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**EVIDENCE OF PRODUCT DIFFERENTIATION IN THE MICROFINANCE
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Abstract

Microfinance institutions (MFIs) have experienced exponential growth and have spread throughout the world in the last 15 years. Their high repayment rates of up to 96% have drawn immense interest from both for-profit and non-profit institutions, with the number of for-profit MFIs increasing by over 800% within the last decade. Due to the rapid expansion of for-profit MFIs, there has been much debate over potential crowding-out effects of non-profit MFIs. Yet little research has focused on the current market structure of institutions, and how the interaction between for-profit and non-profit MFIs has shaped the market. Our research focuses on determining the impact of the growth of for-profit MFIs on consumer and producer welfare. Using a Bertrand differentiated product framework, we model both the price setting and demand functions of for-profit and non-profit MFIs. Solving for the Nash equilibrium conditions we proceed to structurally estimate the parameters of the underlying demand equation, subsequently deriving welfare implications. We find from both the theoretical and empirical models that for-profit MFIs provide greater welfare for consumers than non-profit MFIs.

Keywords: microfinance, Bertrand product differentiation, for-profit, non-profit

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1. Introduction

1.1. Overview

Arising from humble beginnings, microfinance is now considered by many to be the preeminent solution to eradicating global poverty. Microfinance provides the *unbankables* access to financial services, which include deposits and more importantly credit. Access to credit allows the poor to overcome initial capital barriers when starting businesses. Ultimately, this can foster growth in the economy and provide an avenue to escape potential poverty traps. Despite the suggestion that microfinance can help fight poverty, the industry today is also facing a strong backlash from previously staunch proponents such as Hillary Clinton, who recently declared that micro lenders are “sucking blood from the poor in the name of poverty alleviation” (Kristoff, 2011, Para. 3). These condemnations coincide with the recent rise of for-profit MFIs such as SKS and Banco Compartamos, both of which have gone public and charge average interest rates of well over 80% (Yunus, 2007).

1.2. Rise of For-Profit MFIs

To understand this shift in sentiment, a theoretical framework is required to model the microfinance industry. Unfortunately, the current economic literature does not provide a theoretically based approach to analyze the interaction between for-profit and non-profit microfinanciers. Applying a Bertrand differentiated product model to the microfinance industry, we can study the competition and welfare implications in this market.

Microfinance provides credit access to many individuals who are typically deemed risky for traditional banks. Innovations such as peer and group lending technologies have allowed MFIs to overcome issues of moral hazard that are inherent in traditional non-collateral loans and have shown to offer efficiency gains in contracting.¹ As a consequence of high repayment rates, the successes of MFIs have allowed for a rapid global expansion of microfinance. Figure 1 shows the spread of MFIs in the world in 2000 with deeper blue representing higher numbers of MFIs.

¹ Stiglitz (1990), Banerjee et al. (1994), Besley and Coate (1995) and Ghatak (1999, 2000) suggest that group lending technologies provide revealed credit worthiness that allows banks to offer loan contracts that more closely reflect the credit ratings of the borrowers (e.g. a low risk borrower will be offered a lower interest rate).

Figure 1: Spread of microfinance institutions in 2003



Figure 2 shows the MFI numbers in 2009. Microfinance has indeed expanded in almost every nation. Within the decade, the prominent rise of microfinance has drawn significant attention to the industry that was once thought of being non-feasible due to the high default risks. Consequently, an industry that was once primarily comprised of non-profit MFIs now faces competition from for-profit MFIs such as *Banco Compartamos*.²

Figure 2: Spread of microfinance institutions in 2009



The spread of microfinance provides financial access to the poorest regions of the world and is seen by many as a means of creating self-sustaining markets. The meteoric rise of MFIs has also produced a Nobel Peace Prize winner, Muhammad Yunus, „father“ of the microfinance industry. There exists a growing divide between the for-profit and non-profit MFIs as they debate over what truly is best for global poverty alleviation. The introduction of for-profit MFIs has led to charges by early microfinance entrants such as Grameen’s founder Muhammad Yunus,

² Banco Compartmantos began as a NGO in 1990 but had its Initial Public Offering in 2007.

that for-profit MFIs are “loan sharks” (PTI, Para.1). Allegations have also been made that crowding-out of non-profit MFIs would occur as a consequence of the introduction of for-profit MFIs. A prime example of the alleged “loan sharking” behavior is exhibited by the for-profit firm Banco Compartamos. Banco Comparatmos has recently taken an aggressive action by launching its initial public offering (IPO). Since going public, Compartamos now charges interest rates exceeding 100% annually, which some view as usury, the very evil that microfinance had aimed to weed out.

Perry (2002) provides indirect evidence showing clients who are unable to gain MFI membership are willing to turn to moneylenders charging higher interest rates. If for-profit MFIs are extending loans to clients who are unable to gain access to traditional MFIs, they are potentially filling a gap in the industry and thus contributing to the general idea of outreach. For-profit MFIs argue that higher costs, due to smaller loan sizes, drive increases in interest rates, rather than any opportunistic motives. It has also been noted that in order to sustain low interest rates proposed by Mr. Yunus, access to subsidies and donations are requisite. By having for-profit MFIs, private capital drives expansion and allowing for-profits to expand outreach more than non-profits. Our research aims to determine the welfare implications of the recent growth in for-profit MFIs by developing a theoretical framework modeling the interactions between firms.

