices. We show that for regulations to be effective in such an environment, the regulatory capital ratio must be complemented by a constraint on portfolio allocation – such as requiring a minimum investment in a safe asset yielding the safe interest rate (or

policy rate of the monetary authority) to make bank capital scarcer. Second, we study the political economy of supervision by endogenizing its quality. We uncover a new channel of endogenous risk taking cycles by showing that the political economy exacerbates financial cycles through the pressures it generates on the quality of supervision. When interest rates are low and/or the rate of return on projects are low, agents in the economy tend to prefer a weak quality of supervision to maximize the benefits of leverage (even if risk taking is more likely to be excessively high under these circumstances). As a result, bank monitoring declines, the capital adequacy ratio becomes less effective in ensuring social optimality, and risk taking increases further. Conversely, when interest rates are high and/or the return on projects is high, the market equilibrium is less likely to be inefficient, and pressures to weaken the quality of supervision are less strong (because weaker supervision would have the only effect of generating higher rents for bankers). A general implication of our theory is that choices regulation and supervision should be studied jointly, and even more so in environment in which the latter is less at arms-length from political pressures, that could arise from lobbying or from broader political forces. Our model also suggests that the implementation of the Basel III countercyclical capital buffers would have to involve not only rules but also careful judgement in interpreting indicators of risk-taking and incentives of market participants (banks, borrowers, and investors), and how they interact with each other and determine the aggregate market outcome.

Appendix

- **Proof of proposition 1:**

(A) Consider the optimal collusion proof contract with investment size I_{NC} . Combining the incentive constraints of the entrepreneur (1) and of the bank (2), the minimum ex-post payoff that needs to be left to the bank in order to induce monitoring with no collusion is given by:

$$R_B = \frac{c + k\Delta B}{p} \cdot I_{NC}$$

Hence the expected pledgeable amount that has to be left to the bank is:

$$pR_B - cI_{NC} = k\Delta B \cdot I_{NC} = \Lambda_{NC} \cdot I_{NC}$$

Using the participation constraint of the bank (3), one then obtains the size of bank loans:

$$I_B = \frac{\Lambda_{NC}}{\beta} \cdot I_{NC}$$

The pledgeable income left to uninformed investors is:

$$R_I = RI_{NC} - R_B - R_E = \left(R - \frac{b}{p} - \frac{c + k\Delta B}{p} \right) I_{NC}$$

The size of the uninformed investors investment is obtained from the participation constraint of the uninformed investors (4):

$$I_I = \frac{p}{\gamma} R_I = \frac{\Phi_{NC}}{\gamma} \cdot I_{NC}$$

The project size under the optimal collusion contract satisfies:

$$\begin{aligned} I_{NC} &= 1 + I_B + I_I \\ &= 1 + \frac{\Lambda_{NC}}{\beta} \cdot I_{NC} + \frac{\Phi_{NC}}{\gamma} \cdot I_{NC} \end{aligned}$$

From which we get:

$$I_{NC} = \frac{1}{1 - \frac{\Phi_{NC}}{\gamma} - \frac{\Lambda_{NC}}{\beta}} \equiv \frac{1}{V_{NC}(\beta, \gamma)}$$

(B) Consider now the optimal partial collusion contract with investment size I_C . Following the same line of reasoning, and using the incentive constraints of the entrepreneur (??) and of the bank (5a), we characterize the minimum ex-post payoff that needs to be left to the bank in order to induce monitoring in the state of with perfect auditing:

$$R_B = \frac{c}{p} \cdot I_C$$

Now the expected pledgeable amount that has to be left to the bank is given by $\tilde{p}R_B - qcI_C + (1 - q)k\Delta BI_C$. The bank is paying the monitoring cost cI_C only in the

state of nature with perfect auditing while it enjoys bribes $k\Delta BI_C$ in the state of nature without perfect auditing. This can be written as:

$$\begin{aligned}\tilde{p}R_B - qcI_C + (1 - q)k\Delta BI_C &= (1 - q)k\Delta B \cdot I_C \\ &= \Lambda_C \cdot I_C\end{aligned}$$

Using then (6), the size of bank loans is given by:

$$I_B = \frac{\Lambda_C}{\beta} \cdot I_C$$

Similarly, under partial collusion, the pledgeable income that is left to uninformed investors is:

$$R_I = RI_C - R_B - R_E = \left[R - \frac{c + b + k_L \Delta B}{\Delta p} \right] \cdot I_C$$

From (7), one obtains the size of the uninformed investors investment:

$$I_I = \frac{\tilde{p}}{\gamma} R_I = \frac{\Phi_C}{\gamma} \cdot I_{NC}$$

Using $I_C = 1 + I_B + I_I$ provides immediately:

$$I_C = \frac{1}{1 - \frac{\Phi_{NC}}{\gamma} - \frac{\Lambda_{NC}}{\beta}}$$

QED.

- **Proof of proposition 2:** The entrepreneur will choose the partial-collusion contract if and only if :

$$U_E^C = bI_C > U_E^{NC} = bI_{NC}$$

which, using proposition 1 and assumptions A, B, and C is equivalent to:

$$\beta \geq \gamma \cdot \Psi$$

where $\Psi = \frac{\Lambda_{NC} - \Lambda_C}{\Phi_C - \Phi_{NC}}$ and

$$\Psi(k, \Delta B, c) = \frac{\Lambda_{NC} - \Lambda_C}{\Phi_C - \Phi_{NC}} = \frac{qk\Delta B}{qk\Delta B - (1 - q)p \cdot \left(R - \frac{b+c+k\Delta B}{p} \right)}$$

and simple differentiation of the function $\Psi(k, \Delta B, c)$ shows immediately that it is also a decreasing function of k , ΔB , and c . **QED.**

- **Proof of Proposition 3 and Corollary 4:**

In regime $j \in \{NC, C\}$, the equilibrium return on bank capital $\beta_j(\gamma)$ must be given by the following expression:

$$\beta_j(\gamma) = \frac{\Lambda_j}{1 - \frac{\Phi_j}{\gamma}} \left[1 + \frac{1}{K_B} \right]$$

which is a decreasing function of the return on uninformed capital γ .

Define then the two thresholds $\bar{\gamma}$ and $\underline{\gamma}$ given respectively by

$$\begin{aligned} \beta_{NC}(\bar{\gamma}) &= \bar{\gamma} \cdot \Psi \\ \beta_C(\underline{\gamma}) &= \underline{\gamma} \cdot \Psi \end{aligned}$$

It follows that

$$\begin{aligned} \bar{\gamma} &= \Phi_{NC} + \frac{\Lambda_{NC} \left[1 + \frac{1}{K_B} \right]}{\Psi}, \\ \underline{\gamma} &= \Phi_C + \frac{\Lambda_C \left[1 + \frac{1}{K_B} \right]}{\Psi}. \end{aligned}$$

i) First, note that $\tilde{\gamma} < \underline{\gamma}$. Indeed:

$$\tilde{\gamma} < \underline{\gamma} \Leftrightarrow \Phi_C + \frac{(\Phi_C - \Phi_{NC})\Lambda_C}{\Lambda_{NC} - \Lambda_C} < \Phi_C + \frac{\Lambda_C \left[1 + \frac{1}{K_B} \right]}{\Psi}$$

It is easy to see that the second inequality is satisfied as it is equivalent to

$$\frac{(\Phi_C - \Phi_{NC})\Lambda_C}{\Lambda_{NC} - \Lambda_C} < \frac{(\Phi_C - \Phi_{NC})\Lambda_C}{\Lambda_{NC} - \Lambda_C} \left[1 + \frac{1}{K_B} \right]$$

which is always true.

Similarly it is easy to show that $\bar{\gamma} > \underline{\gamma}$. Indeed,

$$\bar{\gamma} > \underline{\gamma} \Leftrightarrow \Phi_{NC} + \frac{\Lambda_{NC} \left[1 + \frac{1}{K_B} \right]}{\Psi} > \Phi_C + \frac{\Lambda_C \left[1 + \frac{1}{K_B} \right]}{\Psi}$$

Again the second inequality is equivalent to

$$\frac{(\Lambda_{NC} - \Lambda_C) \left[1 + \frac{1}{K_B} \right]}{\Psi} > \Phi_C - \Phi_{NC}$$

or

$$(\Phi_C - \Phi_{NC}) \left[1 + \frac{1}{K_B} \right] > \Phi_C - \Phi_{NC}$$

which is always true.

ii) if $\gamma > \bar{\gamma}$, then $\beta_C(\gamma) < \gamma\Psi$. It follows that only a collusion proof equilibrium is possible in such region with a bank return $\beta_{NC}(\gamma) < \gamma\Psi$.

iii) Similarly when $\gamma < \underline{\gamma}$, then as $\bar{\gamma} > \underline{\gamma}$ one has $\beta_{NC}(\gamma) > \gamma\Psi$. It follows that only a collusion equilibrium is possible in such region with a bank return $\beta_C(\gamma) > \gamma\Psi$.

