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Endogenous risk in monopolistic competition

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HIGHLIGHTS

- We consider a model where financial intermediaries are monopolistic competitors.
- The borrowers optimally derive the riskiness of their investment projects.
- The financial intermediaries compete for borrowers a la Dixit–Stiglitz.
- U-shaped relationship between the risk and the degree of competition is obtained.

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ABSTRACT

We consider a model of financial intermediation with a monopolistic competition market structure. A non-monotonic relationship between risk measured as a probability of default and the degree of competition is established.

There is growing evidence, both theoretical and empirical, of a non-monotonic relationship between competition and the risk undertaken by financial institutions. According to the so-called traditional view, banks have incentives to take more risk as competition increases since in less competitive markets there is no need to take on more risk due to a high monopoly rent (Keeley, 1990). However, there is also evidence of a negative relationship between bank risk taking and competition as in Boyd and de Nicolò (2005) and Boyd et al. (2007, 2009). There are a few papers where a U-shaped relation between bank risk taking and the degree of competition is predicted: in Boyd and de Nicolò (2003) the effect of competition on bank risk taking is investigated when a bankruptcy cost is allowed; in Martinez-Miera and Repullo (2010, MMR hereafter), due to common shocks there is a default correlation between loans which leads to a U-shaped relationship between risk and competition.

MMR consider the case of imperfectly correlated loan defaults where the probability of default is endogenously derived by entrepreneurs. The supply side is characterized by a finite number of banks engaged in Cournot competition for entrepreneurial loans. However, it is well known that banks do not supply identical financial products so, as a more realistic case, we consider monopolistic competition between a continuum of financial intermediaries, while keeping imperfect correlation in loan defaults as an important and realistic feature. In our setting, the entrepreneurs purchase a basket of differentiated financial products, characterized by a constant elasticity of substitution, each of them supplied by a single bank. In effect, entrepreneurs have to solve the portfolio problem by deriving how much of each differentiated product they have to purchase in order to minimize borrowing cost.

We find that a U-shaped relationship between the probability of default and the degree of competitiveness exists in a monopolistically competitive market as well. This is important for two reasons.

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First, in our case, the nature of competition is quite different since FIs compete by differentiated products in contrast to an MMR setting where they compete by a single product. Second, we have a continuum of banks.[1]

1. Model

There is a continuum of entrepreneurs, financial intermediaries (FIs) and depositors. Financial intermediaries are monopolistic competitors and provide loans to entrepreneurs. For simplicity, loans are financed by a perfectly elastic supply of funds from depositors at zero price. We build on MMR by adding a continuum of monopolistically competitive banks which provide a variety of intermediate financial products (credits) characterized by their prices (interest rates) r_i.

1.1. Entrepreneurs

There is a continuum of penniless risk-neutral entrepreneurs of measure one, indexed by $i \in [0, 1]$. To run the investment project, one unit of capital is needed and the revenue R generated by entrepreneur's ith investment project is a binomial random variable defined as

$$R = \begin{cases} 1 + \zeta(p_i) & \text{with probability } 1 - p_i \\ \lambda & \text{with probability } p_i \end{cases} \tag{1}$$

where $\zeta(p_i)$ is an increasing and concave function of p_i, reflecting the fact that a project with a higher revenue has a higher probability of default, and $\lambda < 1$. When the investment project is undertaken, the probability of its default p_i is endogenously chosen by the entrepreneur.[2]

There is a continuum of banks of measure one indexed by $j \in [0, 1]$ whose market power in the loan market is modeled in a Dixit–Stiglitz (Dixit and Stiglitz, 1977) framework: one unit of capital purchased by the entrepreneur is a basket of differentiated financial products (each supplied by bank j) with a constant elasticity of substitution $\theta > 1$

$$1 = \left(\int l_j^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}} \tag{2}$$

where l_j is the quantity purchased of product j. This approach[3] may be a realistic way of capturing competition between FIs at the aggregate level.

The cost of borrowing for the entrepreneur is given by

$$\int (1 + r_j) l_j dj \tag{3}$$

where $1 + r_j$ is the price of financial product j.

