An Investigation of Optimal Interaction between Monetary Policy and Bank Capital Requirements

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INTRODUCTION

Motivation

- Move towards tougher prudential standard for banks; at the same time, central bank policy rates are at record low level.
- Should the equilibrium level of central bank policy rates be higher or lower in a world with more stringent capital regulations for banks?
- What might an optimal combination of monetary policy and regulatory capital requirement look like?

Our Approach

Simple model of bank lending decisions
- adaptation of the Bernanke-Gertler (1990) paper on financial fragility.

Main changes:

1. Banks
2. Debt and equity funding
3. Policy tools are interest rate and capital requirement

Key mechanics:

- Banks need external financing in order to proceed with risky lending projects.
- Banks have private information on the likelihood of success for the projects they undertake, and enjoy limited liability in the event of failure.
- Asymmetry relative to the external providers of funds give rise to moral hazard and a departure from Modigliani-Miller.

Main Results

We found:

- Monetary policy and bank capital requirements operate as imperfect substitutes.
- Both instruments increase 'prudence' of banks at the cost of 'participation'.
- The optimal stance of monetary policy loosens as capital requirement tightens.

... and under benchmark calibration:

- Capital requirements should be substantial and binding
- Interest rate set by the central bank should be slightly above the level that is optimal in the absence of information asymmetry.

THE MODEL

Agents

Two types of risk-neutral agents:

1. Households with access to risk-free deposit facility remunerated at $(1 + r)$.

2. Banks with access to both the deposit facility and the risky lending project.

   – risky lending pays out $y_h > (1 + r)$ when it succeeds with probability p; and $y_l < (1 + r)$ when it fails with probability $1 - p$.

   – risky lending always require 1 unit of input, but banks start with endowment $\omega < 1$.

Random Variables

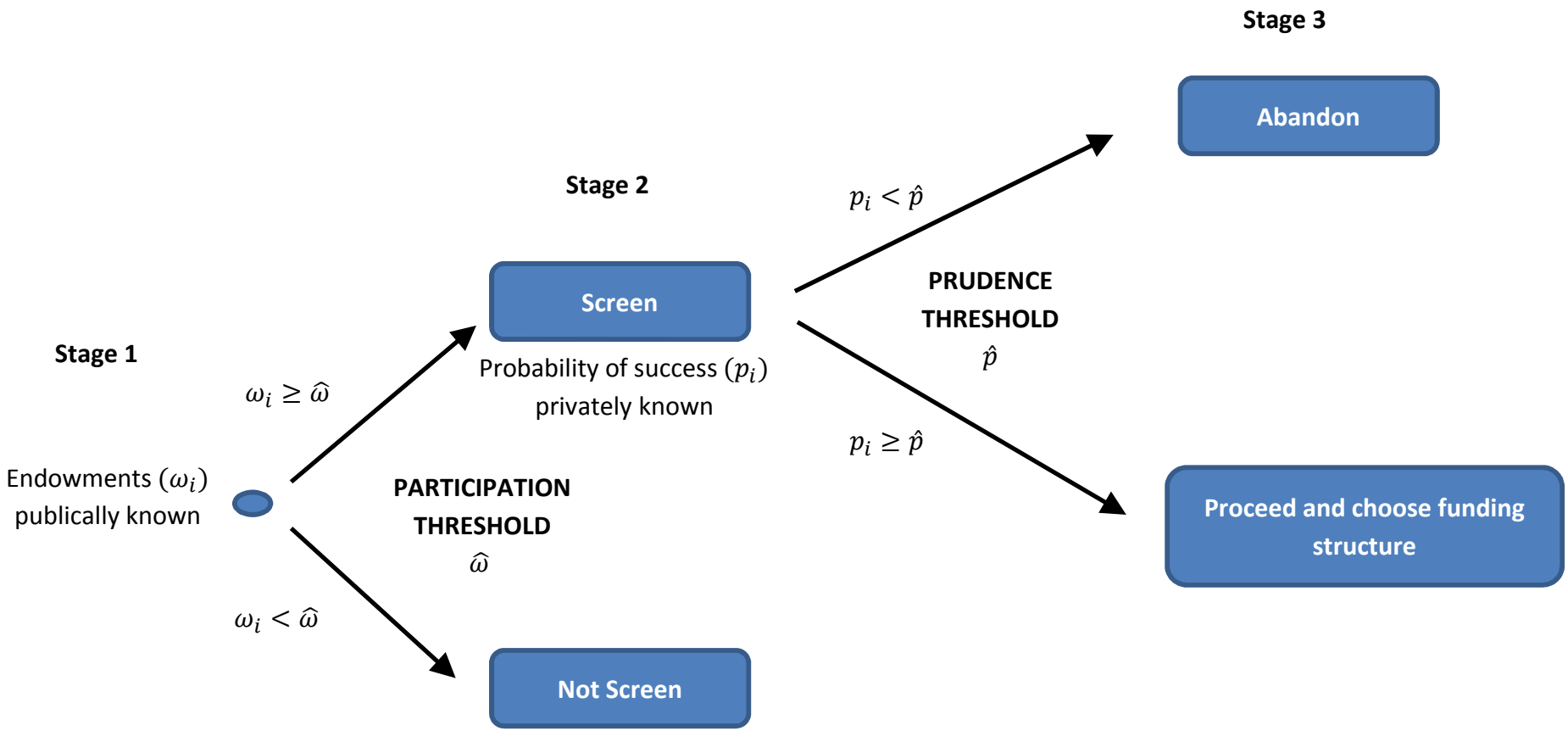
Two random variables:

