ESRC-DFID Growth Research Programme
Grant No. ES/L012022/1

Growth and Welfare Effects of Macroprudential Regulation

Pierre-Richard Agénor

University of Manchester
Principal Investigator

Background

- Much of recent debate on financial regulation: focus almost exclusively on the implications of financial volatility for **short-term** economic stability and on the short-run benefits of regulation.

- Case for macroprudential policy (systemic approach to financial stability), which aims at mitigating procyclicality of the financial system and dampening fluctuations in credit and output.

- However, potential **dynamic trade-off** associated with the fact that regulatory policies, designed to **reduce procyclicality and the risk of financial crises**…

- …could well be detrimental to **economic growth**, due to their effect on risk taking and incentives to borrow and lend…

- …despite contributing to a stable environment in which agents can assess risks and returns associated with their investment decisions.

- In LICs, where sustaining high growth rates is essential to increase standards of living and escape poverty, understanding the terms of this trade-off is particularly important.

- LICs: underdeveloped formal financial systems, and thus limited opportunities to borrow and smooth shocks.

- Real effects of financial volatility on firms and individuals can therefore be not only large but also highly persistent, with adverse effects on growth.

- Benefits of regulatory measures aimed at promoting financial stability could be substantial.

- Yet, regulatory constraints may have a persistent effect on the risk-taking incentives of financial intermediaries—because, e.g., they induce structural shifts in banks' portfolio composition; move away from risky assets toward safe(r) investments.

- From loans to firms to risky investments.

- They may also constrain their capacity to lend.

- They may translate into high interest rate spreads, and suboptimal levels of borrowing by entrepreneurs to finance investment, which could also affect negatively growth and welfare.

- Key question: optimal degree of financial regulation that internalizes this trade-off.

- Scant literature; Van den Heuvel (2008).

- Focus on bank capital requirements; trade-off between banking efficiency and financial safety.

Available online at www.sciencedirect.com

ScienceDirect

Journal of Monetary Economics 55 (2008) 298–320

Journal of MONETARY ECONOMICS

www.elsevier.com/locate/jme

The welfare cost of bank capital requirements ☆

Skander J. Van den Heuvel*

- However, no endogenous growth; long-run effects on growth **cannot** be ascertained.

- Focus here: growth and welfare effects of macro-prudential regulation in an OLG with banking.

- Reserve requirements (Agénor and Pereira da Silva (2015)); part of the liquidity requirement guidelines under Basel III (Basel Committee on Banking Supervision (2013)).

- **Dual moral hazard problem** à la Holmström and Tirole (HT, 1997).

- Entrepreneurs, who need external funds to finance their investment projects, may be tempted to choose less productive projects with higher non-verifiable returns.

- Although bank monitoring mitigates the moral hazard problem associated with the behavior of entrepreneurs, the fact that banks use deposits from households to fund their loans creates an incentive to shirk when monitoring is costly.

- However, model departs from HT paradigm in two important ways.

- 1. Households cannot lend directly to producers.
- More appropriate for a low-income environment, where capital markets are underdeveloped if not entirely absent.
- 2. The intensity of monitoring, which affects private returns from shirking, is endogenous.
- Crucial features for the results.
- Model also dwells on Chakraborty and Ray (2006).

The Model

Basic Assumptions

- Continuum of agents who live for two periods, adulthood and old age.
- Population is constant.
- Agents are of two types: fraction $n \in (0,1)$ are workers, remaining are entrepreneurs.
- n is normalized to 0.5 and the measure of each type of agents is 1.

- 3 production sectors, all of them producing perishable goods.
- Bank-dominated financial sector, which channels funds from lenders to borrowers.
- Financial regulator.

Workers and entrepreneurs

- Worker (or saver): born with 1 unit of time in adulthood, supplied inelastically to the labor market.
- Generation-*t* worker's lifetime utility depends only upon second period consumption so that the entire wage income, w_t, is saved in adulthood.
- Workers do not lend directly to producers; they invest all their savings (or w_t) either in bank deposits, d_t, or abroad.

- Arbitrage implies that both placements yield the same (gross) return, $R^D > 1$, set exogenously.

- Entrepreneurs: risk neutral, indexed by $j \in [0,1]$.

- Each of them is also born with one unit of labor time in adulthood, which is used to operate one of two types of technologies.

- A **modern technology**, used to convert units of the final good into a marketable capital good;

- A **traditional technology**, used to produce only nonmarketed consumption goods.

- Whatever the technology chosen, operating it generates no income in the first period.

- Entrepreneurs do not consume in that period.

- They are altruists and derive utility from old-age consumption, c^E_{t+1}, and bequests made to their offspring, b_{t+1}.