Combining (1) and (3), the ith entrepreneur's problem can be written as

$$\overline{u} = \max_{p_i, l_j} (1 - p_i) \left(1 + \zeta(p_i) - \int (1 + r_j) l_j dj \right). \tag{4}$$

$$s.t. \tag{5}$$

$$1 = \left(\int l_j^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}. \tag{6}$$

Apart from choosing the probability of default p_i, the entrepreneur i will also choose fractions l_j to minimize the repayment cost subject to (2).

1.1.1. Demand

The FOC of problem (4) gives us the downward-sloping demand that bank j faces from a single entrepreneur i

$$l_j = \left(\frac{1 + r_j}{1 + r} \right)^{-\theta},$$

where $1 + r$ is the aggregate gross rate defined as

$$1 + r = \left[\int (1 + r_j)^{1-\theta} dj \right]^{\frac{1}{1-\theta}}. \tag{7}$$

Since all entrepreneurs who are in need of investment demand the same amount of capital l_j from bank j, the total demand faced by bank j is

$$L_j = \left(\frac{1 + r_j}{1 + r} \right)^{-\theta} L(r) \tag{8}$$

where the total demand $L(r)$ is exogenously given and is a decreasing function of r.

1.1.2. Distribution of the default rate

As in MMR, we assume that each investment project i is characterized by a latent random variable y_i so that whenever $y_i < 0$, the project is in the default state. y_i is defined as[4]

$$y_i = -\Phi^{-1}(p_i) + \sqrt{\rho} z + \sqrt{1 - \rho} \varepsilon_i, \quad z, \varepsilon_i \sim \mathcal{N}(0, 1),$$

where z is a common shock, ε_i is an idiosyncratic shock, all independently and normally distributed from each other, $0 \leq \rho \leq 1$ is a parameter which measures the correlation in project defaults, and $\Phi^{-1}(p_i)$ stands for the inverse standard normal cdf. Because $\sqrt{\rho} z + \sqrt{1 - \rho} \varepsilon_i \sim N(0, 1)$ we have that $\mathbb{P}(y_i < 0) = p_i$ where p_i is the expected probability of default which will be endogenously selected by the entrepreneur and, in equilibrium, will depend on the loan rate r.

Since, in equilibrium,[5] all entrepreneurs will choose the same p, the fraction of projects in default (the default rate) conditional on the realization of z is given by

$$\gamma(z) = \mathbb{P}(y_i < 0 | z) = \Phi \left(\frac{\Phi^{-1}(p) - \sqrt{\rho} z}{\sqrt{1 - \rho}} \right)$$

from which it follows that a cumulative distribution of the default rate is given by

$$\begin{aligned} F(x) &= \mathbb{P}(\gamma(z) < x) = \mathbb{P}(z < \gamma^{-1}(x)) \\ &= \Phi \left(\frac{\sqrt{1 - \rho} \Phi^{-1}(x) - \Phi^{-1}(p)}{\sqrt{\rho}} \right). \end{aligned} \tag{9}$$

1.2. FI's problem

Here, we focus on an FI's optimization problem assuming, for simplicity, that deposits are supplied at zero cost and fully insured. Given the default rate x, the jth FI's profit is

$$\pi_j = \max \left[L_j (1 + r_j)(1 - x) + L_j \lambda x - L_j, 0 \right] \tag{10}$$

$$= L_j \max \left[r_j - (r_j + 1 - \lambda) x, 0 \right] \tag{11}$$

where the revenue comes from two channels: full repayment from the fraction $1 - x$ of entrepreneurs being in the no default state and

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[1] A model with a continuum of banks seems to be more appropriate for the US banking system.

[2] See, for example, Allen and Gale (2001, 2004), Vereshchagina and Hopenhayn (2009) and Martinez-Miera and Repullo (2010) for further references.

[3] Some authors use this approach. See, for example, Gerali et al. (2010).

[4] See McNeil et al. (2005) for more details about deriving this relation.

[5] In what follows, the existence of a symmetric equilibrium where all FIs choose the same interest rate r is established.