Implications of Optimal Price Regulation in Sub-Prime Banking Markets

Prepared for the 41st Annual Conference on Monetary and Finance, Guyana 2009

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Why Do We Care

- The current Financial Sector crisis can be traced backed to sub-prime lending.
- The question then becomes: “Should we regulate sub-prime lending?”
- The answer lies in what the implications are for participants in sub-prime lending transactions.
- This paper focuses on one set of participants, namely: banks

Background and Introduction

- This paper investigates a model of endogenous product differentiation in the banking sector which incorporates credit risks as well as increasing returns to scale (IRS), and Variable annual percentage rate (APR) lending behavior.
- The paper fills a gap in the literature which largely ignores IRS, Variable APRs and risks.
- Moreover, most of the generally empirical literature tends to assume product differentiation rather than obtain it as an endogenous choice.

Main Findings

- The main findings are that when an average cost pricing rule is imposed, banks will:
- Maximally differentiate their product.
- However, high quality-type banks benefit from increased market power, while low quality type banks could benefit from either increased market share, or increased market power.

Main Findings

- Each type of bank advertises a teaser loan price which is an increasing function of the distance between types.
- The high quality-type charges a higher teaser loan interest rate than does the low quality type.
- This suggests that the difference in prices charged by the high quality bank and the low quality bank is an increasing function of the difference between bank types.

Literature Review

- A large body of literature has been devoted to product differentiation and competition in banking markets in recent years.
- However, the literature, especially that in the tradition of the New Empirical Industrial Organization (NEIO), has largely ignored two aspects of crucial importance in understanding banking markets.
- These aspects are risks and the widely posited increasing returns to scale (IRS) underlying banking activities.
- Additionally, there is little attempt to address variable annual percentage rate (APR) lending behavior, which is very popular in mortgage, credit card and payday advances lending behavior.

Literature Review

- Some models of product differentiation among banks can be found in Barros (1997); Cohen and Mazzeo (2004); Degryse (1996); Kim, Kristiansen and Vale (2004); among others.
- Explorations into pay day advances lending and more generally on variable APR lending behavior are contained in Flannery and Samolyk (2005), and the references therein.

The Model

- To be more specific the model is a two-stage game between duopolistic banks.
- Loan price competition, in the context of lines of credit, takes place in the second stage and a quality/type choice at the first stage.
- Comparative statics are then used to show the effect of average cost pricing on type/quality choice.

The Model

- Let $\nu \equiv N/n$; and let consumers be uniformly distributed on the closed interval $u \in [0; n/N]$.
- In essence, in larger banking markets the preference parameter is distributed over a wider space to reflect increased diversity in the market.
- The location u is interpreted as a preference parameter. Therefore, the value of u is the fraction of consumers located to the left of u on the given interval.

The Model

$$\begin{cases} \hat{u}\nu H - r_H & \text{when buying from type } H; \\ \hat{u}\nu L - r_L & \text{when buying from type } L; \\ 0 & \text{when not buying} \end{cases}$$

The Model

Now, solving the consumer's problem by finding the consumer u indifferent between buying from the high type or low type yields[8]:

$$\hat{u}\nu H - r_H = \hat{u}\nu L - r_L \iff u = \frac{(r_H - r_L)}{\nu(H-L)} \geq 0. \quad (1)$$

Now, let $U \equiv \nu u \,\epsilon [0,1]$. Therefore we can write each firm's demand, denoted by $\ell_t \equiv D_t(r_H, r_L)$. as follows:

$$\ell_H \equiv D_H(r_H, r_L) = \begin{cases} 0 & \text{if } U \geq 1 \\ \frac{n}{N}(1-U) & \text{if } 0 \leq U \leq 1 \\ \frac{n}{N} & \text{if } U \leq 0 \end{cases}$$

The Model

- A bank of type t then maximizes expected profits, $\Pi = (\alpha, \gamma, \theta, r_t, r_{-t})$, expected revenue - expected costs, in each stage, given the other bank's choices.

$$\gamma = 1 - e^{-\delta d_t} \qquad \alpha = 1 - e^{-\sigma l_t} \quad l_t = (1 - rr_t)d_t$$

$$\theta = \frac{e^{-\delta} - e^{-\sigma}}{e^{-\delta \frac{l_t}{1-rr_t}} - e^{-\sigma l_t}}, \sigma > \frac{\delta e}{1 - rr_t}$$