iv) Assume now that $\gamma \in [\underline{\gamma}, \bar{\gamma}]$. The proportion of firms ν of firms choosing collusion-proof contracts is given by the equilibrium on the credit market, and the condition that firms must be indifferent between the collusion-proof contract and the partial collusion contract in equilibrium:

$$\begin{aligned} K_B &= [\nu I_B^{NC} + (1 - \nu) I_B^C] \\ \beta &= \gamma \cdot \Psi \end{aligned}$$

From $\beta = \gamma \cdot \Psi$, we get $V_{NC} = V_C$. Hence in the mixed regime, total investment size is the same under both types of contracts

$$I^{NC} = I^C = \frac{1}{1 - \frac{\Phi_{NC}}{\gamma} - \frac{\Lambda_{NC}}{\gamma\Psi}} \quad (23)$$

Substituting (23), the equilibrium condition on the bank capital market writes as:

$$K_B = \frac{\nu\Lambda_{NC} + (1 - \nu)\Lambda_C}{\gamma\Psi - \Psi\Phi_{NC} - \Lambda_{NC}}$$

which gives

$$\nu = \nu^*(\gamma) = \frac{[\gamma\Psi - \Psi\Phi_{NC} - \Lambda_{NC}]K_B - \Lambda_C}{\Lambda_{NC} - \Lambda_C}$$

which is an increasing function of γ . The mixed equilibrium prevails when $\nu^*(\gamma) \in [0, 1]$. Straightforward computations show that $\nu^*(\underline{\gamma}) = 0$ while $\nu^*(\bar{\gamma}) = 1$. Hence the mixed equilibrium prevails for $\gamma \in [\underline{\gamma}, \bar{\gamma}]$.

v) Note also that for all $\gamma > \bar{\gamma}$, or $\gamma < \underline{\gamma}$, the equilibrium interest rate β is given by

$$\beta_j(\gamma) = \frac{\Lambda_j}{1 - \frac{\Phi_j}{\gamma}} \left[1 + \frac{1}{K_B} \right] \quad \text{for } j \in \{C, NC\}$$

which is a decreasing function of the cost of external finance γ

and ii) for $\gamma \in [\underline{\gamma}, \bar{\gamma}]$, the equilibrium interest rate $\beta = \gamma \cdot \Psi$ which is an increasing function of the cost of external finance γ . **QED.**

• **Proof of proposition 5 on social optimality**

i) To characterize whether collusion contracts are socially better than collusion proof contracts, one needs to compare

$$\begin{aligned} \frac{\Lambda_{NC} + \Phi_{NC} + b}{V_{NC}(\gamma, \beta_{NC}(\gamma))} &= (\Lambda_{NC} + \Phi_{NC} + b) \frac{\beta_{NC}(\gamma)}{\Lambda_{NC}} K_B \\ &= \frac{(\Lambda_{NC} + \Phi_{NC} + b)}{1 - \frac{\Phi_{NC}}{\gamma}} (1 + K_B) \end{aligned}$$

to

$$\begin{aligned} \frac{\Lambda_C + \Phi_C + b}{V_C(\gamma, \beta_C(\gamma))} &= (\Lambda_C + \Phi_C + b) \frac{\beta_C(\gamma)}{\Lambda_C} K_B \\ &= \frac{(\Lambda_C + \Phi_C + b)}{1 - \frac{\Phi_C}{\gamma}} (1 + K_B) \end{aligned}$$

therefore the collusion contract is socially optimal if and only if

$$\frac{(\Lambda_C + \Phi_C + b)}{1 - \frac{\Phi_C}{\gamma}} \geq \frac{(\Lambda_{NC} + \Phi_{NC} + b)}{1 - \frac{\Phi_{NC}}{\gamma}}$$

or

$$[\gamma - \Phi_C] (\Lambda_{NC} + \Phi_{NC} + b) \leq [\gamma - \Phi_{NC}] (\Lambda_C + \Phi_C + b)$$

or

$$\gamma \leq \gamma^* = \frac{\Phi_C \Lambda_{NC} - \Phi_{NC} \Lambda_C + b [\Phi_C - \Phi_{NC}]}{[\Lambda_{NC} + \Phi_{NC}] - [\Lambda_C + \Phi_C]}$$

given that $\Phi_C > \Phi_{NC}$ and $\Lambda_{NC} > \Lambda_C$, it follows that $\gamma^* > 0$.

ii) Now we now that:

$$\underline{\gamma} = \Phi_C + \frac{\Lambda_C \left[1 + \frac{1}{K_B}\right] [\Phi_C - \Phi_{NC}]}{\Lambda_{NC} - \Lambda_C}$$

From this it follow that $\gamma^* < \underline{\gamma}$ if and only if

$$[\underline{\gamma} - \Phi_C] (\Lambda_{NC} + \Phi_{NC} + b) > [\underline{\gamma} - \Phi_{NC}] (\Lambda_C + \Phi_C + b)$$

or after substitutions:

$$\left[1 + \frac{1}{K_B}\right] \frac{\Lambda_C}{\Lambda_{NC} - \Lambda_C} (\Lambda_{NC} + \Phi_{NC} - \Lambda_C - \Phi_C) > (\Lambda_C + \Phi_C + b)$$

This is satisfied when K_B is small enough (bank capital is sufficiently scarce) **QED**.

• **Proof of proposition 6:**

i) Suppose that $\beta \geq \frac{\Lambda_{NC}}{CAR}$ then the CAR is binding and in such a case, the maximum payment to the investor declines and is given by:

$$R_I = \left[R - \frac{b}{p}\right] I - R_B^1 < \left[R - \frac{b}{p}\right] I - R_B^2$$

The size of the investment is given by:the relation

$$I = 1 + I_B + I_I = 1 + CAR \cdot I + \frac{pR_I}{\gamma}$$

which gives after substitution of $R_B^1 = \frac{\beta CAR + c}{p} I$, the following value of total investment

$$I_{CAR}^N = \frac{1}{V_{CAR}^N(\beta, \gamma)}$$

where:

$$V_{CAR}^N(\beta, \gamma) = 1 - \frac{\Phi_{CAR}^{NC}}{\gamma} - CAR$$

and

$$\Phi_{CAR}^{NC} = p \left[R - \frac{b}{p} - \frac{c + \beta CAR}{p} \right]$$

Formally, the optimal size of the investment declines (compared to the case without the CAR) if and only if: $V_{CAR}^N(\beta, \gamma) > V_{NC}(\beta, \gamma)$

This equivalent to :

$$CAR + \frac{\Phi_{CAR}^{NC}}{\gamma} < \frac{\Phi_{NC}}{\gamma} + \frac{\Lambda_{NC}}{\beta} \quad (24)$$

The condition is met if the capital adequacy ratio is binding. Indeed:

$$CAR + \frac{\Phi_{CAR}^{NC}}{\gamma} = \frac{p}{\gamma} \left[R - \frac{b}{p} - \frac{c}{p} \right] + CAR \left(1 - \frac{\beta}{\gamma} \right)$$

And:

$$\frac{\Phi_{NC}}{\gamma} + \frac{\Lambda_{NC}}{\beta} = \frac{p}{\gamma} \left[R - \frac{b}{p} - \frac{c}{p} \right] + \frac{\Lambda_{NC}}{\beta} \left(1 - \frac{\beta}{\gamma} \right)$$

As $\beta \geq \frac{\Lambda_{NC}}{CAR}$, the capital adequacy ratio rule is binding (ie. $\frac{\Lambda_{NC}}{\beta} < CAR$), and (24) holds.

ii) When $\beta < \frac{\Lambda_{NC}}{CAR}$, the CAR is not binding and therefore the optimal collusion proof contract is just as if the CAR does not exist (ie. the optimal investment scale is $I_{NC}(\beta, \gamma) = \frac{1}{V_{NC}(\beta, \gamma)}$). **QED.**

• **Proof of proposition 7:**

i) Suppose that $\beta > \frac{\Lambda_C}{CAR}$ then the optimal collusion proof contract is constrained by the CAR and by the same token as in proposition 6, on may deduce that the optimal size of the investment under such contract is given by:

$$I_{CAR}^C = \frac{1}{V_{CAR}^C(\beta, \gamma)}$$

where:

$$V_{CAR}^C(\beta, \gamma) = 1 - \frac{\Phi_{CAR}^C}{\gamma} - CAR$$

and

$$\Phi_{CAR}^C = \tilde{p} \left[R - \frac{b}{p} - \frac{qc - (1-q)k\Delta B + \beta CAR}{\tilde{p}} \right]$$

Formally, the optimal size of the investment declines (compared to the case without the CAR) if and only if: $V_{CAR}^C(\beta, \gamma) > V_C(\beta, \gamma)$

This is equivalent to :

$$CAR + \frac{\Phi_{CAR}^C}{\gamma} < \frac{\Phi_C}{\gamma} + \frac{\Lambda_C}{\beta} \quad (25)$$

The condition is met if the capital adequacy ratio is binding. Indeed:

$$CAR + \frac{\Phi_{CAR}^C}{\gamma} = \frac{\tilde{p}}{\gamma} \left[R - \frac{b}{p} - \frac{qc - (1-q)k\Delta B}{\tilde{p}} \right] + CAR \left(1 - \frac{\beta}{\gamma} \right)$$