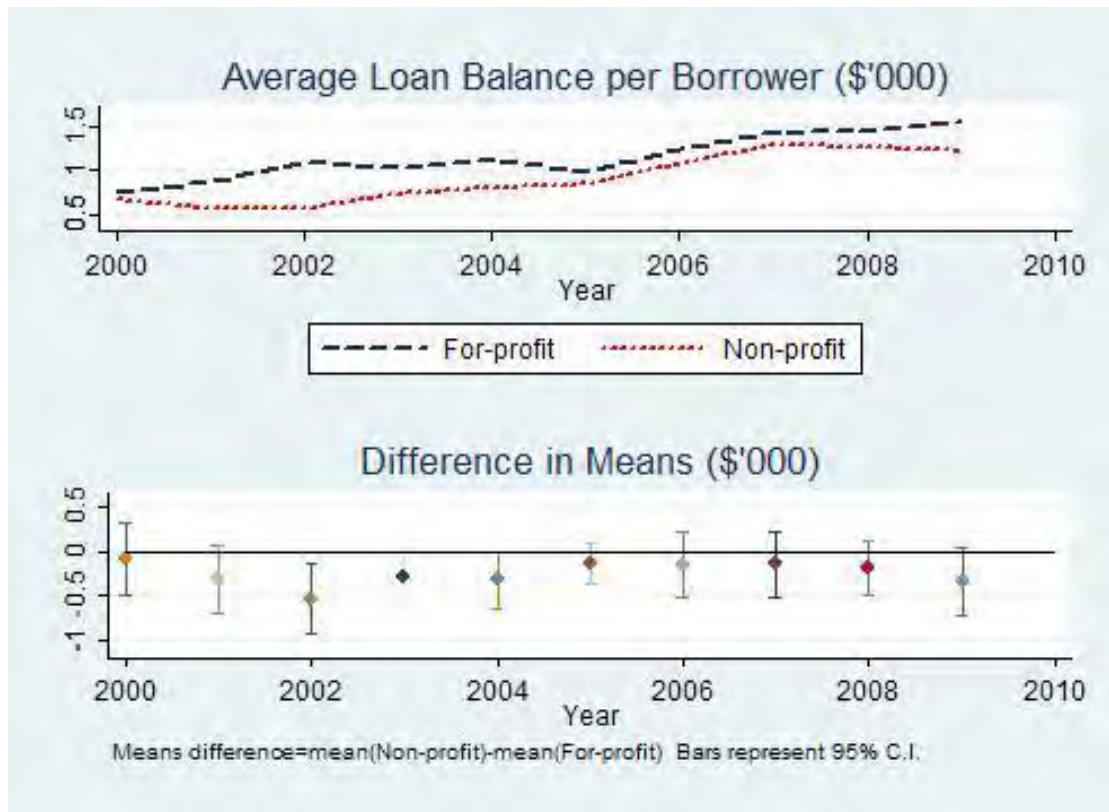
1.3. Stylized Facts

Data³ obtained from the publically available microfinance information exchange provides insight into the current clash between for-profit and non-profit MFIs. For-profit MFIs have higher average loan balances per borrower than their non-profit counterparts. Figure 3 shows the average loan balances of borrowers separated by for-profits (blue) and non-profits (red). From 2002 onwards, the differences in loan balances for the two types of firms are not statistically significant at the 95% level.⁴ The lack of difference in loans size raises questions regarding why the interest rates differ.

³ The data consists of 91.3 million borrowers from ~1900 MFIs and is aggregated on the firm level ranging from 1995 to 2009.

⁴ The lower half of figure 3 shows the differences in mean values with a 95% confidence interval.

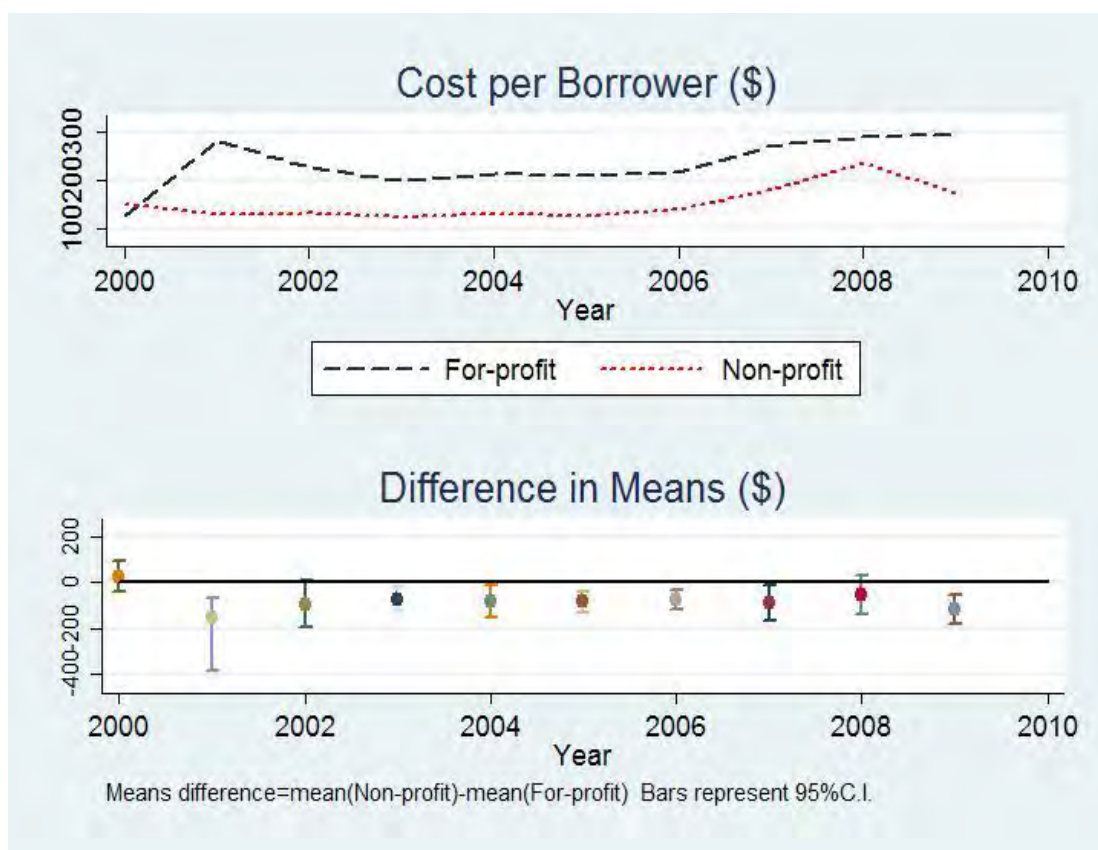
Figure 3: Comparison of average loan balance per borrower (\$)