1. Probability of success, p, uniformly distributed between [0,1].
2. Initial endowment of banks, ω, uniformly distributed between $[\omega_{lb}, \omega_{ub}]$, where $1 \geq \omega_{ub} > \omega_{lb} \geq 0$.

Information structure:

- All parameters (and distributions for random variables) are common knowledge.
- The only thing that is not publically known is p_i (each individual bank's realisation of p) which can only be observed by bank i itself - if it chooses to undertake costly screening (for a fixed cost C).

Timing – bank i's decision process



Two key thresholds :

1. Endowment threshold for undertaking screening $\hat{\omega}$: determines level of `**participation**'.
2. Success threshold for undertaking lending $\hat{p}$: a measure for the level of `**prudence**'.

Types of Funding

Funding from households can take two forms :

1. **Equity contract**
   - Provide additional equity $\tilde{\omega}$, for a $\frac{\tilde{\omega}}{\omega+\tilde{\omega}}$ share of the bank's profit.

2. **Debt contract**
   - Provide $\left(1-(\omega+\tilde{\omega})\right)$ amount of debt, for a promised gross return of $\mathrm{R}(\omega+\tilde{\omega}, r)$.
   - Since banks are protected by limited liability, if the lending project fails, the actual gross return to debt providers is $\min[\mathrm{R}(\omega+\tilde{\omega}, r), y_l]$

Under asymmetric information, the **participation** and **prudence** thresholds of a particular bank will depend, in part, on its choice of funding structure.

THE FIRST-BEST

Social Planner (the model under perfect information)

- Social planner ensures that banks only proceed with the risky lending project post screening if its expected return at least matches that from the risk-free deposit facility. That is: $p(y_h - y_l) + y_l \geq 1 + r$.

- So the **'prudence threshold'** for accepting a project in the first-best is given by:

$$\hat{p}_{fb} = \frac{1 + r - y_l}{(y_h - y_l)}$$

Social Planner (cont.)

- We assume that the cost of screening is less than the expected value-added from the project when banks act prudently:

$$C < V(\hat{p}_{fb}) = \int_{\hat{p}_{fb}}^{1} [p(y_h - y_l) + y_l - (1+r)]h(p)dp$$

… such that it would be optimal for the social planner to screen every project.

- So the **'participation threshold'** for accepting a project in the first-best is given by:

$$\hat{\omega}_{fb} = 0$$

- Not surprisingly, the first-best gives the Modigliani-Miller result.

Summary:

- All banks screen (regardless of ω_i).
- But only those with $p_i \geq \hat{p}_{fb} = \frac{(1+r)-y_l}{(y_h-y_l)}$ proceed with the risky lending project after screening.

THE MODEL UNDER ASYMMETRIC INFORMATION

Prudence Threshold

The **prudence threshold** of bank i, $\hat{p}_i = \hat{p}(\omega_i + \tilde{\omega}_i, \mathrm{r})$, and the terms of its funding contract are jointly determined by the following three equations (subscript i henceforth suppressed for brevity):

1. The condition where the bank is indifferent between lending and depositing

$$\frac{\omega}{\omega + \tilde{\omega}}\left\{\hat{p}\big(y_h - R(\omega + \tilde{\omega}, r)\big) + (1 - \hat{p})max[0, y_l - R(\omega + \tilde{\omega}, r)]\right\} = \omega(1 + r) \quad (1)$$

2. The condition where the households are indifferent between providing debt and depositing

$$A(\hat{p})R(\omega + \tilde{\omega}, r) + \big(1 - A(\hat{p})\big)(min[y_l\,, R(\omega + \tilde{\omega}, r)]) = (1 - \omega - \tilde{\omega})(1 + r) \quad (2)$$

where $A(\hat{p}) \equiv E[p|p \geq \hat{p}] \equiv \frac{1}{1-H(\hat{p})}\int_{\hat{p}}^{1} ph(p)dp$ denotes the conditional expectation of p given that $p \geq \hat{p}$.