And:

$$\frac{\Phi_C}{\gamma} + \frac{\Lambda_C}{\beta} = \frac{\tilde{p}}{\gamma} \left[R - \frac{b}{p} - \frac{qc - (1-q)k\Delta B}{\tilde{p}} \right] + \frac{\Lambda_C}{\beta} \left(1 - \frac{\beta}{\gamma} \right)$$

As $\beta \geq \frac{\Lambda_C}{CAR}$, the capital adequacy ratio rule is binding (ie. $\frac{\Lambda_C}{\beta} < CAR$), and (25) holds.

ii) When $\beta < \frac{\Lambda_C}{CAR}$, the CAR is not binding and therefore the optimal collusion proof contract is just as if the CAR does not exist (ie. the optimal investment scale is $I_C(\beta, \gamma) = \frac{1}{V_C(\beta, \gamma)}$). **QED.**

• **Proof of proposition 8:**

i) When $\beta \geq \frac{\Lambda_{NC}}{CAR}$, for both the collusion proof and the collusion contracts, the CAR is binding and the constrained collusion proof contract will dominate the constrained collusion contract if and only if:

$$I_{CAR}^C = \frac{1}{V_{CAR}^C(\beta, \gamma)} < I_{CAR}^N = \frac{1}{V_{CAR}^N(\beta, \gamma)}$$

or

$$\tilde{p} \left[R - \frac{b}{p} - \frac{qc - (1-q)k\Delta B + \beta CAR}{\tilde{p}} \right] < p \left[R - \frac{b}{p} - \frac{c + \beta CAR}{p} \right]$$

or

$$[-qc + (1-q)k\Delta B - \beta CAR] < [p - \tilde{p}] \left[R - \frac{b}{p} \right] - c - \beta CAR$$

$$(1-q)[c + k\Delta B] < [p - \tilde{p}] \left[R - \frac{b}{p} \right]$$

or

$$[c + k\Delta B] < p \left[R - \frac{b}{p} \right]$$

or

$$R - \frac{b}{p} - \frac{c + k\Delta B}{p} > 0$$

which is always satisfied.

ii) When $\beta < \frac{\Lambda_{NC}}{CAR}$ and $\beta < \Psi\gamma$, The CAR is not binding for the collusion proof contract. Given that $\beta < \Psi\gamma$ such a contract dominates also a non constrained collusion contract and at fortiori a constrained collusion contract. Hence for this configuration of parameters, the collusion proof contract (which is non constrained) is the optimal contract.

iii) When $\beta < \frac{\Lambda_C}{CAR}$ and $\beta > \Psi\gamma$, the CAR is neither binding for a collusion proof contract nor a collusion contract. Given that $\beta > \Psi\gamma$, we know that a non constrained collusion contract dominates the collusion proof contract.

iv) Finally consider the case where $\beta \in \left] \frac{\Lambda_C}{CAR}; \frac{\Lambda_{NC}}{CAR} \right[$ and $\beta > \Psi\gamma$. Then under such configuration of parameters, the CAR is not binding for the optimal collusion proof contract while it is binding for the collusion contract. The (constrained) collusion contract dominates when

$$\frac{\Phi_{CAR}^C}{\gamma} + CAR > \frac{\Phi_{NC}}{\gamma} + \frac{\Lambda_{NC}}{\beta} = \frac{p}{\gamma} \left[R - \frac{b}{p} - \frac{c}{p} \right] + \frac{\Lambda_{NC}}{\beta} \left(1 - \frac{\beta}{\gamma} \right) \quad (26)$$

where

$$\Phi_{CAR}^C = \tilde{p} \left[R - \frac{b}{p} - \frac{qc - (1-q)k\Delta B + \beta CAR}{\tilde{p}} \right]$$

(26) writes therefore as

$$\begin{aligned} & \frac{\tilde{p}}{\gamma} \left[R - \frac{b}{p} - \frac{qc - (1-q)k\Delta B + \beta CAR}{\tilde{p}} \right] + CAR \\ & > \frac{p}{\gamma} \left[R - \frac{b}{p} - \frac{c}{p} \right] + \frac{\Lambda_{NC}}{\beta} \left(1 - \frac{\beta}{\gamma} \right) \end{aligned}$$

or :

$$\frac{(1-q)p}{\gamma} \left[R - \frac{b}{p} - \frac{(c+k\Delta B)}{p} \right] + \left(CAR - \frac{\Lambda_{NC}}{\beta} \right) \left(\frac{\beta}{\gamma} - 1 \right) < 0$$

when this inequality is reversed, we obviously have the region of parameters where the collusion proof contract dominates. **QED.**

- **Proof of proposition 9: Banking capital market equilibrium under fixed capital adequacy ratio**

Note first that for all $CAR \geq \frac{\Lambda_{NC}}{\Psi\gamma}$, a banking capital market equilibrium with non constrained collusion contracts cannot exist. Suppose that by contradiction such an equilibrium with non constrained collusion contracts exists. Then such contracts can only be chosen equilibrium contracts if $\beta > \Psi\gamma$ and for $\gamma < \underline{\gamma}$. In such a case, the rate of return on banking capital is $\beta = \beta_C(\gamma) = \frac{\Lambda_C}{1 - \frac{\Phi_C}{\gamma}} \left[1 + \frac{1}{KB} \right]$ and is larger than

$\beta_C(\underline{\gamma}) = \Psi\underline{\gamma} > \frac{\Lambda_{NC}}{CAR}$. From proposition 8, we know however that in such situation, the optimal contract has to be constrained collusion proof, contradicting therefore the fact that the contract is non constrained collusion.

From this it follows that for any $CAR \geq \frac{\Lambda_{NC}}{\Psi\gamma}$, equilibrium banking collusion can only eventually exist with constrained collusion contracts. Now again from proposition 8, this can only occur when $\beta \in \left] \frac{\Lambda_C}{CAR}; \frac{\Lambda_{NC}}{CAR} \right[$, $\beta > \Psi\gamma$, and the following inequality is satisfied

$$\frac{(1-q)p}{\gamma} \left[R - \frac{b}{p} - \frac{(c+k\Delta B)}{p} \right] + \left(CAR - \frac{\Lambda_{NC}}{\beta} \right) \left(\frac{\beta}{\gamma} - 1 \right) < 0$$

which given that $\Lambda_{NC} = k\Delta B$ can be rewritten as

$$(1-q)p \left[R - \frac{b}{p} - \frac{(c+k\Delta B)}{p} \right] < \left(\frac{k\Delta B}{\beta} - CAR \right) (\beta - \gamma) \quad (27)$$

For all $\gamma > \frac{1}{\Psi} \cdot \frac{k\Delta B}{CAR}$, the conditions $\beta > \Psi\gamma$ and $\beta < \frac{k\Delta B}{CAR}$ are incompatible and therefore a constrained collusion contract cannot be chosen at equilibrium. Consider then the case where $\gamma < \frac{1}{\Psi} \cdot \frac{k\Delta B}{CAR}$. Then given that $\Psi > 1$, this also implies that $\gamma < \frac{k\Delta B}{CAR}$. Now consider the function $f(\beta, CAR, \gamma) = \left(\frac{k\Delta B}{\beta} - CAR\right) (\beta - \gamma)$. For all $\gamma < \frac{k\Delta B}{CAR}$, It has a maximum value at $\beta^* = \sqrt{\frac{k\Delta B\gamma}{CAR}}$ and this maximum value $m(CAR, \gamma) = f(\beta^*, CAR, \gamma)$ is a decreasing function of γ and CAR . with $m(CAR, 0) = \infty$ and $m(CAR, \frac{k\Delta B}{CAR}) = 0$. Hence there exists a unique threshold $\tilde{\gamma}(CAR)$ such that

$$m(CAR, \tilde{\gamma}) = (1 - q)p \left[R - \frac{b}{p} - \frac{(c + k\Delta B)}{p} \right]$$

Then for all $\gamma > \tilde{\gamma}(CAR)$ we have

$f(\beta, CAR, \gamma) < m(CAR, \tilde{\gamma}) < (1 - q)p \left[R - \frac{b}{p} - \frac{(c + k\Delta B)}{p} \right]$. This implies again that (27) is not satisfied and that for such values of γ a constrained collusion contract cannot be chosen at equilibrium. Also differentiation shows easily that given that $m(CAR, \gamma)$ is a decreasing function of CAR , the threshold $\tilde{\gamma}(CAR)$ is a decreasing function of CAR .

From the previous discussion, it follows finally that for any $CAR \geq \frac{\Lambda_{NC}}{\Psi\gamma}$ and $\gamma > \tilde{\gamma}(CAR)$, the banking capital market equilibrium can only be associated with collusion-proof contracts.