In recent years, for-profit MFIs have held more assets and consequently had larger gross loan portfolios.⁵ The large size of for-profit institutions has generated fears that as more for-profit MFI enter the microfinance industry, non-profit MFIs will be crowded out, reducing borrowers' access to financial services. The differences in interest rates and asset sizes may in part be due to differing cost structures between the for-profit and non-profit MFIs.

Figure 4 clearly shows the difference in cost structures between the two types of MFIs, with for-profits having higher costs per borrower. It also shows us the statistical significance of the differences in their means. The for-profit MFIs' cost per borrower is illustrated by the blue line, while that of the non-profit MFIs' is shown by the red line. The differences in cost are statistically significant at the 5% level for most years, suggesting that the two types of MFIs have different cost structures that could potential explain the different interest rates charged.

⁵ The gross loan portfolio is the total dollar amount of all loans an MFI provides.

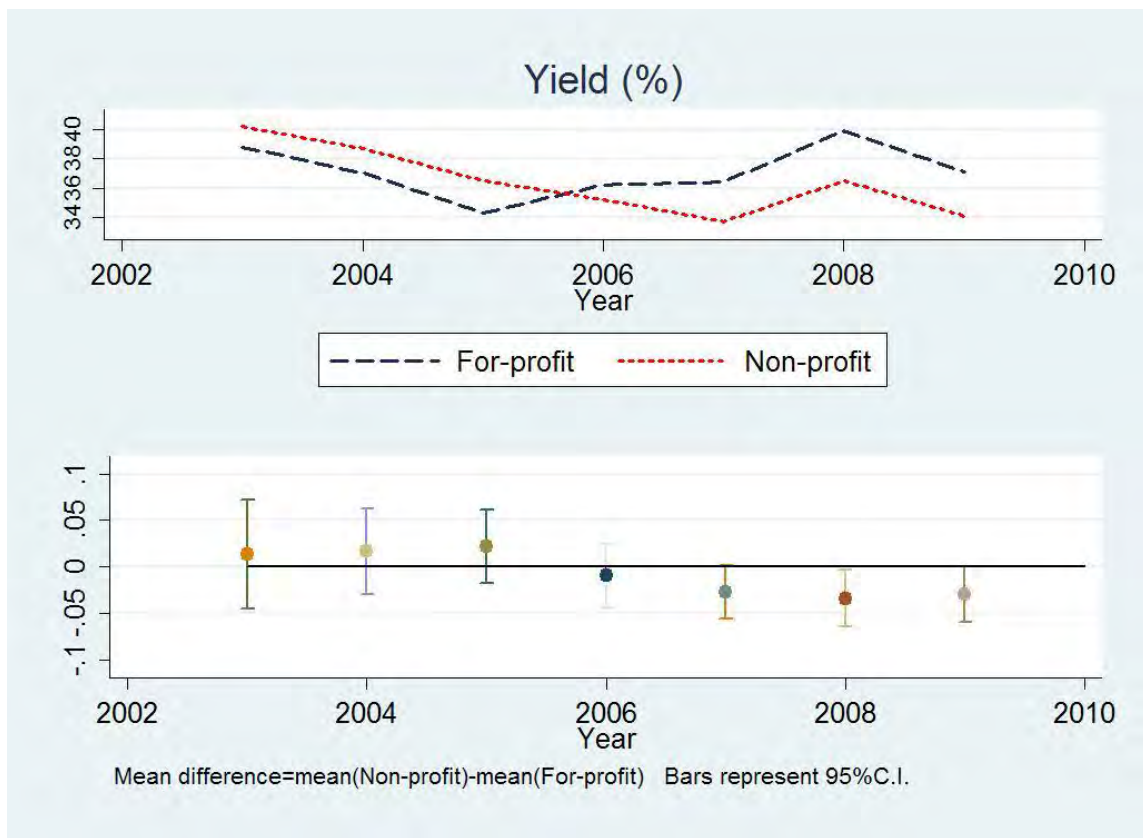
Figure 4: Comparison of cost per borrower (\$)