Prudence Threshold (cont.)

3. The condition where for the households providing additional equity to the bank, their expected return from the capital injection is at least equal to the safe rate of return:

$$\frac{\tilde{\omega}}{\omega+\tilde{\omega}}\left\{A(\hat{p})\left(y_h - R(\omega+\tilde{\omega},r)\right) + \left(1-A(\hat{p})\right)max[0, y_l - R(\omega+\tilde{\omega},r)]\right\} \geq \tilde{\omega}(1+r) \qquad (3)$$

Proposition 1

Proposition 1: Banks that are not 'fully capitalised' will take excessive risks:

i. Let ω^* denote the level of capital such that $y_l = R(\omega^*, r)$, then $\omega^* = 1 - \frac{y_l}{1+r}$ and banks with $\omega + \tilde{\omega} \geq \omega^*$ can borrow at the risk-free rate.

- We refer to any bank with $\omega + \tilde{\omega} \geq \omega^*$ as a "*fully capitalised*' bank, because such a bank can pay its debt in full - even in the bad state.

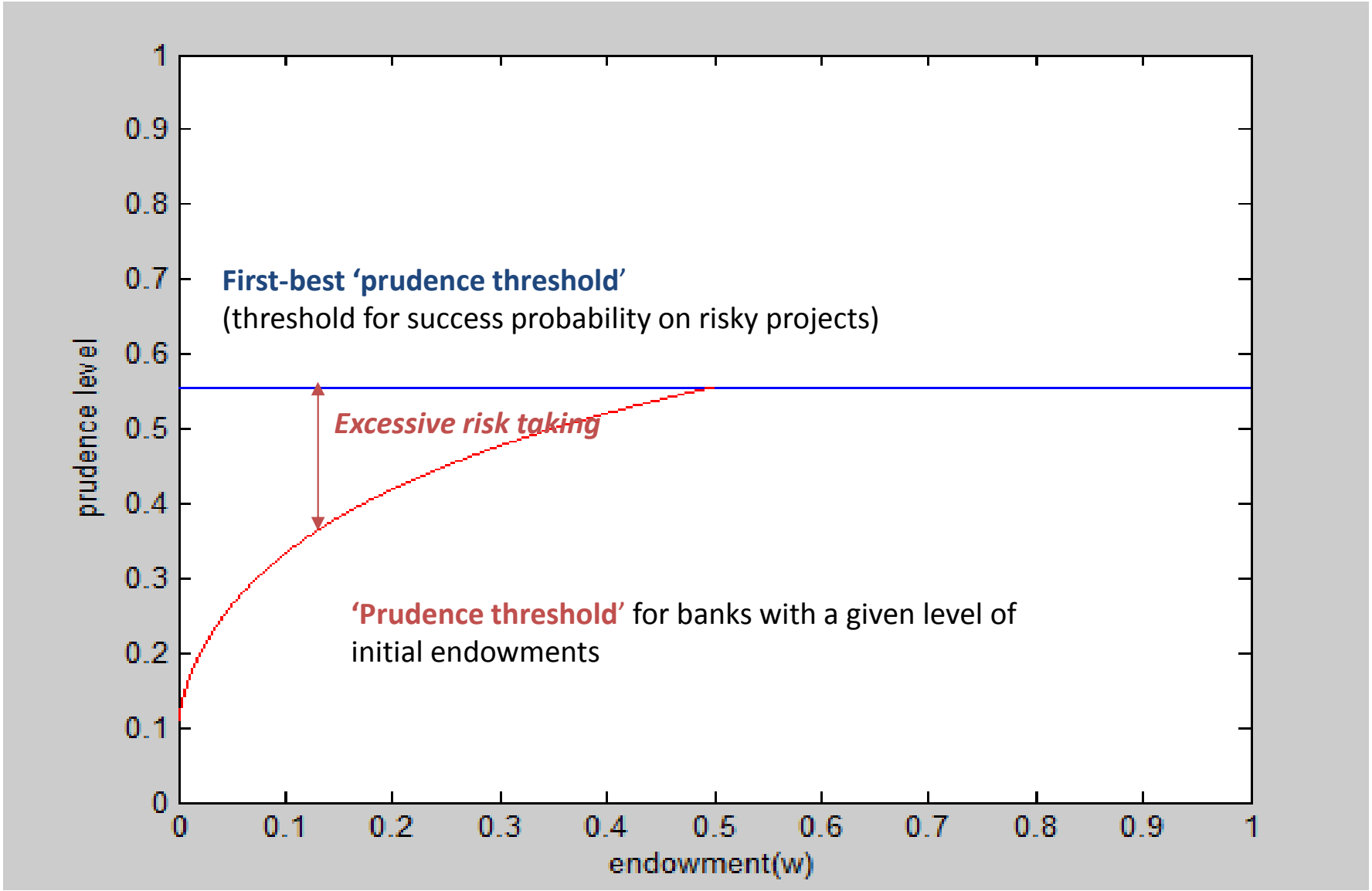
ii. $\hat{p}(\omega + \tilde{\omega}, \mathrm{r}) \leq \hat{p}_{fb} = \frac{1+r-y_l}{(y_h - y_l)}$, with equality only when $\omega + \tilde{\omega} \geq \omega^*$.