Note that we may then characterize this banking market equilibrium rate of return with collusion proof contracts, using the banking capital market equilibrium. It will be given by $\beta_{NC}^e(\gamma)$ such that

$$\begin{aligned} \beta_{NC}^e(\gamma) &= \beta_{NC}(\gamma) \quad \text{when } \gamma \geq \gamma^{CAR} \\ &= \beta_{NC}^{CAR}(\gamma) \quad \text{when } \tilde{\gamma}(CAR) < \gamma < \gamma^{CAR} \end{aligned}$$

with:

$$\gamma^{CAR} = \frac{\Phi_{NC}}{1 - CAR \left[1 + \frac{1}{K_B} \right]}$$

and

$$\beta_{NC}^{CAR}(\gamma) = -\lambda\gamma + \frac{p}{CAR} \left[R - \frac{b+c}{p} \right] \quad \text{and } \lambda = \frac{1}{CAR} - \left[1 + \frac{1}{K_B} \right]$$

Indeed when the cost of external finance is below a threshold γ^{CAR} constrained non collusion contracts will be implemented, while for $\gamma \geq \gamma^{CAR}$, we have a non constrained collusion proof banking equilibrium.

The equilibrium with a fixed capital adequacy ratio decreases welfare in the intermediate range $\gamma^* < \tilde{\gamma}(CAR) < \gamma < \bar{\gamma}$ if the constrained return of bank capital is lower than in the decentralized market equilibrium (recall that the utility of both the entrepreneur and the uninformed agents is proportional to the size of the investment):

- if $\beta = \Psi\gamma$, the condition for a welfare decreasing capital ratio is: $\Psi\gamma > \beta_{NC}^{CAR}(\gamma)$, or:
 $\gamma - \left(1 + \frac{1}{K_B} \right) > \frac{p}{\gamma CAR} \left(R - \frac{b+c+\gamma}{p} \right)$

- if $\beta = \beta_C = \frac{\Lambda_C}{1 - \frac{\Phi_c}{\gamma}} \left[1 + \frac{1}{K_B} \right]$, the condition is:

$$\left(\frac{\Lambda_c}{\gamma - \Phi_c} - 1 \right) \left[1 + \frac{1}{K_B} \right] > \frac{p}{\gamma CAR} \cdot \left(R - \frac{b+c-\gamma}{p} \right)$$

these conditions are more likely to hold if the bank capital is the capital adequacy ratio is high.

- **Proof of proposition 10:** i) As is obvious from (15), the optimal CAR is increasing in γ and K_B .

ii) Also the optimal CAR is decreasing in Φ_{NC} . As Φ_{NC} is itself increasing in the value of R, c , and $k\Delta B$, the result follows immediately. **QED.**

- **Proof of proposition 15: Market equilibrium with productive externalities**

The following lemma is useful to characterize the banking capital market equilibrium with productive externalities:

Lemma : *Suppose that $q < 1/2$, then $\frac{\partial \bar{\gamma}}{\partial R} < 0$ and $\frac{\partial \underline{\gamma}}{\partial R} < 0$*

proof: i) Note that

$$[\Phi_C - \Phi_{NC}](R) = \tilde{p} \frac{k\Delta B}{p} - (p - \tilde{p}) \left[R - \frac{b}{p} - \frac{c + k\Delta B}{p} \right]$$

is a decreasing function of R while $\Lambda_{NC} - \Lambda_C = \tilde{p} \frac{k\Delta B}{p}$ is independent from R . Thus

$$\Psi(R) = \frac{\Lambda_{NC} - \Lambda_C}{[\Phi_C - \Phi_{NC}](R)}$$

is an increasing function of R .

ii) Now we have:

$$\begin{aligned} \bar{\gamma}(R) &= \Phi_{NC}(R) + \frac{\Lambda_{NC} \left[1 + \frac{1}{K_B} \right]}{\Psi(R)} \\ &= \frac{\Lambda_{NC} \Phi_C(R) - \Lambda_C \Phi_{NC}(R)}{\Lambda_{NC} - \Lambda_C} + \frac{\Lambda_{NC}}{\Psi(R) K_B} \end{aligned}$$

and

$$\begin{aligned} \underline{\gamma}(R) &= \Phi_C(R) + \frac{\Lambda_C \left[1 + \frac{1}{K_B} \right]}{\Psi(R)} \\ &= \frac{\Lambda_{NC} \Phi_C(R) - \Lambda_C \Phi_{NC}(R)}{\Lambda_{NC} - \Lambda_C} + \frac{\Lambda_C}{\Psi(R) K_B} \end{aligned}$$

Therefore

$$\frac{\partial \bar{\gamma}}{\partial R} = \frac{\partial}{\partial R} \left[\frac{\Lambda_{NC} \Phi_C(R) - \Lambda_C \Phi_{NC}(R)}{\Lambda_{NC} - \Lambda_C} \right] \underbrace{- \frac{\Lambda_{NC}}{\Psi^2 K_B} \frac{\partial \Psi}{\partial R}}_{-} \quad (28)$$

and

$$\frac{\partial \underline{\gamma}}{\partial R} = \frac{\partial}{\partial R} \left[\frac{\Lambda_{NC} \Phi_C(R) - \Lambda_C \Phi_{NC}(R)}{\Lambda_{NC} - \Lambda_C} \right] \underbrace{- \frac{\Lambda_C}{\Psi^2 K_B} \frac{\partial \Psi}{\partial R}}_{-} \quad (29)$$

The second term of (28) and (29) is unambiguously a decreasing function of R . For the first term, one has:

$$\begin{aligned} \frac{\partial}{\partial R} \left[\frac{\Lambda_{NC} \Phi_C(R) - \Lambda_C \Phi_{NC}(R)}{\Lambda_{NC} - \Lambda_C} \right] &\propto \left[\Lambda_{NC} \frac{\partial}{\partial R} \Phi_C(R) - \Lambda_C \frac{\partial}{\partial R} \Phi_{NC}(R) \right] \\ &\propto [\Lambda_{NC} qp - \Lambda_C p] \end{aligned}$$

But $[\Lambda_{NC} qp - \Lambda_C p]$ has the sign of $(pk\Delta B) qp - (1-q)pk\Delta Bp = k\Delta Bp^2 [2q - 1]$. Therefore when $2q - 1 < 0$

$$\frac{\partial}{\partial R} \left[\frac{\Lambda_{NC} \Phi_C(R) - \Lambda_C \Phi_{NC}(R)}{\Lambda_{NC} - \Lambda_C} \right] < 0$$

From this it follows finally that

$$\frac{\partial \bar{\gamma}}{\partial R} < 0 \quad \text{and} \quad \frac{\partial \underline{\gamma}}{\partial R} < 0$$

when $q < 1/2$. **QED.**

• **Proposition 15:**

i) define:

$$\bar{\Psi}(\epsilon) = \frac{\Lambda_{NC} - \Lambda_C}{\bar{\Phi}_C(\epsilon) - \bar{\Phi}_{NC}(\epsilon)} \quad \text{and} \quad \underline{\Psi}(\epsilon) = \frac{\Lambda_{NC} - \Lambda_C}{\underline{\Phi}_C(\epsilon) - \underline{\Phi}_{NC}(\epsilon)}$$

with obvious notations: $\underline{\Phi}_C(\epsilon) = \Phi_C(\underline{R}(\epsilon))$, etc...

It follows from $\bar{R}(\epsilon) > \underline{R}(\epsilon)$ that $\bar{\Psi}(\epsilon) > \underline{\Psi}(\epsilon)$. Note also that through simple differentiation $\bar{\Psi}'(\epsilon) > \underline{\Psi}'(\epsilon) > 0$ and $\bar{\Psi}(0) = \underline{\Psi}(0)$

2) Define:

$$\Theta(\epsilon) = \bar{\gamma}(\bar{R}(\epsilon)) - \underline{\gamma}(\underline{R}(\epsilon))$$

Differentiation gives:

$$\Theta'(\epsilon) = \frac{\partial \bar{\gamma}}{\partial R} \bar{R}'(\epsilon) - \frac{\partial \underline{\gamma}}{\partial R} \underline{R}'(\epsilon)$$

Given that $p\Omega > 1 > pq\Omega$, we have $\bar{R}'(\epsilon) > 0 > \underline{R}'(\epsilon)$. Also when $q < 1/2$, $\frac{\partial \bar{\gamma}}{\partial R} < 0$ and $\frac{\partial \underline{\gamma}}{\partial R} < 0$; Hence it follows that

$$\Theta'(\epsilon) = \underbrace{\frac{\partial \bar{\gamma}}{\partial R}}_{-} \underbrace{\bar{R}'(\epsilon)}_{+} - \underbrace{\frac{\partial \underline{\gamma}}{\partial R}}_{-} \underbrace{\underline{R}'(\epsilon)}_{-} < 0$$

and $\Theta(\epsilon)$ is decreasing in ϵ . Note also that $\Theta(0) = \bar{\gamma}(\bar{R}(0)) - \underline{\gamma}(\underline{R}(0)) = \bar{\gamma}(R_0) - \underline{\gamma}(R_0) > 0$

3) Now note that for all $R \geq 0$

$$\begin{aligned} \bar{\gamma}(R) - \underline{\gamma}(R) &= \frac{1}{K_B} [\Phi_C(R) - \Phi_{NC}(R)] \\ &= \frac{1}{K_B} \left[pq \left(R - \frac{b+c}{p} \right) - p \left(R - \frac{b+c+k\Delta B}{p} \right) \right] \\ &= \frac{1}{K_B} [(1-q)(b+c) + k\Delta B - p(1-q)R] \end{aligned}$$

and there is a value R^* such that $\bar{\gamma}(R^*) - \underline{\gamma}(R^*) = 0$. Therefore there exists also a unique value $\tilde{\epsilon} > 0$ such that $\bar{R}(\tilde{\epsilon}) = R^*$ as $\bar{R}(\epsilon)$ is an increasing function of ϵ such that $\bar{R}(0) = R_0 < R^*$ (R_0 satisfies assumption C (for $\theta = 0$) ensuring the existence of collusive regimes without externalities) and $\lim_{\epsilon \rightarrow \infty} \bar{R}(\epsilon) = +\infty$.