IRS in the Model

Recall that IRS implies that marginal costs, (mc), are less than average costs (ac). Consequently, the ratio mc/ac should be less than one for IRS to exists. This can now be shown from the cost function. Substituting w_t in the cost function yields :

$$C_t(\ell_t) = \left[\frac{e^{-\frac{\delta}{(1-rr_t)}} - e^{-\sigma}}{e^{-\frac{\delta\ell_t}{(1-rr_t)}} - e^{-\sigma\ell_t}}\right] \frac{\varpi_t}{1-rr_t}\ell_t$$

from which ac is:

$$\left[\frac{e^{-\frac{\delta}{(1-rr_t)}} - e^{-\sigma}}{e^{-\frac{\delta\ell_t}{(1-rr_t)}} - e^{-\sigma\ell_t}}\right] \frac{\varpi_t}{1-rr_t}$$

IRS in the Model

and mc is:

$$\frac{\theta\varpi_t}{1-rr_t}-\left[\frac{\left(e^{-\frac{\delta}{(1-rr_t)}}-e^{-\sigma}\right)\left(\sigma e^{-\sigma\ell_t}-\frac{\delta}{(1-rr_t)}e^{-\frac{\delta\ell_t}{(1-rr_t)}}\right)}{\left(e^{-\frac{\delta\ell_t}{(1-rr_t)}}-e^{-\sigma\ell_t}\right)^2}\right]\frac{\varpi_t}{1-rr_t}\ell_t+\frac{\theta\ell_t\varpi_t\prime(\ell_t)}{1-rr_t}$$

Hence one can deduce that

$$\frac{mc}{ac}=1-\left[\frac{\left(e^{-\frac{\delta}{(1-rr_t)}}-e^{-\sigma}\right)\left(\sigma e^{-\sigma\ell_t}-\frac{\delta}{(1-rr_t)}e^{-\frac{\delta\ell_t}{(1-rr_t)}}\right)}{\left(e^{-\frac{\delta\ell_t}{(1-rr_t)}}-e^{-\sigma\ell_t}\right)^2}\right]\frac{\ell_t}{\theta}+\frac{\theta\ell_t\varpi_t\prime(\ell_t)}{1-rr_t}$$

But the term

$$\left[\frac{\left(e^{-\frac{\delta}{(1-rr_t)}}-e^{-\sigma}\right)\left(\sigma e^{-\sigma\ell_t}-\frac{\delta}{(1-rr_t)}e^{-\frac{\delta\ell_t}{(1-rr_t)}}\right)}{\left(e^{-\frac{\delta\ell_t}{(1-rr_t)}}-e^{-\sigma\ell_t}\right)^2}\right]\frac{\ell_t}{\theta}>0$$

This is true because $\sigma > \frac{\delta e}{(1-rr_t)}$ implies that all the terms contained therein are positive. And to reiterate $\varpi_t\prime(\ell_t) < 0$, hence $\frac{mc}{ac} < 1$ and therefore it is shown that this structure exhibits IRS.

Second Stage Profits and Solution

$$\Pi_t = \left[(1 - e^{-\sigma \ell_t})\theta r_t - (1 - e^{-\frac{\delta \ell_t}{(1-rr_t)}})\frac{\theta \varpi_t}{(1-rr_t)}\right] \ell_t$$

Recalling $r_t = \frac{\varpi_t}{(1-rr_t)}$ yields: $\Pi_t = \theta\left[(1 - e^{-\sigma \ell_t})r_t - (1 - e^{-\frac{\delta \ell_t}{(1-rr_t)}})r_t\right] \ell_t$

Simplifying and substituting for θ gives:

$$\Pi_t = \left[\frac{e^{-\frac{\delta}{(1-rr_t)}} - e^{-\sigma}}{e^{-\frac{\delta \ell_t}{(1-rr_t)}} - e^{-\sigma \ell_t}}\right]\left[e^{-\frac{\delta \ell_t}{(1-rr_t)}} - e^{-\sigma \ell_t}\right] r_t \ell_t$$