- Banks that are not 'fully capitalised' ($\omega + \tilde{\omega} < \omega^*$) will take excessive risks.

iii. $\frac{\partial \hat{p}(\omega+\tilde{\omega},\mathrm{r})}{\partial \omega} = \frac{\partial \hat{p}(\omega+\tilde{\omega},\mathrm{r})}{\partial \tilde{\omega}} \geq 0$, with equality only when $\omega + \tilde{\omega} \geq \omega^*$.

- Banks become more prudent as they increase their capital, up to a cap when they become 'fully capitalised'. An increase in initial endowment has the same marginal impact on prudence as an increase in external equity. Banks lending behaviour is influenced by the size of their equity rather than its source.

Proposition 1 (illustration)



Proposition 2

Proposition 2: Banks prefer debt to equity:

i. After screening, banks invest in the risky lending project if and only if $p \geq \hat{p}(\omega + \tilde{\omega}, \mathrm{r})$; and

ii. When banks undertake the project they choose to fund with external debt rather than external equity (i.e. banks will choose to set $\tilde{\omega} = 0$).

- Because profits are shared equally with external equity providers, insiders don't want to dilute their stake.

Corollary: In the absence of capital regulations, banks will not seek external equity injections when they undertake risky lending.

Participation Threshold

The **'participation threshold'** of banks is defined as the level of initial endowment that equates the expected value of screening (V) to the fixed cost of screening (C).

Formally, the expected value of screening (V) is given by:

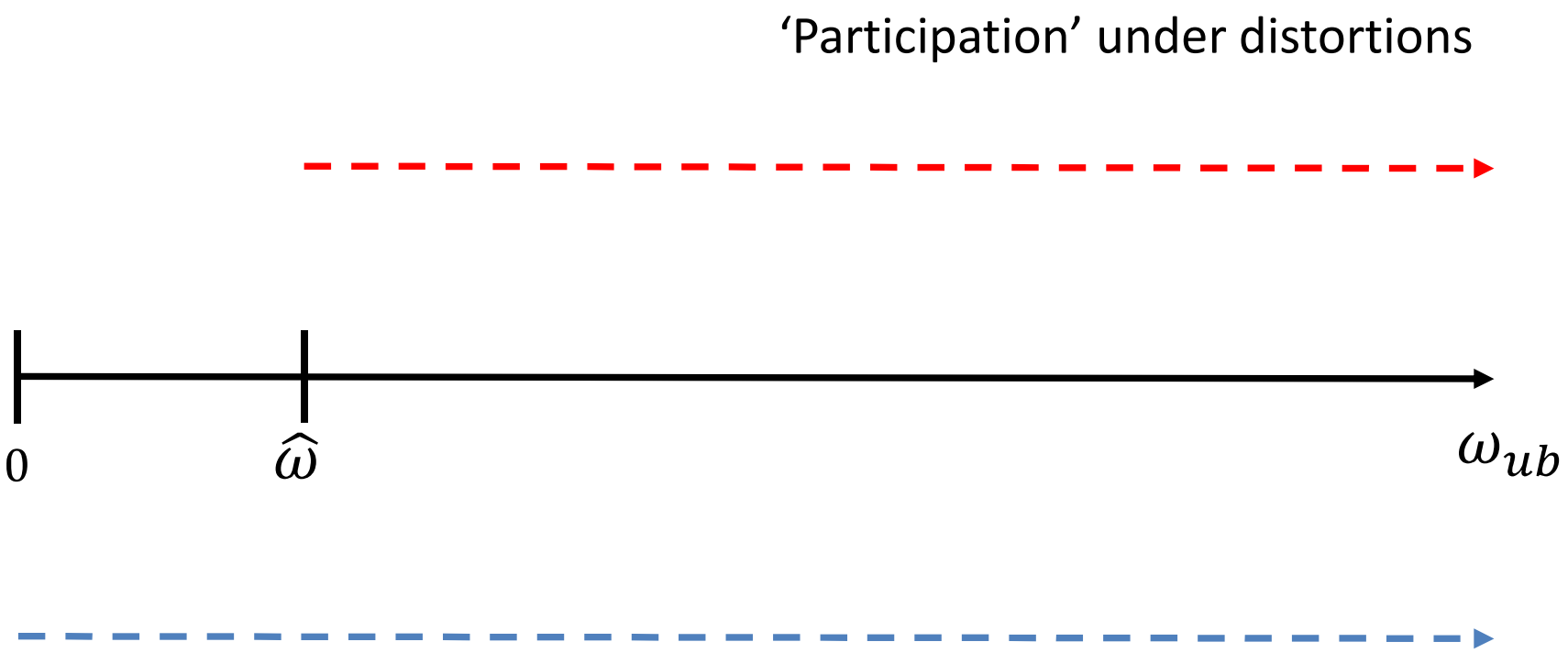
$$V(\omega, \tilde{\omega}, r) \equiv E_p \left[max \left\{ 0 , \frac{\omega}{\omega + \tilde{\omega}} (p(y_h - R) + (1-p) max[0, y_l - R]) - \omega(1+r) \right\} \right]$$
$$= \frac{\omega}{\omega + \tilde{\omega}} \int_{\hat{p}(\omega+\tilde{\omega},r)}^{1} [p(y_h - y_l) + y_l - (1+r)] h(p) dp \qquad (4)$$