Simple inspection then shows that:

$$\begin{aligned} \Theta(\tilde{\epsilon}) &= \bar{\gamma}(\bar{R}(\tilde{\epsilon})) - \underline{\gamma}(\underline{R}(\tilde{\epsilon})) = \bar{\gamma}(R^*) - \underline{\gamma}(\underline{R}(\tilde{\epsilon})) \\ &= \underline{\gamma}(R^*) - \underline{\gamma}(\underline{R}(\tilde{\epsilon})) = \underline{\gamma}(\bar{R}(\tilde{\epsilon})) - \underline{\gamma}(\underline{R}(\tilde{\epsilon})) < 0 \end{aligned}$$

Given that $\bar{R}(\tilde{\epsilon}) > \underline{R}(\tilde{\epsilon})$ and $\underline{\gamma}(R)$ is a decreasing function of R when $q < 1/2$. Hence, given that $\Theta(\epsilon)$ is decreasing in ϵ and that $\Theta(0) > 0 > \Theta(\tilde{\epsilon})$, there is a unique threshold value $\epsilon^* \in]0, \tilde{\epsilon}[$ such that $\Theta(\epsilon^*) = 0$. Also for all values of $\epsilon > \epsilon^*$ $\Theta(\epsilon) < 0$ and therefore

$$\bar{\gamma}(\bar{R}(\epsilon)) \leq \underline{\gamma}(\underline{R}(\epsilon))$$

3) For $\gamma \in [\bar{\gamma}(\bar{R}(\epsilon)); \underline{\gamma}(\underline{R}(\epsilon))]$, when agents have expectations of a collusive market equilibrium, they expect the rate of return on successful productive projects to be $\underline{R}(\epsilon)$, Hence as $\gamma \leq \underline{\gamma}(\underline{R}(\epsilon))$, a market equilibrium with collusion contracts prevails. However, for the same value of γ , if agents have expectations of a collusion proof market equilibrium, then they expect the rate of return on successful productive projects to be $\bar{R}(\epsilon)$, Hence as $\gamma \geq \bar{\gamma}(\bar{R}(\epsilon))$, a market equilibrium with no collusion contracts also prevails. **QED.**

• **Political economy of banking supervision with collusion-proof contract**

$$\bar{\gamma}(k) = \Phi_{NC}(k) + \frac{\Lambda_{NC}(k) \left[1 + \frac{1}{K_B} \right]}{\Psi(k)}$$

Simple differentiation of this expression gives that:

$$\frac{\partial \bar{\gamma}}{\partial k} = \frac{\partial}{\partial k} \left[\frac{\Lambda_{NC}(k)\Phi_C - \Lambda_C(k)\Phi_{NC}(k)}{\Lambda_{NC}(k) - \Lambda_C(k)} \right] - \frac{\Lambda_{NC}(k)}{\Psi^2 K_B} \Psi'(k) + \frac{\Lambda'_{NC}(k)}{\Psi K_B}$$

+

As

$$\frac{\Lambda_{NC}(k)\Phi_C - \Lambda_C(k)\Phi_{NC}(k)}{\Lambda_{NC}(k) - \Lambda_C(k)} = \frac{pq \left(R - \frac{b+c}{p} \right) - p(1-q) \left(R - \frac{b}{p} - \frac{c+k\Delta B}{p} \right)}{q}$$

it is increasing in k and $\frac{\partial \bar{\gamma}}{\partial k} > 0$. Therefore $\frac{\partial \bar{\gamma}}{\partial k} > 0$.

Using (19), and (17) simple differentiation immediately implies that:

$$\begin{aligned} \frac{U'_E(k)}{U_E(k)} &= \frac{\frac{1}{\gamma} \frac{\partial \Phi_{NC}}{\partial k}}{1 - \frac{\Phi_{NC}}{\gamma}} < 0 \\ \frac{U'_B(k)}{U_B(k)} &= \frac{\frac{\partial \Lambda_{NC}}{\partial k}}{\Lambda_{NC}} + \frac{\frac{1}{\gamma} \frac{\partial \Phi_{NC}}{\partial k}}{1 - \frac{\Phi_{NC}}{\gamma}} = \frac{\frac{\partial \Lambda_{NC}}{\partial k}}{\Lambda_{NC} \left[1 - \frac{\Phi_{NC}}{\gamma} \right]} \left[1 - \frac{\Lambda_{NC} + \Phi_{NC}}{\gamma} \right] \geq 0 \\ \frac{U'_I(k)}{U_I(k)} &= \frac{\frac{\partial \Phi_{NC}}{\partial k}}{\Phi_{NC}} + \frac{\frac{1}{\gamma} \frac{\partial \Phi_{NC}}{\partial k}}{1 - \frac{\Phi_{NC}}{\gamma}} = \frac{\frac{\partial \Phi_{NC}}{\partial k}}{\Phi_{NC} \left[1 - \frac{\Phi_{NC}}{\gamma} \right]} < 0 \end{aligned}$$

• **Political Economy of banking supervision in the collusion region**

$$\underline{\gamma}(k) = \Phi_C(k) + \frac{\Lambda_C(k) \left[1 + \frac{1}{K_B} \right]}{\Psi(k)}$$

Again simple differentiation gives that

$$\frac{\partial \underline{\gamma}}{\partial k} = \frac{\partial}{\partial k} \left[\underbrace{\frac{\Lambda_{NC}(k)\Phi_C - \Lambda_C(k)\Phi_{NC}(k)}{\Lambda_{NC}(k) - \Lambda_C(k)}}_{+} \right] - \underbrace{\frac{\Lambda_C(k)}{\Psi^2 K_B} \Psi'(k)}_{+} + \frac{\Lambda'_C(k)}{\Psi K_B}$$

and $\underline{\gamma}(k)$ is also increasing in k .

One has:

$$\begin{aligned} U_E(k) &= bI_C = \frac{b}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C}{\beta_C(\gamma)}} = \frac{bK_B}{1 - \frac{\Phi_C}{\gamma}} \left[1 + \frac{1}{K_B} \right] \\ U_B(k) &= \Lambda_C I_C = \frac{\Lambda_C}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C}{\beta_C(\gamma)}} = \frac{\Lambda_C K_B}{1 - \frac{\Phi_C}{\gamma}} \left[1 + \frac{1}{K_B} \right] \\ U_I(k) &= \Phi_{NC} I_{NC} = \frac{\Phi_C}{1 - \frac{\Phi_C}{\gamma} - \frac{\Lambda_C}{\beta_C(\gamma)}} = \frac{\Phi_C K_B}{1 - \frac{\Phi_C}{\gamma}} \left[1 + \frac{1}{K_B} \right] \end{aligned} \tag{30}$$

with the equilibrium rate of return of banking capital given by:

$$\beta_C(\gamma) = \frac{\Lambda_C}{1 - \frac{\Phi_C}{\gamma}} \left[1 + \frac{1}{K_B} \right]$$

It follows immediately from (21) that:

$$\begin{aligned}\frac{U'_E(k)}{U_E(k)} &= \frac{\frac{1}{\gamma} \frac{\partial \Phi_C}{\partial k}}{1 - \frac{\Phi_C}{\gamma}} = 0 \\ \frac{U'_B(k)}{U_B(k)} &= \frac{\frac{\partial \Lambda_C}{\partial k}}{\Lambda_C} + \frac{\frac{1}{\gamma} \frac{\partial \Phi_C}{\partial k}}{1 - \frac{\Phi_C}{\gamma}} = \frac{\partial \Lambda_C}{\partial k} > 0 \\ \frac{U'_I(k)}{U_I(k)} &= \frac{\frac{\partial \Phi_C}{\partial k}}{\Phi_C} + \frac{\frac{1}{\gamma} \frac{\partial \Phi_C}{\partial k}}{1 - \frac{\Phi_C}{\gamma}} = 0\end{aligned}$$

The equilibrium return on bank capital is:

$$\beta_C(\gamma) = \frac{\Lambda_C}{1 - \frac{\Phi_C}{\gamma}} \left[1 + \frac{1}{K_B} \right]$$