- Generation-*t* “warm-glow” utility function:

$$U_t^E = (c_{t+1}^E)^{\beta}(b_{t+1})^{1-\beta} \qquad \beta \in (0,1)$$

- Entrepreneur *j*'s initial wealth at date *t* (bequest obtained from generation *t*-1: b^j_t; realized income in old age: z^j_{t+1}.

- Given Cobb-Douglas preferences, optimal decision rules are linear in z^j_{t+1}. Thus, bequest is

$$b^j_{t+1} = (1-\beta) z^j_{t+1},$$

- And fraction consumed is

$$c^{E,j}_{t+1} = \beta z^j_{t+1}$$

Production sectors

- **Final goods sector**. Good can either be consumed or used as a production input.

- Production technology:

$$Y_t = A_t N_t^{1-\alpha} K_t^{\alpha} \qquad \alpha \in (0,1)$$

- A_t: productivity parameter. N_t: Number of workers.

- Aggregate capital stock: $K_t = \int_{j \in E_t} K_t^j dG_t$

- Arrow-Romer type externality:

$$A_t = Ak_t^{1-\alpha}$$

- $k_t = K_t/N_t$: capital labor ratio.

- Combining the two equations yields

$$y_t = Ak_t$$

- Equilibrium capital rental and wage rates:

$$R_t^K = \alpha A > 1, \quad w_t = (1-\alpha)Ak_t$$

- **Capital goods sector**. Each capital good *j* is produced by a single entrepreneur *j*.

- Generations of entrepreneurs are interconnected through a bequest motive, firm *j* is effectively infinitely lived.

- Adult member of entrepreneurial family *j*, the owner-manager of the family firm, converts units of the final good into capital with a one-period lag.

- Entrepreneur *j* invests an indivisible amount q^j, taken as given for the moment.

- When the project succeeds, it produces capital:

$$K_{t+1}^{j} = q_{t}^{j}$$

- But as long as $q^j > b^j$, entrepreneur has to raise the difference $q^j - b^j$ from banks.

- All entrepreneurs produce the same type of capital good and are price takers.

- Common return they earn from renting out their capital is $R^K > 1$.

- Capital goods fully depreciate upon use.

- **Home production**. Traditional technology yields output that is entirely self-consumed. It enables entrepreneur *j* to produce, with a one period lag, the same consumption good (in quantity x^j_{t+1}) that the final goods sector produces:

$$x^j_{t+1} = a_t (b^j_t)^\delta \qquad \delta \in (0,1)$$

- a_t: productivity parameter; restriction needed on process driving it (see paper).

- If entrepreneurs cannot borrow, they can invest their initial wealth to produce consumption goods.

Financial sector

- Banks: obtain their supply of loanable funds from workers' deposits, which they lend to entrepreneurs to build capital.

- However, deposits are subject to a reserve requirement imposed by the regulator.

- Each bank lends to one entrepreneur only.

- Banks are endowed with an **imperfect monitoring technology** (specialized skills)…

- …which allows them to inspect a borrower's cash flows and balance sheet, observe the owner-manager's activities, and ensure that the entrepreneur conforms to the terms agreed upon in the financial contract.

- As in HT, each entrepreneur can choose between 3 types of investment projects, which differ in their success probability and the **nonverifiable private benefits** that they bring.

- Entrepreneur must raise q^j - b^j to invest.

- When the project succeeds, it realizes the verifiable amount of capital K^j_{t+1}.
- But when the project fails, it produces nothing.
- Moral hazard problem: probability of success depends on an **unobserved action** (the choice of how to spend q^j) taken by the entrepreneur.
- He can spend it on an **efficient** projects that results in success with probability $\pi^H < 1$, and thus returning $R^K q^j$, but uses up all of q^j.

- Or, he can spend it on one of two **inefficient** projects that may not succeed.

- First inefficient choice: a **low-moral hazard project**, which costs $q^j - \upsilon q^j$, $\upsilon \in (0,1)$, leaving υq^j for the entrepreneur to appropriate.

- Second inefficient choice: a **high-moral hazard project**, which costs $q^j - Vq^j$, $V \in (0,1)$, and leaves Vq^j in private benefits.

- Both inefficient technologies carry the same probability of success, $\pi^L < \pi^H$, but $0 < \upsilon < V < 1$.

- Thus, entrepreneur will always prefer the high-moral hazard project over the low-moral hazard one.

- Only the efficient technology is, however, economically viable and thus socially valuable.

- To ensure that's the case, Assumption 1:

$$\pi^H \alpha A - R^D > 0 > \pi^L \alpha A + V_t - R^D$$

- Expected net surplus per unit invested in a good project is positive, while that of a high-moral hazard project is negative, even with the private benefit.

- As in HT, by monitoring borrowers, banks eliminate the high-moral hazard project but not the low-moral hazard one.