… where the last line follows because the debt is provided by households at a zero-profit basis.

Definition: The **participation threshold** for banks, $\hat{\omega}(\tilde{\omega},r)$, is implicitly defined by:

$$V(\hat{\omega}, \tilde{\omega}, r) = \frac{\hat{\omega}}{\hat{\omega} + \tilde{\omega}} \int_{\hat{p}(\hat{\omega}+\tilde{\omega},r)}^{1} [p(y_h - y_l) + y_l - (1+r)] h(p) dp = C$$

Participation Threshold (illustration)



Summary

Not enough banks screen; and too many take excessive risks

- The presence of moral hazard in the model give rise to sub-optimal outcomes compared to the first-best scenario.
- Banks have no incentives to top-up their capital.
- The hurdle for **participation**, $\hat{\omega}(\tilde{\omega}, r) > 0$, is too high; and
- The level of **prudence**, $\hat{p}(\omega + \tilde{\omega}, \mathrm{r}) \leq \hat{p}_{fb}$, is too low.

POLICY TOOLS AND THEIR TRANSMISSION

Monetary Policy

- We introduce monetary policy by allowing the central bank to affect the risk-free rate of return on the deposit facility (r).
- The central bank remunerates all resources placed in the deposit facility and recoups the cost through lump-sum taxation on all agents (τ)
- We normalise $r = 0$ as the neutral stance of monetary policy.

Proposition 3: ***Monetary policy tightening improves 'prudence' at the cost of decreasing 'participation'. Monetary policy loosening achieves the converse.***

i. $\frac{\partial \hat{p}(\omega+\tilde{\omega},\mathrm{r})}{\partial r} > 0 \; ; and$