It follows immediately from (21) that:

$$\begin{aligned}\frac{U'_E(k)}{U_E(k)} &= \frac{\frac{1}{\gamma} \frac{\partial \Phi_C}{\partial k}}{1 - \frac{\Phi_C}{\gamma}} = 0 \\ \frac{U'_B(k)}{U_B(k)} &= \frac{\frac{\partial \Lambda_C}{\partial k}}{\Lambda_C} + \frac{\frac{1}{\gamma} \frac{\partial \Phi_C}{\partial k}}{1 - \frac{\Phi_C}{\gamma}} = \frac{\partial \Lambda_C}{\partial k} > 0 \\ \frac{U'_I(k)}{U_I(k)} &= \frac{\frac{\partial \Phi_C}{\partial k}}{\Phi_C} + \frac{\frac{1}{\gamma} \frac{\partial \Phi_C}{\partial k}}{1 - \frac{\Phi_C}{\gamma}} = 0\end{aligned}$$

• **Political economy of banking supervision in the mixed equilibrium region**

Lemma : $\nu(k)$ is decreasing in k

proof: $\nu(k)$ is determined by:

$$\nu(k)\Lambda_{NC}(k) + (1 - \nu(k))\Lambda_C(k) = K_B\Psi(k)\gamma \left[1 - \frac{1}{\gamma}\Delta(k) \right]$$

where

$$\Delta(k) = \frac{\Lambda_{NC}(k)\Phi_C - \Lambda_C(k)\Phi_{NC}(k)}{\Lambda_{NC}(k) - \Lambda_C(k)}$$

and $\Delta'(k) > 0$. Therefore

$$\begin{aligned}\nu(k) &= K_B \frac{1}{\Phi_C - \Phi_{NC}(k)} [\gamma - \Delta(k)] - \frac{\Lambda_C(k)}{\Lambda_{NC}(k) - \Lambda_C(k)} \\ &= K_B \frac{1}{\Phi_C - \Phi_{NC}(k)} [\gamma - \Delta(k)] - \frac{(1 - q)}{q}\end{aligned}$$

the function

$$\Xi(k) = K_B \frac{1}{\Phi_C - \Phi_{NC}(k)} [\gamma - \Delta(k)]$$

is decreasing in k implies immediately that $\nu(k)$ is decreasing in k . **QED.**

Lemma : $U_I(k)$ is decreasing in k

Proof: Indeed

$$U_I(k) = [\nu(k)\Phi_{NC}(k) + (1 - \nu(k))\Phi_C] I(k)$$

which after substitution of $\nu(k)$ gives

$$\begin{aligned} U_I(k) &= \frac{\left[K_B \frac{1}{\Phi_C - \Phi_{NC}(k)} [\gamma - \Delta(k)] - \frac{(1-q)}{q} \right] [\Phi_{NC}(k) - \Phi_C] + \Phi_C}{\left[1 - \frac{1}{\gamma} \Delta(k) \right]} \\ &= \frac{-K_B [\gamma - \Delta(k)] + \frac{(1-q)}{q} [\Phi_C - \Phi_{NC}(k)] + \Phi_C}{\left[1 - \frac{1}{\gamma} \Delta(k) \right]} \end{aligned}$$

as $\Delta(k)$ is increasing in k and $\Phi_{NC}(k)$ is decreasing in k , the numerator is increasing in k while the denominator is decreasing in k . It results that in the mixed regime $U_I(k)$ is increasing in k and uniformed investors are in favor of relaxed supervision on banks **QED.**

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Figure 1: Banking Market Equilibrium rate of return