- Thus, an entrepreneur is left with two choices under monitoring: selecting the efficient or the low -moral hazard project.

- At the same time, monitoring involves a **nonpecuniary cost** for the bank, representing an amount $\gamma_t \in (0,1)$, in terms of goods, per unit invested.

- Hence, bank monitoring will be an optimal arrangement only if the gains from resolving agency problems outweigh the monitoring costs.

Optimal Financial Contract

- Three parties to the financial contract.

- **Entrepreneur**: whether or not he prefers to be diligent depends upon appropriate incentives and outside monitoring.

- **Bank**: either lend the full amount needed to invest in the efficient technology (net of the borrower's initial wealth) or not at all.

- **Workers**: delegate to the bank the task of monitoring; they must be guaranteed a return that is sufficiently high for them to deposit their funds.

- Optimal contract: no party (due to limited liability) earns anything when the project fails; when it succeeds the gross return, R^K, is distributed so that

$$R_{t+1}^{B} + R_{t+1}^{E} + R_{t+1}^{W} = R^{K}$$

- R^B, R^E, R^W: gross returns to the bank, the entrepreneur, and workers.

- Incentive compatibility constraint for entrepreneur:

$$\pi^{H} R_{t+1}^{E} q_{t}^{j} \geq \pi^{L} R_{t+1}^{E} q_{t}^{j} + \upsilon_{t} q_{t}^{j}$$

- Or equivalently , with $\Delta\pi = \pi^H - \pi^L$:

$$R^E_{t+1} \geq \frac{\upsilon}{\Delta\pi}$$

- Incentive compatibility constraint for the bank:

$$\pi^H R^B_{t+1} q^j_t - \gamma R^D q^j_t \geq \pi^L R^B_{t+1} q^j_t$$

- Or equivalently

$$R^B_{t+1} \geq \frac{\gamma R^D}{\Delta\pi}$$

- Participation constraint for workers:

$$\pi^H R_{t+1}^W q_t^j \geq R^D d_t$$

- Contract's objective: maximize the representative entrepreneur's expected share of the return, $\pi^H R^E q^j$, to the incentive compatibility constraints, the participation constraint…

- …and the bank's resource constraint:

$$l_t^j = q_t^j - b_t^j \leq (1-\mu) d_t - \gamma_t q_t^j$$

- $\mu \in (0,1)$: reserve requirement rate.

- Expected (gross) **income that the borrower can credibly pledge** is

$$\pi^H (R^K - R^E_{t+1} - R^B_{t+1}) q^j_t$$

- The participation constraint for workers must therefore also satisfy

$$\pi^H R^W_{t+1} q^j_t \leq \pi^H (R^K - R^E_{t+1} - R^B_{t+1}) q^j_t$$

$$\pi^H R^W_{t+1} q^j_t \leq \pi^H [R^K - (\frac{\upsilon + \gamma R^D}{\Delta\pi})] q^j_t$$

- Or equivalently

$$R^D d_t^j \le \pi^H R_{t+1}^W q_t^j \le \pi^H [R^K - (\frac{\upsilon+\gamma R^D}{\Delta\pi})] q_t^j$$

- Using the bank's resource constraint yields

$$b_t^j \ge b_m(q_t^j) = (1+\gamma) q_t^j - \frac{(1-\mu)\pi^H}{R^D} [R^K - (\frac{\upsilon+\gamma R^D}{\Delta\pi})] q_t^j$$

- Entrepreneurs with initial wealth lower than $b_m^j(q^j)$ **cannot borrow**; workers have no incentives to deposit the funds that the bank needs to lend.

- ***P1**: $b_m^j(q^j)$ is increasing in reserve requirement rate.*

- In equilibrium:

$$R_{t+1}^{E} = \frac{\upsilon}{\Delta\pi}, \quad R_{t+1}^{B} = \frac{\gamma R^{D}}{\Delta\pi}$$

$$R_{t+1}^{W} = R^{K} - \left(\frac{\upsilon + \gamma R^{D}}{\Delta\pi}\right)$$

- By definition, if the project succeeds

$$R_{t+1}^{L} l_t^j = R_{t+1}^{B} q_t^j$$

- Competition: banks make zero (expected) profits.

$$\pi^{H} R_{t+1}^{L} l_t^j = R^{D} d_t$$

- After manipulations, gross loan rate R^L and loans:

$$R_{t+1}^{L} = \frac{R^D}{(1-\mu)\pi^H - \Delta\pi}$$

$$l_t^j = \frac{\gamma[(1-\mu)\pi^H - \Delta\pi]}{\Delta\pi} q_t^j = \Theta q_t^j$$

- Assumption 3:

$$(1-\mu)\pi^H > \Delta\pi$$

- We also need $\Theta < 1$ to ensure that $l^j < q^j$.