ii. $\frac{\partial \widehat{\omega}(\tilde{\omega},r)}{\partial r} > 0$

Capital Requirements

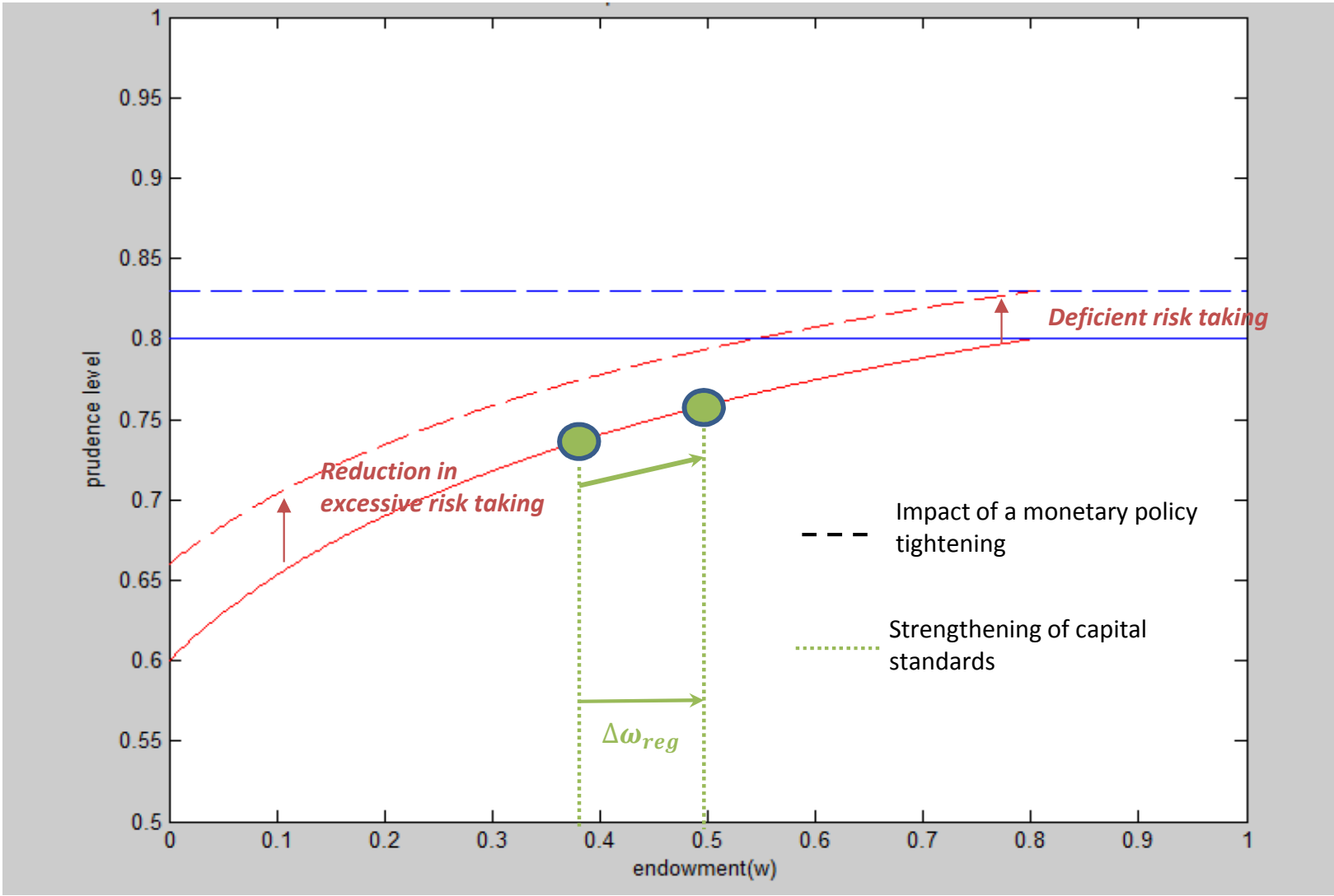
- We model capital regulations in the simple form of a leverage ratio.
- Regulators impose a minimum capital requirement ω_{reg} such that banks with endowments $\omega < \omega_{reg}$ must seek outside equity of at least $(\omega_{reg} - \omega)$ or are barred from lending.
- A strengthening of capital requirements achieves the same qualitative effect as a tightening of monetary policy, albeit through slightly different means.

Proposition 4: ***Capital regulations improve prudence by forcing some banks to seek additional equity funding, but do so at the cost of decreased participation.***