Lower cost per borrower for non-profit MFIs may occur because of the use of dynamic incentives inherent in group contracts as opposed to individualized loans offered by for-profit MFIs. Because for-profit banks rely on individual loans, the cost of monitoring is borne by the banks due to the lack of dynamic incentives that group lending possesses. The monitoring cost of group lending borne by the customers rather than by the bank is not included in the measured costs. For example, the long travel times to get to these group meetings, with some Chinese clients taking over an hour to walk to the meeting places (Armedáriz and Morduch, 2000) reflects the unseen transaction costs borne by borrowers. As such, interest rate differences may arise as consumers perceive the actual cost to them as being the interest rate plus the transaction costs. Throughout the last decade, for-profits have tended to charge higher interest rates at various times. Figure 5 provides a graphical representation of the average interest rates set by both the for-profit and non-profit MFIs. Figure 5 shows that although the interest rates differ, these differences are not statistically different at the 5% level.

The presence of interest rate difference begets the question, *how do MFIs set interest rates?* Traditionally, cost determines the prices of goods in a homogeneous market. If the assumption of a homogeneous and perfectly competitive market holds, we can expect a single equilibrium price. At first glance, it would appear logical to presume that all MFIs produce a homogeneous product, loans. However, this single price equilibrium does not hold true as firms

are shown to charge different interest rates (Figure 5). This can occur when goods are heterogeneous, leading us to postulate that MFIs produce differentiated products allowing firms to charge different interest rates. This product differentiation may take various forms such as different terms on the loans ranging from one month to five years, group lending stipulations versus individual lending, and other criteria such as weekly meetings. These MFIs are, therefore, understood to have different attributes; it is these attributes that differentiate the loans produced by these MFIs, which we believe is a driver of prices.

Figure 5: Comparison of interest rates (yield) (%)



1.4. Literature Review

To better comprehend the interaction between for-profit and non-profit MFIs, a theoretical framework and model are required in order to analyze the mechanics of interest rates and loan demand within the industry. Although various *ad hoc* empirical studies have been conducted, no theoretical model exists to explain the working of the microfinance industry.

Non-collateralized lending research done to date involves studies that model group lending versus individual lending such as Ghatak (1999) and interactions between the bank and borrower under asymmetric information conditions (Chan and Thakor, 1987). Chan and Thakor (1987) find that high-quality borrowers may have to put up higher collateral when private

information is unknown. Using a risk-based pricing model, Edelberg (2003) studies the US non-collateralized consumer loans and suggests that demand for non-collateralized loans decreases when risk based pricing is used. Edelberg (2003) also suggests that very little is known about the determination of interest rates on non-collateralized consumer loans. Cull, Kunt, and Morduch (2008) find that non-profits serve more women borrowers and use more subsidies. Female borrowers are generally seen as lower risk than male borrowers, and studies such as the one conducted by Khandor and Pitt (1998) find that women use borrowed funds more efficiently than male borrowers do, at least in terms of social yardsticks.⁶

To date, empirical studies such as Navajas et al. (2003) delve into the effects of microcredit financing in specific countries. Dehejia et al. (2005) find less wealthy borrowers are highly sensitive to interest rate changes based on implied elasticities of loan demand. However, the article also suggests that as MFIs charge higher interest rates, the MFI shifts the customer base to wealthier customers, potentially at the expense of outreach to the poorest customers.⁷

1.5. Approach

To remedy the deficiencies in these studies, we adopt the following approach. Beginning with a Bertrand differentiated model, we develop a theoretical model that allows structural estimation of the parameters using empirics. With these functions, one can then determine the equilibrium price for loans. Using the results from the reduced form estimation, allows one to recover the underlying structural parameters of demand in order to determine the differences in consumer and producer surplus generated by firms, as well as changes in these surpluses across time. Through this model, one can determine if public outcries against for-profit MFIs truly are warranted.

2. Theory

This section describes the theoretical set up and technique used to recover the demand equation parameters.

2.1. The Bertrand Product Differentiation Model

In this research, the microfinance industry is modeled using a Bertrand model with differentiated products. Having a differentiated product model modifies the assumption of identical goods and assigns attributes to goods. This allows us to overcome the Bertrand paradox to derive a Nash equilibrium. In this model, prices are set simultaneously, and firms do not cooperate. In the MFI industry, the two distinctly different firms in the model are represented by for-profit and non-profit firms. Traditionally, a Bertrand differentiated duopoly is treated as a pure price setting equilibrium in a horizontally differentiated market. Bester (1992) uses a

⁶ These yardsticks include, the likelihood of their children getting an education, household expenditure, housing, *etc.*

⁷ Implicitly, we note that if for-profit MFIs charge higher interest rates, their customer base may differ from that of a socially driven MFI, suggesting the possibility of a socially beneficial coexistence.

demand function that relies on a discrete choice model of consumer preference.⁸ However, we are unable to use discrete choice models as consumers are able to borrow from different firms at different prices and quantities (i.e. different products), hence, creating an infinite set of alternatives. Because we assume that consumer preference is continuous rather than discrete, the profit maximization condition is used instead.⁹

2.2.Attributes

The products produced by MFIs are loans whose attributes are used to differentiate the loans provided by various MFIs.¹⁰ Differences in attributes can generate a preference for one firm's product over another firm's product. This translates to the price premium that consumers are willing to pay to purchase the firm's product.¹¹ Since these attributes are often unobservable, proxies are used to capture these attributes.¹² For instance, a consumer may prefer less monitoring than the alternative, a choice not easy to quantify. Instead, we seek a proxy that is both able to capture and measure attribute differences.