- Assumption 4:

$$\gamma/(1+\gamma) < \Delta\pi/(1-\mu)\pi^H$$

- Entrepreneur's income if he does not get financing: he can either deposit his assets abroad at rate R^D or use them in household production.

- Condition for the latter:

$$a_t(b_t^j)^\delta \geq R^D b_t^j$$

$$b_t^j \leq \hat{b}_t^j = (a_t/R^D)^{1/(1-\delta)}$$

- If so

$$z_{t+1}^{j} = a_t (b_t^j)^{\delta}$$

- If the entrepreneur borrows from banks:

$$z_{t+1}^{j} = \frac{\upsilon}{\Delta \pi} q_t^j$$

- Income is a fraction of output.

Investment Decision

- Given optimal contracts and financing arrangements for any investment q^j, entrepreneur j chooses q^j to maximize his income.

- For given b^j above $b_m^j(q^j)$, the choice is

$$q_t^j \leq \frac{R^D b_t^j}{(1+\gamma)R^D - (1-\mu)\pi^H[\alpha A - (\upsilon + \gamma R^D)/\Delta\pi]} = \Phi b_t^j$$

- For maximum level of investment, $\tilde{q}^j = \Phi b^j$: required level of bank loans is $\tilde{q}^j - b^j$.

- However, for investment $\tilde{q}^j$ bank provides Θq^j.

- Equilibrium with maximum investment $\tilde{q}^j$ exists if and only if at the same time

$$\tilde{q}_t^j - b_t^j = \Theta \tilde{q}_t^j \;\Rightarrow\; \tilde{q}_t^j = \frac{b_t^j}{1-\Theta}$$

- That is

$$\Phi(1 - \Theta) = 1$$

- See Proposition 2.

- If above condition is not satisfied, constrained investment is $b^j/(1 - \Theta)$.

- Assumption 5:

$$\gamma R^D < (1-\mu)\pi^H[\alpha A - (\upsilon + \gamma R^D)/\Delta\pi]$$

- Graphical illustration.

- Case where $\Phi(1 - \Theta) < 1$: no equilibrium.

Figure 1
Determination of Optimal Bank Borrowing and Optimal Investment
Case I: $\Theta > \max(1/\Phi, 1 - 1/\Phi)$