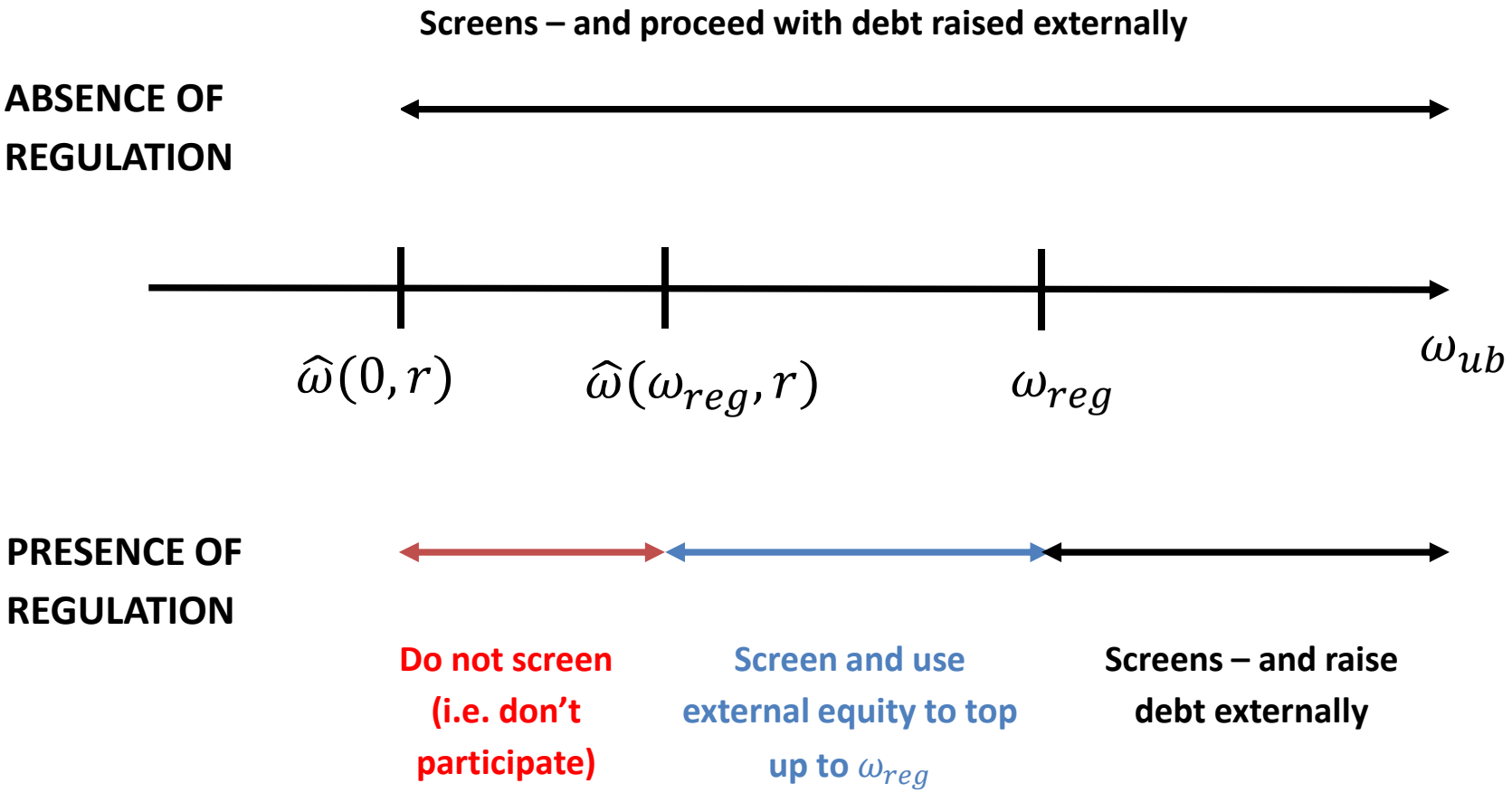
i. $\frac{\partial \hat{p}(\omega+\tilde{\omega},\mathrm{r})}{\partial \omega_{reg}} \geq 0$; *and*

ii. $\frac{\partial \widehat{\omega}(\tilde{\omega},r)}{\partial \omega_{reg}} \geq 0$

Policy transmission (impact on prudence)



Policy transmission (impact on participation)



NUMERICAL SIMULATIONS

Objective Function

- Policy makers set policy tools (r, ω_{reg}) to maximise the expected level of aggregate output:

$$
\begin{aligned}
Q\left(\omega_{reg}, r\right) = & \; 1 + \mu \int_{\omega(\omega_{reg}-\omega, r)}^{\min[\omega_{reg}, \omega_{ub}]} \left[\int_{p(\omega_{reg}, r)}^{1} \left[p\left(y_h - y_l\right) + y_l - 1 \right] h(p) dp \right] dF(\omega) \\
& + \mu \int_{\min[\omega_{reg}, \omega_{ub}]}^{\omega_{ub}} \left[\int_{p(\omega, r)}^{1} \left[p\left(y_h - y_l\right) + y_l - 1 \right] h(p) dp \right] dF(\omega) \\
& - \mu C \left[\int_{\omega(\omega_{reg}-\omega, r)}^{\omega_{ub}} f\left(\omega\right) d\omega \right]
\end{aligned}
$$

