Loan Pricing under Basel Capital Requirements

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Rafael Repullo and Javier Suarez

CEMFI, Madrid, Spain

Purpose of paper

- Model to assess impact of capital regulation on loan pricing
- Effects of moving from Basel I to Basel II
    - Interest rates for different types of loans
    - Probabilities of bank failure

Ingredients of model

- Perfectly competitive banks
- Zero intermediation costs
- Full deposit insurance
- Costly bank capital
- *Single risk factor* determines default rates (as in Basel II)

Overview of presentation

- **Description of model**
    - Banks' objective function
    - Capital regulation
    - Loan pricing equation
- **Main results**
    - Implications for loan rates and bank solvency
    - Equilibrium and actuarially fair rates
    - Net interest income correction
- **Concluding remarks**

The model

- Two dates ($t = 0,1$)
- Large number of banks
- Limited liability and zero intermediation costs
- Unit loan portfolio funded with $1-k$ deposits and k capital
- Depositors are fully insured and require zero return
- Shareholders are risk neutral and require return $\delta > 0$
- Different types of loans characterized by probability of default $\overline{p}$

Result: Each bank specializes in a single type of loans

Loan defaults

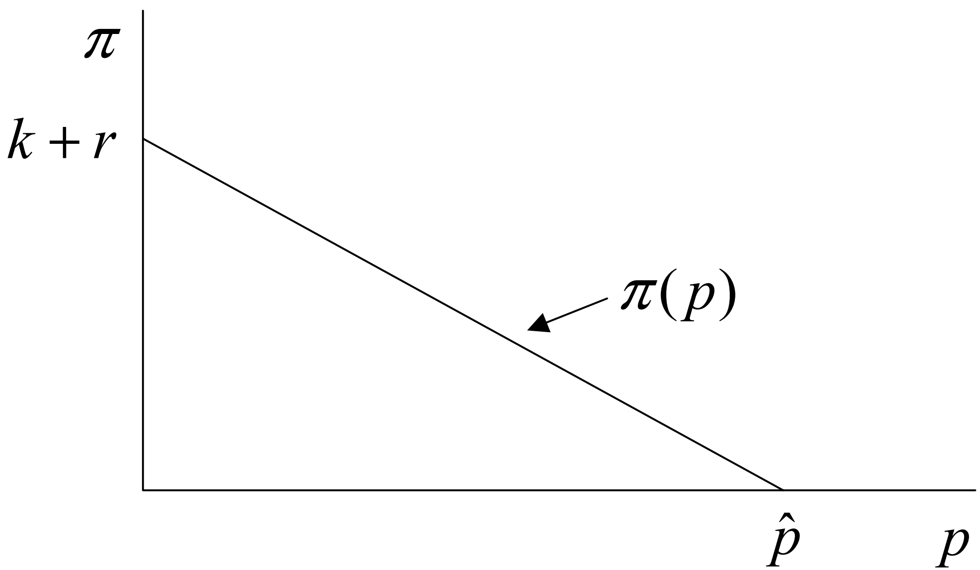
- From each loan the bank gets
  - $1 + r$ if it does not default $\rightarrow$ r = loan rate
  - $1 - \lambda$ if it defaults $\rightarrow$ λ = loss given default (LGD)

- Default rate (fraction of loans that default) = p

  $\rightarrow$ Random variable with density function $g(p)$

Bank's net worth

- Bank's net worth at $t = 0 \;\rightarrow\; k$
- Bank's net worth at $t = 1 \;\rightarrow\; \pi(p) = k + \underbrace{r - p(\lambda + r)}_{\text{net interest income}}$



- Bankruptcy default rate $\hat{p} = \dfrac{k + r}{\lambda + r}$

Bank's objective function

- Shareholders maximize net present value

$$V = -k + \frac{1}{1+\delta}\int_0^{\hat{p}} [k + r - p(\lambda + r)]g(p)dp$$

Result: $\frac{\partial V}{\partial k} = -1 + \frac{\Pr(p < \hat{p})}{1+\delta} < 0 \quad \rightarrow$ Corner solution for k