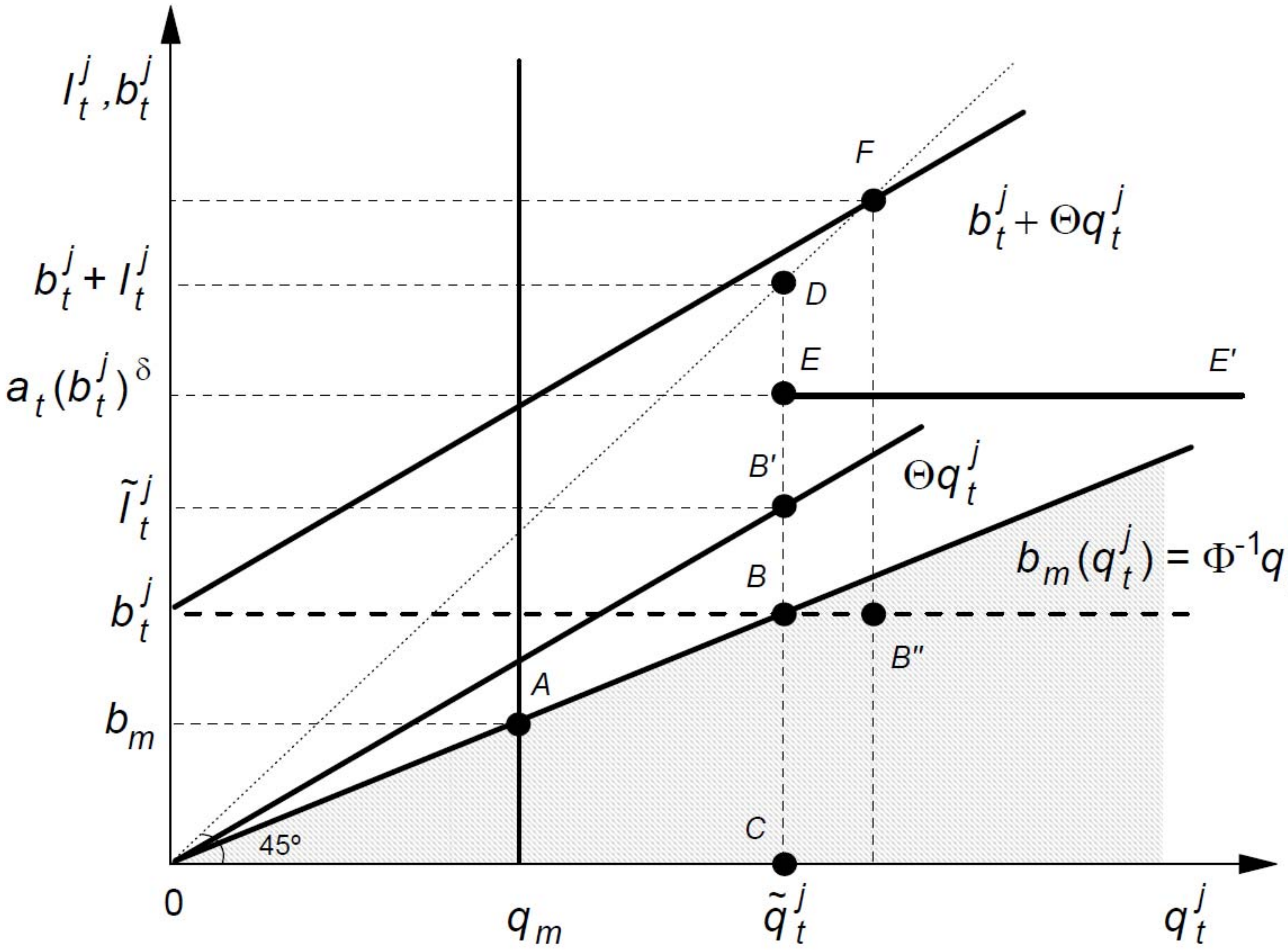


Figure 2
Determination of Optimal Bank Borrowing and Optimal Investment
Case II: $1/\Phi < \Theta < 1 - 1/\Phi$