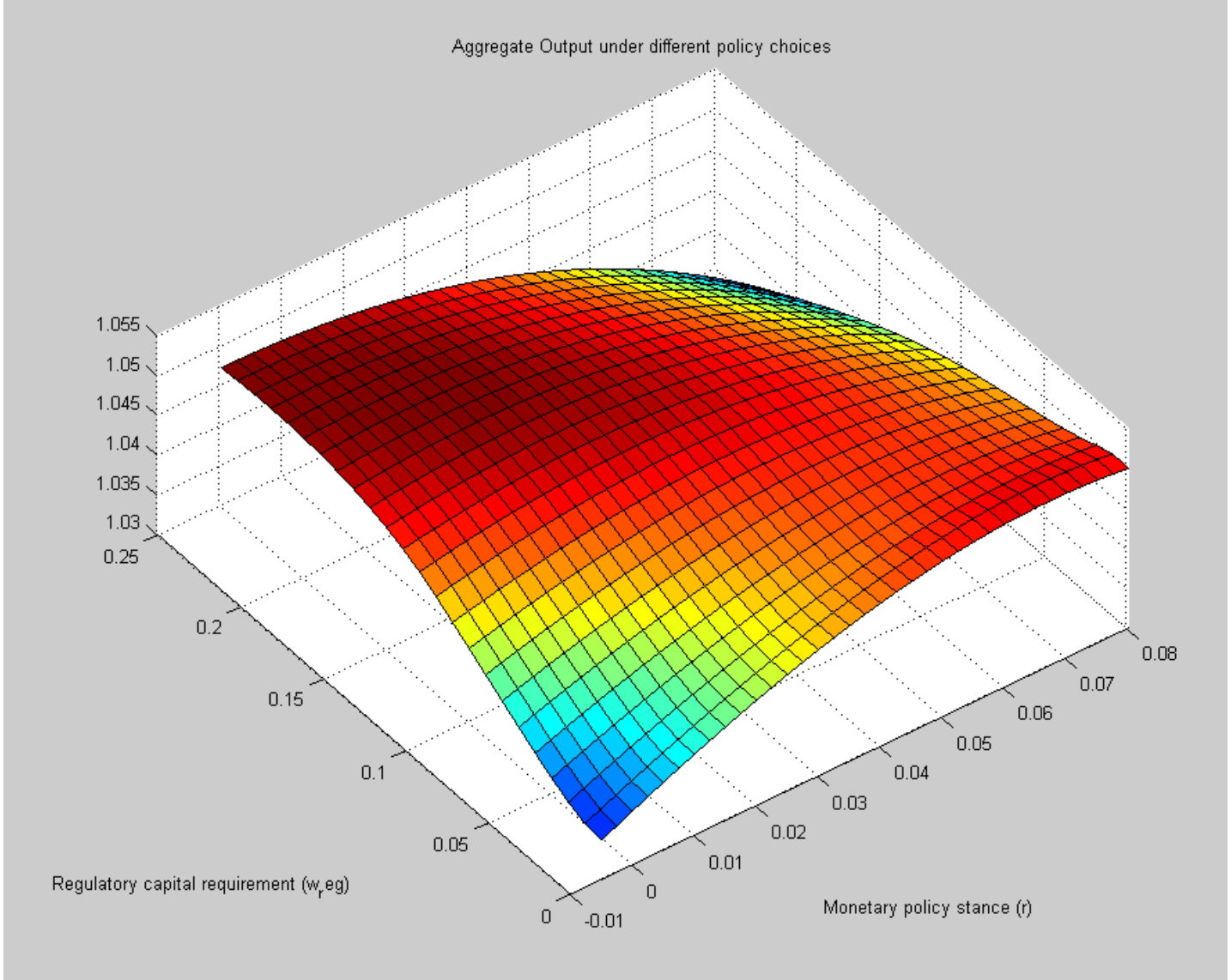
- This objective function accounts for both the volume and the quality of bank lending.

Benchmark Calibration

- We choose a combination of parameters that delivers a banking sector which adds around 5% to aggregate output
  - a figure that broadly corresponds to the average GDP weight of the UK and the US banking sector in recent times.

Parameters	Benchmark Calibration
The payoff from risky bank lending in the good state (y_h)	1.4
The payoff from risky bank lending in the bad state (y_l)	0.5
The probability of success on bank lending projects (p)	$p \sim U[0\,,1]$
The initial endowment of banks (ω)	$\omega \sim U[0\,,0.1]$
The cost of screening for banks (C)	0.01
The cost of using monetary policy to address financial stability concerns (α)	2.5%

Outcomes under different policy choices



Outcomes under scenarios

Scenarios	Participation Threshold ($\widehat{\omega}$)	Prudence Threshold ($\widehat{p}$)	Probability of failure for projects undertaken ($1 - A(\widehat{p})$)	Aggregate Lending (I)	Aggregate Output (Q)
No Policy Intervention	0.0037	Varies with ω_t, average = 0.25	0.38	0.71	1.0367
Optimal Policy ($r = 0.75\%$ and $\omega_{req} = 18\%$)	0.0239	0.41	0.30	0.45	1.0531
First-Best	0	0.56	0.22	0.44	1.0789

CONCLUSION

Main Results

We found:

- Monetary policy and bank capital requirements operate as imperfect substitutes.
- Both instruments increase 'prudence' of banks at the cost of 'participation'.
- The optimal stance of monetary policy loosens as capital requirement tightens.

... and under benchmark calibration:

- Capital requirements should be substantial and binding
- Interest rate set by the central bank should be slightly above the level that is optimal in the absence of information asymmetry (which is the cause of the inefficiency under unregulated outcomes).

THANK YOU FOR LISTENING