In our model, we use the for-profit status of firms and women-to-borrower ratios¹³ as proxies for these unobserved attributes. For-profit MFIs generally engage with borrowers on an individual level rather than as a group, resulting in fewer meetings. Therefore, the for-profit status enables us to capture the preference of consumers for reduced monitoring by the MFIs. Product image, another unobservable preference, is captured by the women-to-borrower ratio. Firms that serve more women borrowers are more likely to be geared toward poverty alleviation or are at least perceived to be doing so (Mutalima, 2007; Mayoux and Hartl, 2009; Kandkar 2005 and Hashemi et al. 1996). Borrowers are attracted to firms that are perceived to be in the business of helping them instead of firms that are seen to be trying only to extract profits out of the poor.¹⁴ The women-to-borrower ratio reflects the goals of the MFI, and, because women have been shown to use the funds more efficiently for social good (Khander and Pitt, 1998), it captures the consumer's image preferences.

2.3.Model Set-up

We begin the model set up by first considering the cost function, presuming that all firms seek to minimize costs.¹⁵ Costs of a firm are traditionally determined by both labor and capital cost. The capital cost for an MFI arises primarily from the cost of financing and obtaining the

⁸ A person facing the choice of whether or not to enter the labor market is an example of consumer discrete choice. One makes a choice within a finite number of alternatives.

⁹ McIntosh et al. (2005) found that in Uganda, increasing competition resulted in multiple loan-taking by borrowers, further substantiating the need of a continuous choice model.

¹⁰ These attributes are modeled as an endowment (i.e. firms are unable to choose the amount of each attribute).

¹¹ Throughout this thesis, any reference to product or firm is synonymous as we presume that each firm produces a single product. The product differentiation exists not within the firm but between firms. Hence, the loose interchangeability of terms.

¹² Unobservable attributes are preferences for a good that cannot be measured directly.

¹³ Women-to-borrower ratio refers to the proportion of borrowers within a firm that are female.

¹⁴ The *warm glow* effect suggests a consumer preference to altruistic behavior. For instance, consumers are willing to pay a price premium to shop at Whole Foods because of the *clean and green* image they offer. (Baron, 2007)

¹⁵ This assumption will be justified below.

MFI's capital.¹⁶ The labor cost of a firm comes from the wages paid to the MFI's workers. Because we presume attributes are endowments specific to the firm, the cost of an attribute does not affect the marginal cost of a firm. A constant elasticity of substitution cost function is used to allow greater flexibility when analyzing the effects of input prices and their substitutability. The total cost, TC, takes the following form¹⁷,

$$TC(v_i, w_i, q_i) = q_i^{1/\gamma} (v_i^{1-\sigma} + w_i^{1-\sigma})^{1/(1-\sigma)} + \sum_m^N a_{m,i} \cdot b_m \quad (1.1)$$

Where

- q_i : Amount of loan demanded in dollars
- v_i : Marginal capital cost of firm i
- w_i : Marginal labor cost of firm i
- $a_{m,i}$: Desirability of attribute m provided by firm i 's
- b_m : Price of attribute m
- γ : Scale parameter
- σ : Elasticity of substitution between labor and capital.

Thus, the marginal cost to produce good i thus can be written simply as,

$$c(v_i, w_i) = (v_i^{1-\sigma} + w_i^{1-\sigma})^{\frac{1}{1-\sigma}} \quad (1.1.1)$$

For the purpose of mathematical tractability¹⁸, we assume $\gamma=1$. If, however, we assume otherwise, the resulting Nash price equilibrium is a non-linear function making structural estimation complex and intractable.¹⁹

Cull, Kunt, and Morduch (2008) noted that over the past two decades, for-profit and non-profit firms alike were encouraged to achieve financial sustainability by earning ample profits, which in other words suggests that both for-profit and non-profit have profit maximization objective functions. Holtmann (1983) has shown that in the hospital industry profit maximizing prices would approach non-profit [welfare] maximizing prices when the elasticity of demand is large. Additionally, a lack of consensus on the objective function of non-profit organization results in a profit maximization model for non-profit organizations being an appropriate model (Danzon, 1982).²⁰

Current literature (Dehejia et al. 2005) suggests that microfinance customers have a high elasticity of demand as they were unwilling to pay high prices. Thus, we can deduce that the revealed objective function of non-profit MFIs is similar to for-profit MFIs. Based on our

¹⁶ Throughout the paper, total costs are thought of as the economic costs rather than accounting costs.

¹⁷ See appendix for complete derivation.

¹⁸ Mathematical tractability refers to the simplicity of the equation generated and the ease by which it can be manipulated.

¹⁹ For future research, we expect to relax this assumption allowing for a more realistic picture of the industry.