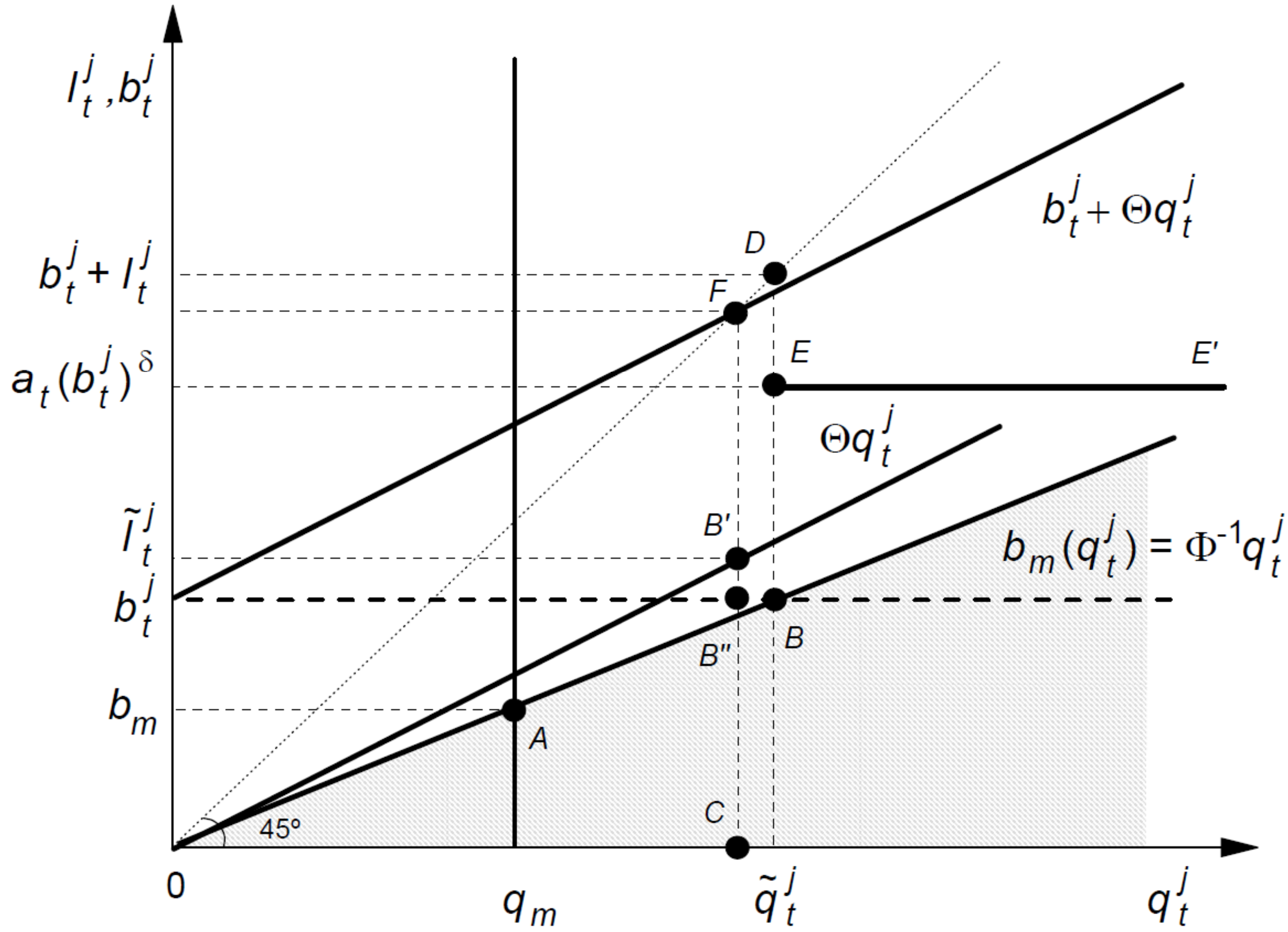
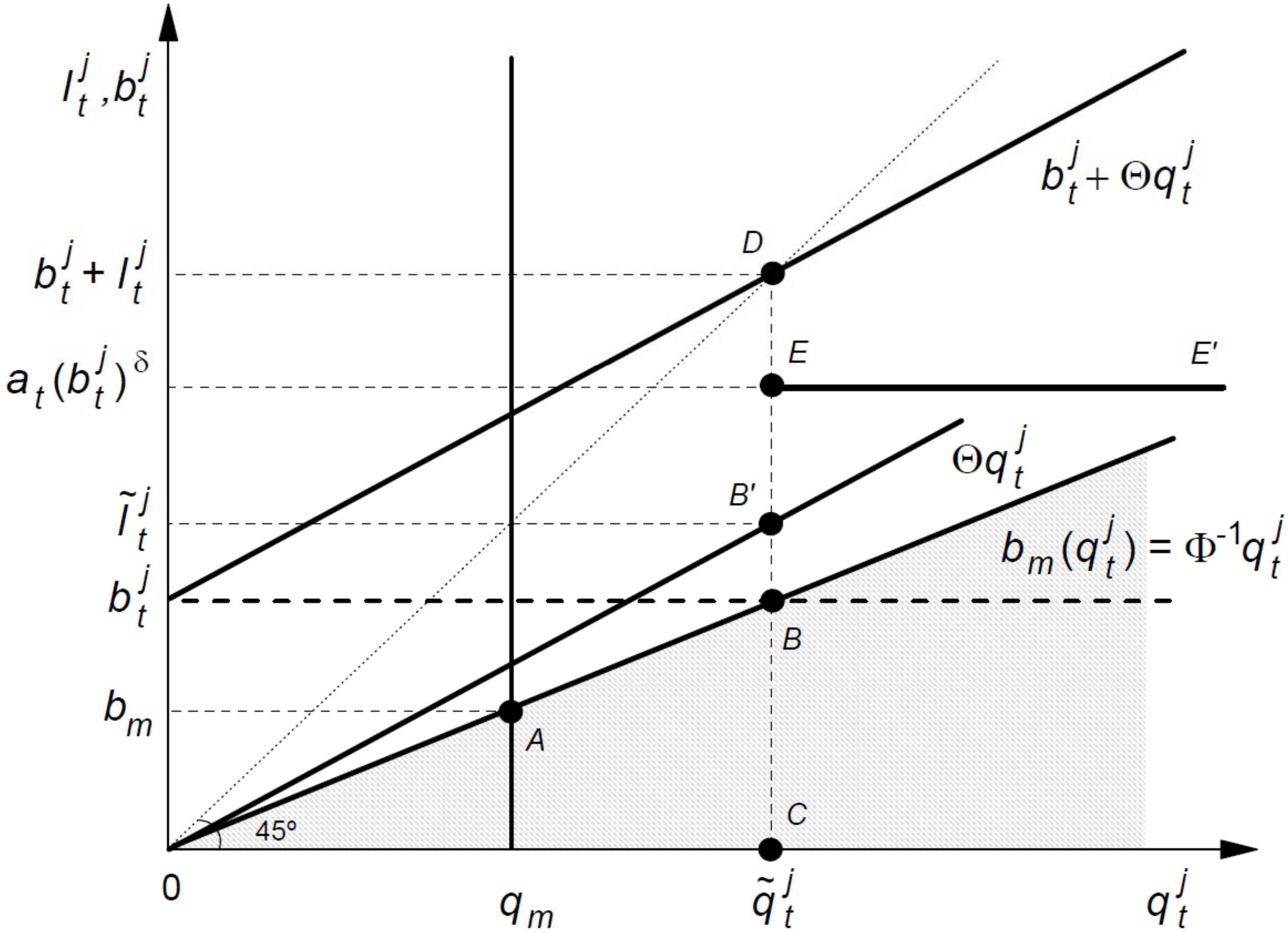