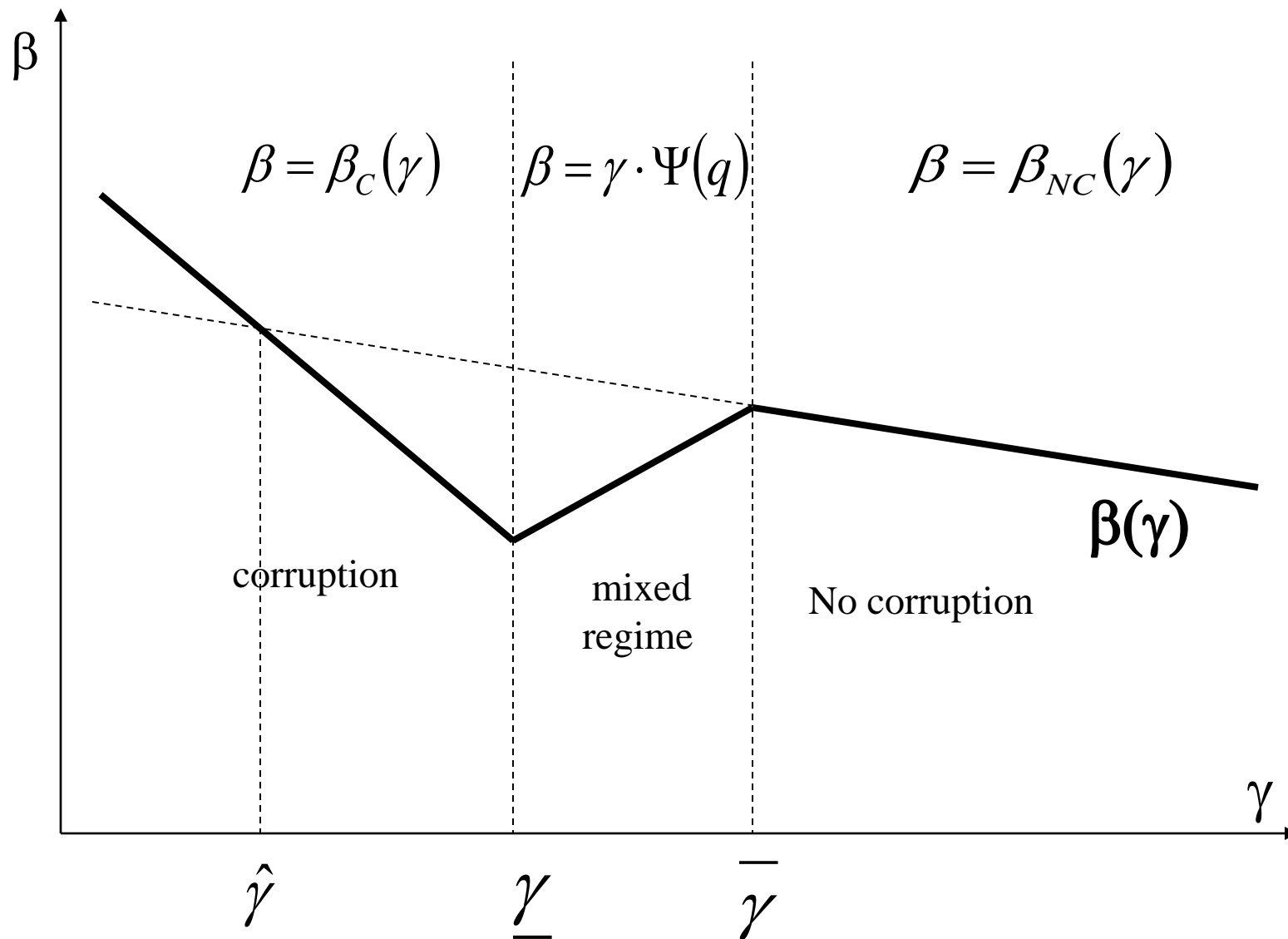


Figure 2: Choice of contracts under fixed capital adequacy rule

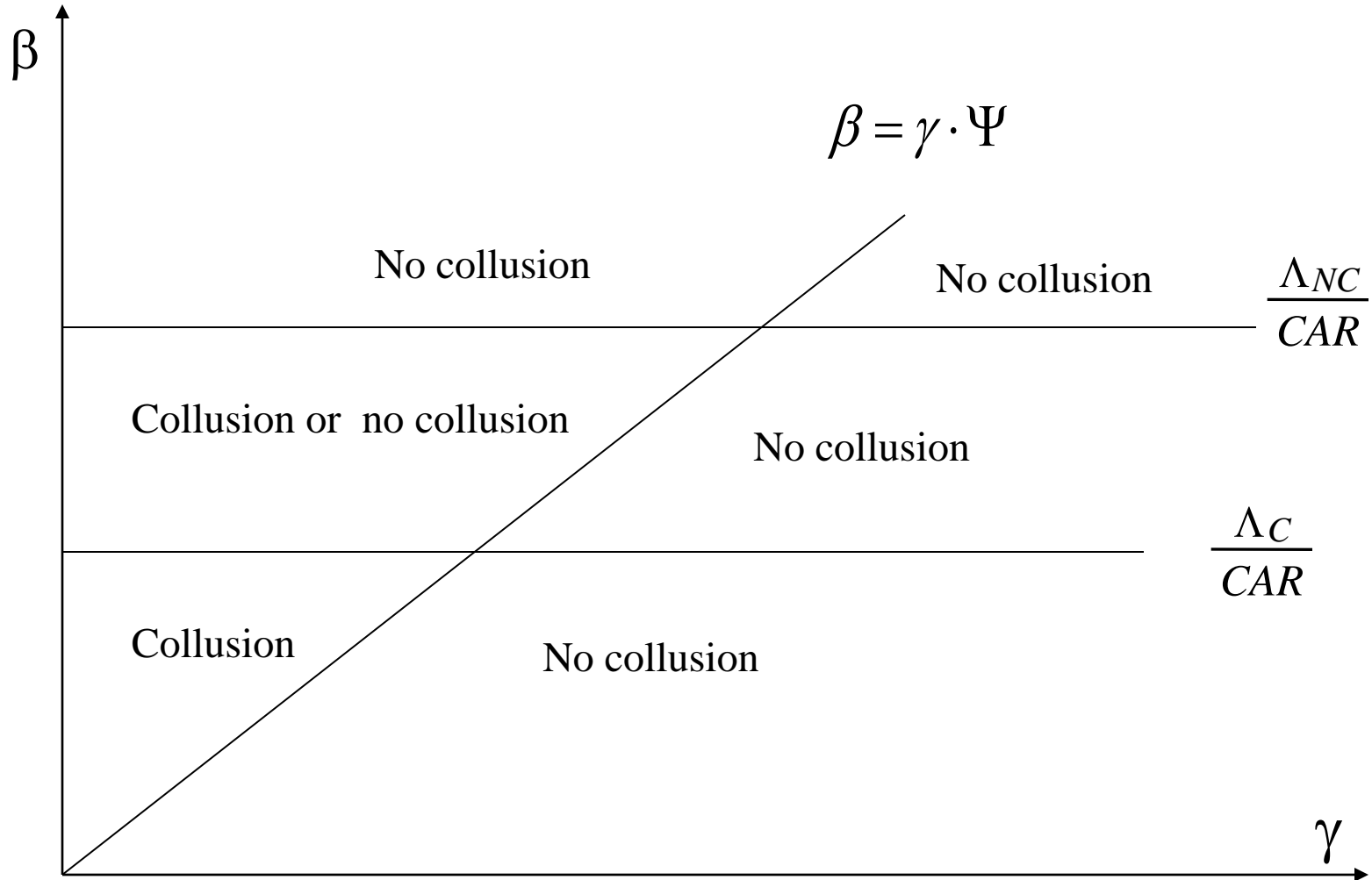


Figure 3: Elimination of collusion equilibria with fixed capital adequacy ratio

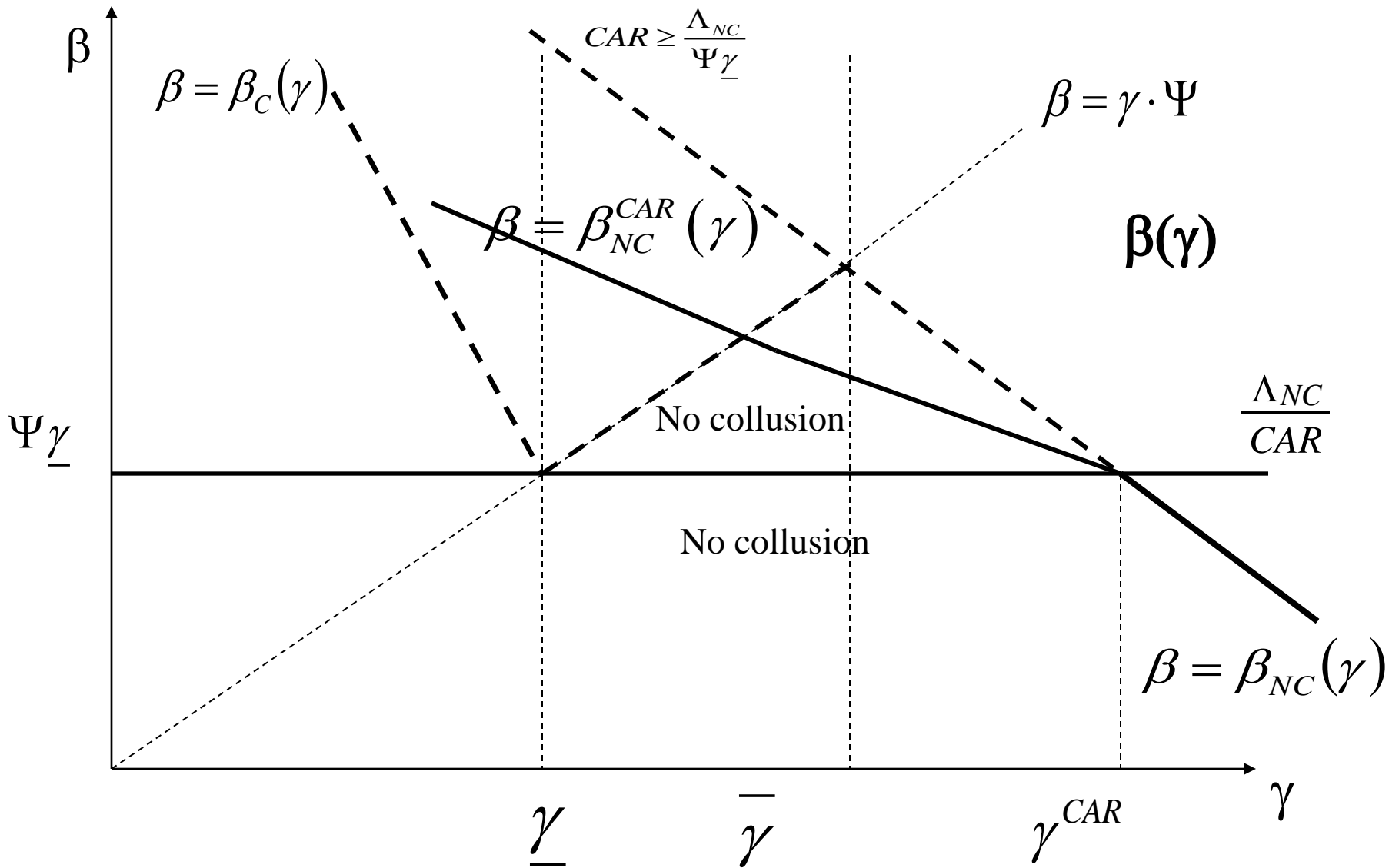


Figure 4: Banking Market Equilibrium with productive externalities ε