²⁰ Danzon (1982) like many other researches on non-profit objective function studies the hospital industry. No study of non-profit MFI objective function has been carried out to date.

deduction, we assume that both types of firms exhibit a profit maximization objective function.²¹ The profit function π_i , is given by,

$$\pi_i = Total\ Revenue - Total\ Cost$$

$$\pi_i = (p_i - c(v_i, w_i)) * q_i(p_i, p_j, a_i, a_j, b_i, b_j). \quad (1.2)$$

In order to determine profits, we use a non-stochastic linear demand function. We also assume that consumers have complete information and freedom of choice between firms. This model uses two firms, firm i and firm j.²² Firm j is defined as the aggregate average of all of the other MFIs within the country where firm i is located. This allows us to model and study the effects of competition between firm j on i. We assume firms have perfect information concerning each other's prices and costs. The demand function for each firm includes attributes of both firm i and not i. We use for-profit status and women-to-borrower ratio as proxies for the unobservable attributes of the MFIs. The for-profit variable captures the consumer's preference for monitoring while the women-to-borrower captures consumer preference for product image. The inclusion of j's attributes allows us to capture the effects of firm j's unobservable attributes on firm i's demand. Demand is given by

$$q_i = \tau + \phi a_i + \psi a_j + \omega b_i + \zeta b_j + \eta p_i + \mu p_j \quad (1.3)$$

Where,

- q_i : Quantity of loan demanded from firm i
- $p_{i/j}$: Price of loan from firm i or j
- $a_{i/j}$: For-profit status of firm i or j
- $b_{i/j}$: Women to active borrower ratio of firm i or j.

Beginning with the demand equation 1.3, we predict the following signs for the coefficients,

$$\begin{aligned} \tau &\rightarrow ? \\ \phi &> 0 \\ \psi &< 0 \\ \omega &> 0 \\ \zeta &< 0 \\ \eta &< 0 \\ \mu &> 0 \end{aligned}$$

The elasticity of demand, η should be negative while cross price elasticity, μ is positive. This is to say that when the price of firm i increases, demand for firm i's loan should decrease. The

²¹ The model used in this thesis potentially can be employed in other industries where both for-profit and non-profit institutions co-exist; an example would be that of the hospital industry.

²² Firm i and j are representative firms that can take on any characteristic and are in competition.

converse would be true when the price of firm i's competitor increases. Therefore, we predict that η would be negative while μ is positive.

From Figure 3, for-profit MFIs have a higher loan balance per borrower than non-profits. Therefore, we should expect that a for-profit MFI has higher demand for its loans than non-profits, with all else being equal. Because for-profit firms have lower levels of monitoring and lack dynamic incentives, consumers are expected to favor the more relaxed lending requirements of for-profit MFIs; hence, a higher demand is anticipated. Therefore, if we define a_i as a for-profit dummy with 1 representing an MFI registered as a for-profit. We expect ϕ to be positive.

Because our model consists of two firms, a_j represents the profit status of the competing firm. As a_j captures the unobservable attribute of ease of borrowing from firm j, we expect less monitoring by firm j will decrease demand for loans from firm i. Since for-profit status proxies for the ease of credit, we expect the presence of a for-profit competitor would affect demand of firm i negatively. Hence, we predict that ψ is negative.

Reports have shown that non-profit MFIs tend to lend to more women due to their stronger sense of financial responsibility and their lower default rates (Khander & Pitt, 1998). We assume the women-to-borrower ratio serves as a proxy for the unobservable consumer preference of positive product image. Firms that have more female borrowers may be perceived by other potential borrowers as being more socially orientated and perhaps even more scrupulous compared to the MFIs with a male-dominated customer base. As such, we predict that if a firm has a more female-orientated customer base, demand for loans will be higher, suggesting ω is positive. Similar to a_j , as the image of j increases, we should expect that demand for firm i's loans will decrease. We expect that an increase in the proportion of female borrowers in firm i leads to a decrease in loans demanded from firm i. This suggests that ζ is negative.

Because we are using a Bertrand differentiated model where firms choose prices, the first order condition is based on maximizing profits with respect to price. Consequently, by assuming that firms are aware of the market demand function that they face, firms will make their profit maximization decisions based on the market demand and their cost function, and this yields a first order condition that describes the market equilibrium prices instead of the traditional supply curve. Substituting equation 1.2 and 1.3 into the profit function, we express firm i's profits as

$$\pi_i = p_i(\tau + \phi a_i + \psi a_j + \omega b_i + \zeta b_j + \eta p_i + \mu p_j) - (\tau + \phi a_i + \psi a_j + \omega b_i + \zeta b_j + \eta p_i + \mu p_j) * \left((v^{1-\sigma} + w^{1-\sigma})^{\frac{1}{1-\sigma}} \right). \quad (1.4)$$

The first order profit maximization of 1.4 with respect to price yields the best response price functions for both firm i and firm j.²³ These best response functions are given by

$$p_i = \frac{1}{2} c_i + \frac{1}{2\eta} [\tau + \phi a_i + \psi a_j + \omega b_i + \zeta b_j + \mu p_j] \quad (1.5)$$

²³The first order condition solves for $\frac{\delta \pi}{\delta p} = 0$. Complete derivation can be found in the appendix.

$$p_{-i} = \frac{1}{2}c_j + \frac{1}{2\eta}[\tau + \phi a_j + \psi a_i + \omega b_j + \zeta b_i + \mu p_i] \quad (1.6)$$