Figure 3
Determination of Optimal Bank Borrowing and Optimal Investment
Case III: $1/\Phi < \Theta = 1 - 1/\Phi$



Balanced Growth Equilibrium

- Entrepreneur's income:

$$\tilde{z}_{t+1}^{j} = \begin{cases} \upsilon\Phi b_t^j/\Delta\pi & \text{if } \Phi(1-\Theta) = 1 \\ \upsilon(1-\Theta)^{-1} b_t^j/\Delta\pi & \text{if } \Phi(1-\Theta) > 1 \end{cases}.$$

- Growth rate 1+*g* is

$$1+g = \begin{cases} (1-\beta)\upsilon\Phi/\Delta\pi & \text{if } \Phi(1-\Theta) = 1 \\ (1-\beta)\upsilon(1-\Theta)^{-1}/\Delta\pi & \text{if } \Phi(1-\Theta) > 1 \end{cases}.$$

- Restrictions given earlier ensure that $g > 0$.

Autonomous Policy Changes

- Assumption now: private benefit of the low-moral hazard project is not constant but decreasing and convex in monitoring intensity:

$$\upsilon = \upsilon(\gamma), \text{ with } \upsilon' < 0, \upsilon'' \geq 0, \text{ and } \lim_{\gamma\to\infty}\upsilon'(\gamma) = 0$$

- Monitoring helps not only to eliminate the high-moral hazard project…

- …but also to mitigate the benefits that can be derived from (and thus the incentives to engage in) low-moral hazard projects.

- ***P3**: A reduction in γ, when $\upsilon' < 0$, has ambiguous effects on investment and steady-state growth rate.*

- Increase in μ: motivated by desire to reduce leverage ratio of borrowers, l^j/b^j, by constraining the capacity of banks to lend, and thereby mitigating systemic risk.

- ***P4**: An increase in μ, with constant monitoring intensity, unambiguously lowers investment and the steady-state growth rate.*

- However, P4 does not hold when γ is endogenous and $\upsilon' < 0$.

Optimal Policy

Optimal Monitoring Intensity

- γ is chosen also to maximize the entrepreneur's expected profits, $\pi^H R^E q^j$.

- Functional form:

$$\upsilon(\gamma) = \begin{cases} \Gamma\gamma^{-\varepsilon/(1-\varepsilon)} & \text{if } \gamma > \gamma_m \\ \upsilon_m & \text{if } \gamma \leq \gamma_m \end{cases}, \quad \varepsilon \in (0,1)$$

- Optimal value

$$\gamma^* = \frac{\varepsilon[(1-\mu)\pi^H \alpha A - R^D]}{R^D + (1-\mu)\pi^H R^D / \Delta\pi}$$

- ***P5**: A The optimal γ, when υ' < 0, is decreasing in μ and increasing in ε.*

- A higher reserve requirement rate reduces the optimal intensity of monitoring because it reduces the bank's income if the project succeeds.

- ***P6**: An increase in μ, with γ set optimally and with υ' < 0, has ambiguous effects on investment and the steady-state growth rate.*

- Key reason for the existence of an optimal reserve requirement rate.

- Growth-maximizing solution of μ:

$$\frac{d\ln(1+g)}{d\mu} = \frac{d\ln\upsilon(\gamma^*)}{d\mu} + \frac{d\ln\Phi(\mu)}{d\mu} = 0$$

$$\ln\Phi(\mu) = \ln R^D - \ln\left\{(1+\gamma^*)R^D - (1-\mu)\pi^H[\alpha A - \tfrac{\upsilon(\gamma^*)+\gamma^* R^D}{\Delta\pi}]\right\}$$

- Welfare criterion:

$$\mathfrak{W}_t = \sum_{h=0}^{\infty}\Lambda^h\{0.5\ln\beta^\beta(1-\beta)^{1-\beta}z_{t+h+1} + 0.5\ln R^D w_{t+h}\}$$

- With $\Lambda \in (0,1)$.