Capital regulation

- Basel I: k is a constant (8%)
- Basel II: k must cover losses with confidence level $\alpha = 99.9\%$

$$k = \lambda p_\alpha = \lambda \Phi\left(\frac{\Phi^{-1}(\bar{p}) + \sqrt{\rho}\,\Phi^{-1}(\alpha)}{\sqrt{1-\rho}}\right)$$

  - p_α is α-quantile of distribution of default rate: $\Pr(p \le p_\alpha) = \alpha$
  - $\Phi(\cdot)$ is the cdf of a normal random variable
  - ρ measures correlation in defaults

Loan pricing equation

- Equilibrium loan rate r^* satisfies zero net value condition

$$V = -k + \frac{1}{1+\delta}\int_0^{\hat{p}} [k + r^* - p(\lambda + r^*)]g(p)dp = 0$$

Implications for loan rates

- Loan rates under Basel II are more sensitive to changes in PD

$$\frac{dr_{II}^{*}}{d\overline{p}} > \frac{dr_{I}^{*}}{d\overline{p}} > 0$$

Equilibrium loan rates

PD	Basel I	Basel II
0.1%	0.85%	0.20%
0.5%	1.03%	0.67%
1.0%	1.26%	1.09%
2.0%	1.73%	1.79%
4.0%	2.70%	3.07%
10.0%	5.83%	7.06%

Parameter values: LGD $\lambda = 45\%$ Cost of capital $\delta = 10\%$

Implications for borrower types

- Low risk firms borrow from Basel II banks $\rightarrow$ lower loan rates
- High risk firms borrow from Basel I banks

Implications for bank solvency

- Probability of bank failure

$$f = \Pr(\pi < 0) = \Pr(p > \hat{p})$$

- Riskiest banks under Basel I are specialized in high risk lending

$$\frac{df_I}{d\overline{p}} > 0$$

- Riskiest banks under Basel II are specialized in low risk lending

$$\frac{df_{II}}{d\overline{p}} < 0$$

Probabilities of bank failure

PD	Basel I	Basel II
0.1%	0.00%	0.07%
0.5%	0.00%	0.06%
1.0%	0.02%	0.05%
2.0%	0.06%	0.04%
4.0%	0.23%	0.03%
10.0%	2.01%	0.01%

Equilibrium and actuarially fair rates

- Actuarially fair rate $\bar{r}$ equates

expected payments from loan = marginal cost of funding

$$(1-\bar{p})\bar{r} - \bar{p}\lambda = \delta k \quad \rightarrow \quad \bar{r} = \frac{\bar{p}\lambda + \delta k}{1-\bar{p}}$$

Equilibrium and actuarially fair rates

- **Result 1:** $\bar{r} > r^*$

  → Deposit insurance subsidy passed on to the borrowers in the form of lower equilibrium rates

- **Result 2:** Under Basel II $\bar{r} - r^* < \lambda(1-\alpha)$ → very small!

  → High confidence level α imply that deposit insurance subsidy is very small, and has negligible effect on pricing

Net interest income correction

- Probability of bank failure under Basel II satisfies $f_{II} < 1 - \alpha$
- Why?

  $\rightarrow$ Because net interest income earned on performing loans (partially) covers losses on defaulting loans, an effect that is not taken into account in Basel II

Net interest income correction

- Alternative: Set k such that

$$\Pr(\pi \geq 0) = \Pr(k + r^* - p(\lambda + r^*) \geq 0) = \alpha$$

$$\rightarrow \quad k = \underbrace{\lambda p_\alpha}_{\text{Basel II}} - \underbrace{r^*(1 - p_\alpha)}_{\text{net interest income correction}}$$

- Closed form solution: $k = \dfrac{\lambda(p_\alpha - \overline{p})}{\delta(1 - p_\alpha) + 1 - \overline{p}}$ $\rightarrow$ decreasing in δ!

Concluding remarks

- Low risk firms borrow from Basel II banks
- High risk firms borrow from Basel I banks
- Basel II charges are too high for risky loans
    - Net interest income correction
- Equilibrium rates approximated by actuarially fair rates
    - Deposit insurance has negligible effect on pricing