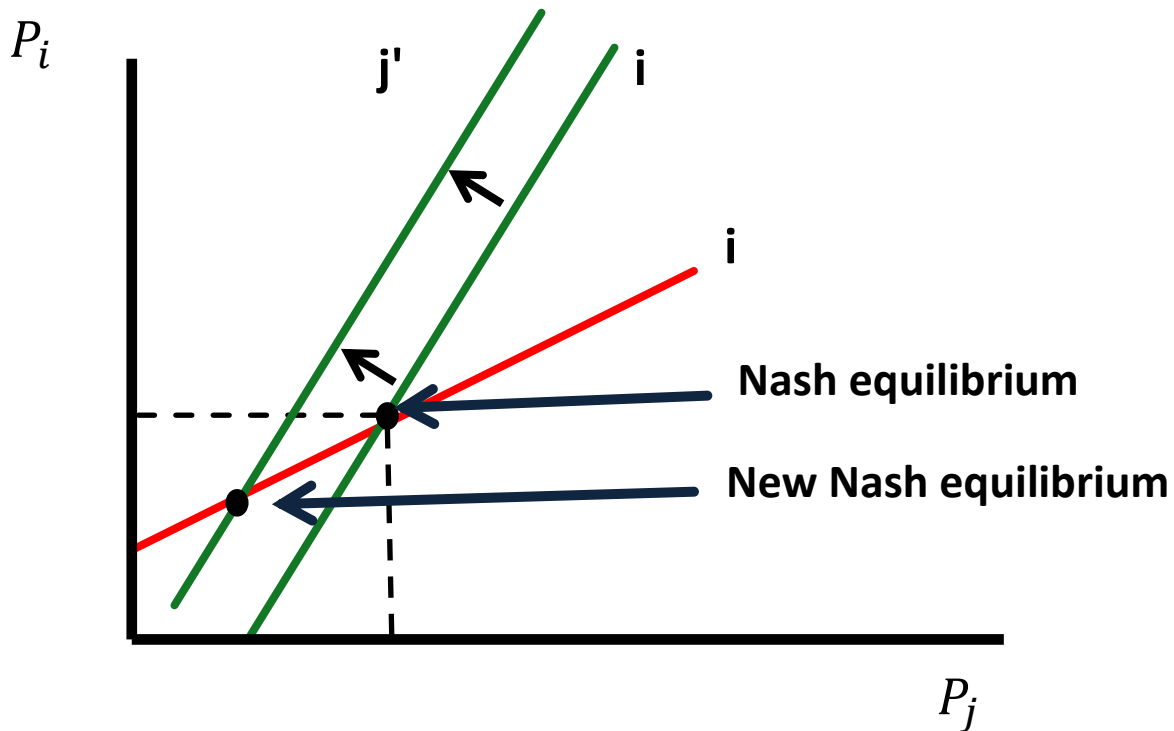
where

$c_{i/j}$: The marginal cost of firm i (or j)²⁴.

Solving simultaneously for 1.5 & 1.6, we obtain the Nash price equation

$$p_i^* = \frac{\left[\frac{\mu}{4\eta^2} - \frac{1}{2\eta}\right]\tau}{1 - \frac{\mu^2}{4\eta^2}} + \frac{1}{2\left(1 - \frac{\mu^2}{4\eta^2}\right)}c_i + \frac{-\frac{\mu}{4\eta^2}}{1 - \frac{\mu^2}{4\eta^2}}c_j + \frac{\frac{\psi\mu}{4\eta^2} - \frac{\phi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}}a_i + \frac{\frac{\phi\mu}{4\eta^2} - \frac{\psi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}}a_j + \frac{\frac{\zeta\mu}{4\eta^2} - \frac{\omega}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}}b_i + \frac{\frac{\omega\mu}{4\eta^2} - \frac{\zeta}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}}b_j. \quad (1.7)$$

Figure 6: Graphical representation of best response functions



²⁴ Marginal cost is given by equation 1.2

A graphical representation of the best response functions and Nash equilibrium is shown in Figure 6. Figure 6 also shows how a decrease in preference for firm j can result in a shift in the best response function of firm j to j'' . This generates a new Nash equilibrium where both firms charge a lower price. Therefore, the strategic interaction in Figure 6 highlights the importance of the strategic interactions between the firms.

Because quantity is endogenous in the profit function, we need to study the Nash equilibrium to determine the effects of prices and attributes on loan demand. The complexities of 1.7 would require that we use structural analysis to determine the coefficients in the demand function. In the next section, we further elaborate on the structural and sensitivity analysis of the theoretical model.

As we are using a Bertrand model, where prices are chosen instead of quantity, the demand function 1.3 cannot be estimated. If we simply estimate 1.3, we will obtain incorrect results, as quantity demanded is a function of both firm i 's and firm j 's prices. We note in the theoretical model that the prices set by each firm are a consequence of an interaction of best response price functions. Therefore, by simply estimating 1.3, we do not take into account the interactions and pricing strategies of both firms. Hence, structural analysis is required to circumvent this obstacle and allows us to recover the true demand parameters.