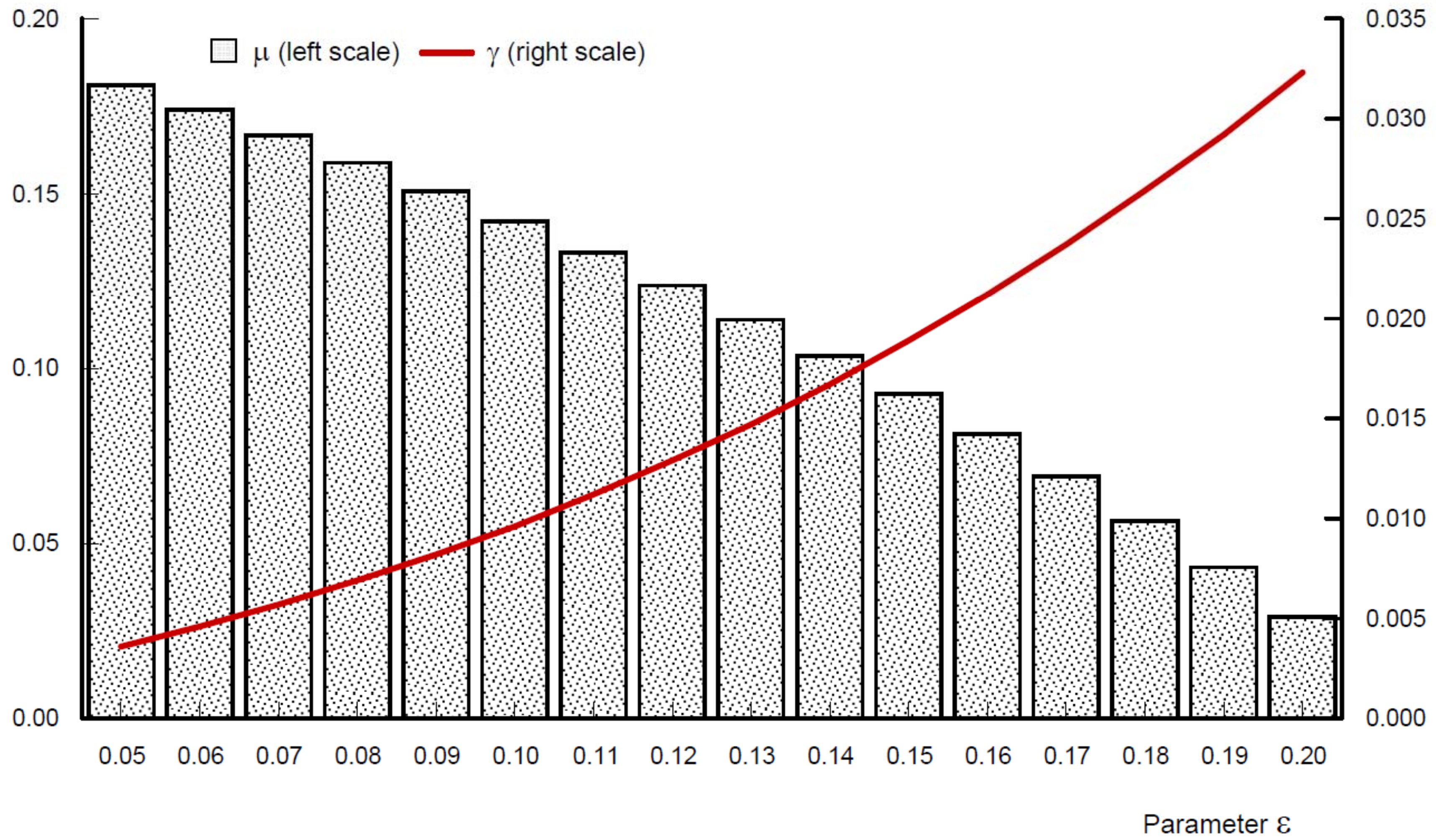
- Solution along the steady-state equilibrium path:

$$\mathfrak{W} \simeq 0.5\frac{\ln \upsilon(\gamma^*)}{1-\Lambda} + \frac{\Lambda}{(\Lambda-1)^2}\ln(1+g)$$

$$-\frac{0.5}{1-\Lambda}\left\{\ln[(1+\gamma^*)R^D - (1-\mu)\pi^H[\alpha A - \frac{\upsilon(\gamma^*)+\gamma^* R^D}{\Delta\pi}]\right\}$$

- Numerical solution.
- Growth- and welfare-maximizing values of μ are similar.
- μ and ε: inversely related; consistent with evidence.

Figure 4
Optimal Monitoring Intensity and Reserve Requirement Rate
Monitoring Parameter ε varying between 0.05 and 0.2



Conclusions

- Trade-off in the use of reserve requirements from a growth perspective.
- Financial stability ((systemic risk) vs. growth.
- But trade-off can be internalized by setting the reserve requirement rate optimally.
- However, model did not account for possibility that when μ is set optimally, it may be so high that it may foster **disintermediation**.
- Need to strengthen financial sector supervision.

- Here, in HT fashion, monitoring reduces entrepreneurial moral hazard, which facilitates access to credit.

- However, it does not affect **projects' profitability**.

- However, monitoring could also affect the quality (or value) of the projects that are implemented, by interfering in the ***ex ante* selection of projects**; See Favara (2012).

- Additional channel through which macroprudential policy can affect growth and welfare.