Which we further simplify to get:

$$\Pi_t = [e^{-\frac{\delta}{(1-rr_t)}} - e^{-\sigma}] r_t \ell_t \quad (2)$$

Second Stage Profits and Solution

$$\max_{r_H} \Pi_H \ = [e^{-\frac{\delta}{(1-rr_H)}} - e^{-\sigma}]r_H l_H \tag{3}$$

Similarly, the low type firm's profit function is:

$$\max_{r_L} \Pi_L \ = [e^{-\frac{\delta}{(1-rr_L)}} - e^{-\sigma}]r_L l_L \tag{4}$$

Then to solve for price, note that the corner solutions imply zero profit but that interior solutions will generate positive profit, therefore the first order conditions (FOCs) give the solution and imply:

$$r_H \ = \frac{2}{3}(H - L) \tag{5}$$

Hence:

$$r_L \ = \frac{1}{3}(H - L) \tag{6}$$

Second Stage Solutions Propositions

Proposition 1: *The high quality-type bank will necessarily advertise a higher teaser rate—minimum value for loan interest rates— than will the low quality-type bank.*

Proposition 2: *As bank types become more distinct banks of each type will be able to advertise higher prices. That is, the more distinct banks are in terms of type, for example, high type vs. low type banks, then competition will be less intense.*

Proposition 3: *The wedge between the teaser rate/interest rate advertised by high quality-types and low-quality types is an increasing function of the distance between the different bank types.*

Second Stage Propositions' Proofs

(1) The proof of proposition 1 is straight forward from the following equation derived from equations (5) and (6).

$$r_H - r_L = \frac{(H - L)}{3} > 0 \qquad (7)$$

(2) Proposition 2's proof is: $\frac{\partial r_H}{\partial (H-L)}, \frac{\partial r_L}{\partial (H-L)} \geq 0$; or, $\frac{\partial r_t}{\partial (H-L)} \geq 0, t \in \{H, L\}$;. These results follow directly from equations (5) and (6).

(3) Proposition 3 follows from the fact that: $\frac{\partial (r_H - r_L)}{\partial (H-L)} \geq 0, t \in \{H, L\}$. Again, the results are derived from equations (5) and (6).

Type Implications: Comparative Statics

Additionally, defining weights on the degree of product differentiation and on the difference in the probability that the banks default and that its borrowers default as $2\delta e^{-\frac{\delta t}{\underline{t}}}$ and $\underline{t}$ respectively, let $A_t \equiv e^{-\frac{\delta}{(1-rr_t)}} - e^{-\sigma}$, such that $A_H > 3(H-L)\nu F'(H)$. Finally, let $Z_t \equiv (H-L)\delta e^{-\frac{\delta t}{\underline{t}}}$. With this established one can proceed to analyze the model. The analysis is as follows: Note from the pricing solutions above that $U = \frac{1}{3}$ and that H and L are exogenous in the second stage. Accordingly, the following assumptions are entirely in terms of exogenous parameters in the second stage:

$$(A1)\ \ \frac{1}{1+\frac{\underline{t}A_t}{Z_t}} < U < \frac{2}{3};\ \ (A2)\ \ \varpi_t(t) < \underline{t}\,U$$

All $(A1)$ says is that both firms will have positive market share since both A_t and Z_t are positive. Further, $(A1)$ implies that:

$$\frac{1}{1+\frac{\underline{t}A_t}{Z_t}} < \frac{1}{3} \Leftrightarrow 3 < 1 + \frac{\underline{t}A_t}{Z_t} \Leftrightarrow 2 < \frac{\underline{t}A_t}{Z_t} \Leftrightarrow 2Z_t < \underline{t}A_t$$

Type Implications: Comparative Statics

<u>Theorem 1</u>: *Under assumptions (A1) and (A2), the principle of maximal product differentiation is sustained.*

<u>Proposition 4</u>: *Under (A1) there is a unique subgame perfect Nash equilibrium. In this equilibrium the two banks choose different types,* $t = \{L, H\}$.

<u>Proposition 5</u>: *Under assumption (A1), bank profitability is increasing in the distance between types.*

<u>Proposition 6</u>: *Under assumption (A1), high type profitability is increasing as* L *falls. .*

<u>Proposition 7</u>: *Under assumptions (A1) and (A2), low type profitability is inversely related to* H.

Summary and Conclusions

- The main findings are that when an average cost pricing rule is imposed, banks will:
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Summary and Conclusions

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