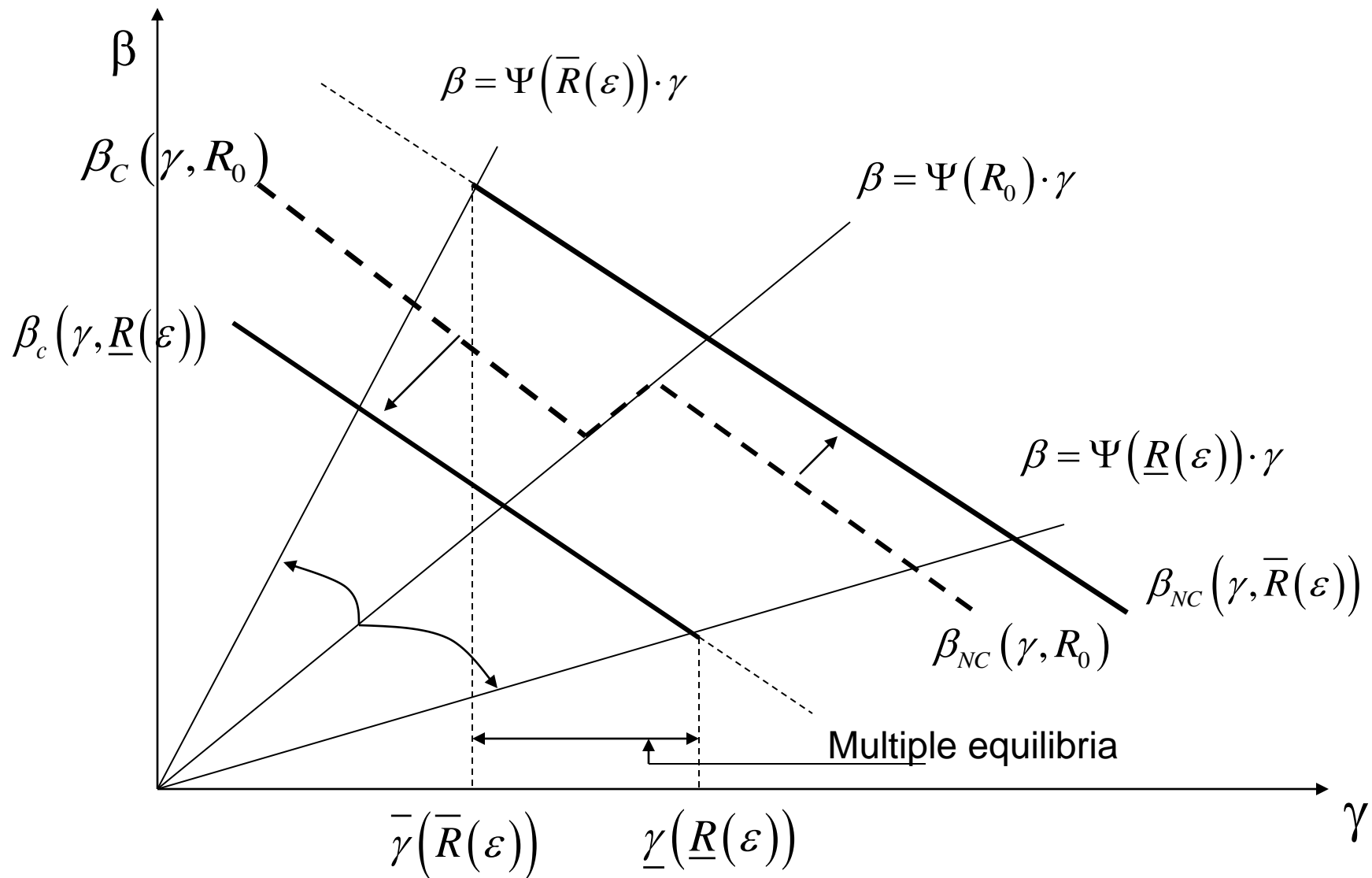


Figure 5a): Preferences of entrepreneurs for banking supervision

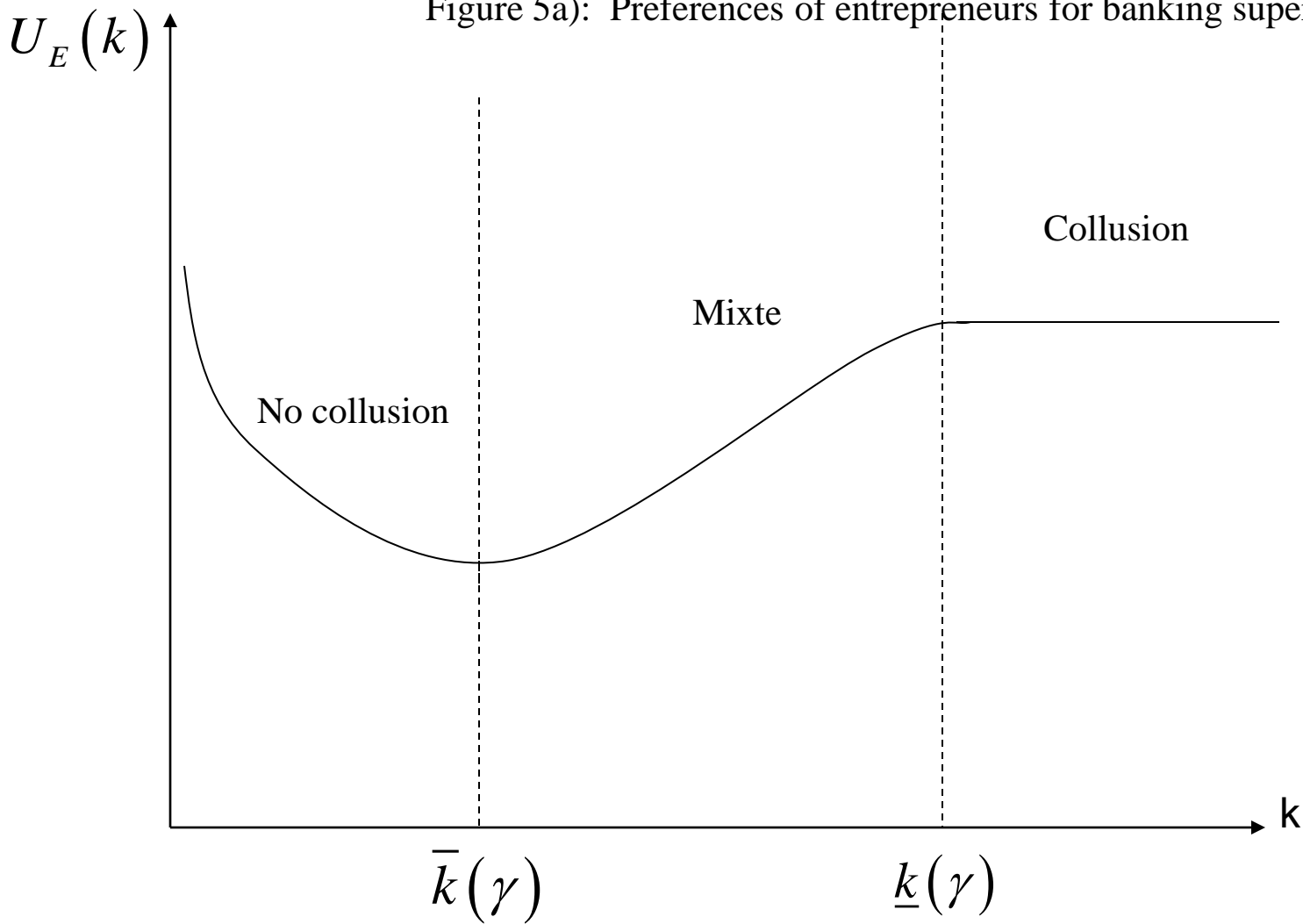


Figure 5b): Preferences of uniformed investors for banking supervision

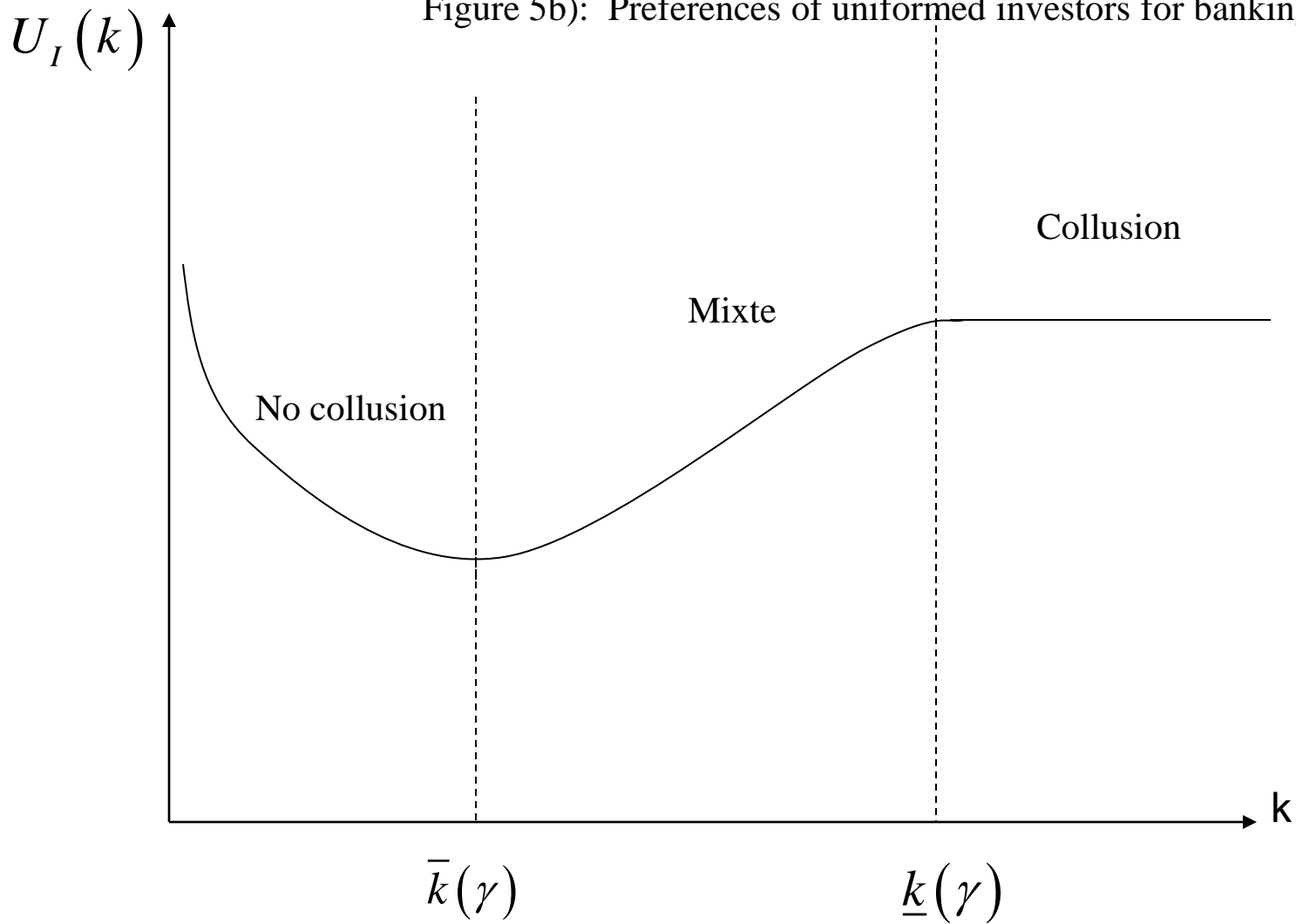


Figure 5c): Preferences of Banks for banking supervision