2.4. Structural Model

The Nash price equation 1.7 is already in a linear form. As such, we are able to estimate the reduced form,

$$p_i^* = \beta_0 + \beta_1 c_i + \beta_2 c_j + \beta_3 a_i + \beta_4 a_j + \beta_5 b_i + \beta_6 b_j + \varepsilon \quad (1.8)$$

The seven betas from equation 1.8 are estimated using ordinary least squared analysis. The beta estimates are then used to solve the equations below to calculate the seven unknown demand parameters.

$$\beta_0 = \frac{\left[\frac{\mu}{4\eta^2} - \frac{1}{2\eta} \right] \tau}{1 - \frac{\mu^2}{4\eta^2}} \quad (2.1)$$

$$\beta_1 = \frac{1}{2 \left(1 - \frac{\mu^2}{4\eta^2} \right)} \quad (2.2)$$

$$\beta_2 = \frac{-\frac{\mu}{4\eta^2}}{1 - \frac{\mu^2}{4\eta^2}} \quad (2.3)$$

$$\beta_3 = \frac{\frac{\psi\mu}{4\eta^2} - \frac{\phi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} \quad (2.4)$$

$$\beta_4 = \frac{\frac{\phi\mu}{4\eta^2} - \frac{\psi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} \quad (2.5)$$

$$\beta_5 = \frac{\frac{\zeta\mu}{4\eta^2} - \frac{\omega}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} \quad (2.6)$$

$$\beta_6 = \frac{\frac{\omega\mu}{4\eta^2} - \frac{\zeta}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} \quad (2.7)$$

Equation 1.8 is estimated using a panel dataset of various MFIs from years 2003-2009. For the purposes of this paper, it is assumed that the product and firm are synonymous, (i.e. firm i produces one type of product, i , which is differentiated by the consumer preference of attributes, a and b). Furthermore, in our two-firm model of i and j , the j firms are defined as the average of all of the other firms within a country. This inherently assumes that firms face competition only from other firms within the same country.²⁵ It also assumes that capital mobility is limited to within a country and, hence, borrowers choose between firms within the same country.

3. Data

The Microfinance Information Exchange (MIX) is a non-profit organization that helps to collect and validate data in all regions of the developing world. The data is publically available online at the MIX market website. We incorporate the for-profit status of MFIs using another MIX publication, the Mircobanking Bulletin, an annual publication. To determine the marginal cost, we refer to equation 1.2.

Yield on gross loan portfolio is chosen as a proxy for price as it is the most tractable and easily available data regarding how a MFI charges borrowers for loans. Yield on gross loan portfolio is *the nominal interest and fees on the gross loan portfolio*.²⁶ To achieve a tractable model, the j firms are not represented by the individual MFIs, but instead are reflected as an aggregate in the data. The adjusted yield on gross loan portfolio and attributes of firm j are p_j , a_j and b_j respectively. The j variables are generated from country averages. Since a period in the data set is defined as one year, we deduced that it was an overly prolonged period and that MFIs respond to changes by their competitors within days rather than the following year. Therefore, we assume the effects of changes in competitors' attributes and prices generate a response within the same time period.

The attribute proxies, *for-profit dummy* and *women-to-active borrower ratio* are used in the reduced form estimation. The for-profit binary variable assigns a value of one to for-profit firms and zero to non-profit firms. Because the j for-profit variable is an average of the firms

²⁵ McIntosh, Janvry and Sadoulet (2005) mention that countries previously were divided into regions by lenders; however, recently lenders are now competing for the same clients within the country.

²⁶ As defined by the dataset obtained from the Microfinance Exchange.

other than i within the country, it reflects the composition of the MFIs within the country, where one reflects that the j firm is a for-profit MFI. The continuous nature of the for-profit j variable allows us to study the possible ease of getting a loan via the for-profit proxy.

From equation 1.2, we see total cost is a function of labor and capital costs. Costs per borrower include the personnel, administrative and amortization costs, which cumulatively serves as a relatively good proxy for overall labor cost. This measure is subsequently adjusted to reflect the labor cost per dollar of gross loan portfolio. We calculate the firm's capital cost by determining the opportunity cost of holding this capital per dollar of gross loan portfolio.²⁷ With all else being equal, higher costs logically result in firms needing to charge higher prices in imperfectly competitive markets. (In perfectly competitive markets, these firms drop out of the market, as they are unable to raise prices.²⁸) With both labor and capital costs, we calculate the marginal cost for each firm using the CES function in equation 1.2. Elasticity of substitution is set at 0.4 based on previous empirical research by Chinriko et. al (2004).²⁹

The pooled ordinary least squares regression model is used to estimate the reduced form Nash equation function. Additionally, fixed and random effects panel regressions are estimated as a form of robustness check of our model. A pooled OLS with continent dummies model is also used as to provide the final robustness check of the pooled OLS model. The data is organized and identified uniquely by the MFI identification number (MFIID), year, country and continent. We calculated the proportion of women borrowers by taking the number of women borrowers and dividing by the total number of active borrowers.

Most of the analysis focuses on 3367 MFI aggregated observations between 2003 and 2009 done on an annual basis and reflect data on 943 microfinance institutions from 105 different countries. The yield on gross loan portfolio is used to reflect the price charged by MFIs. Although the minimum interest rate observed is zero, it should not be a source of concern as the value occurs only in three outlying observations. The minimum value of zero for the for-profit dummy, both for firm i and firm j , is expected because of the binary nature of the variable. The minimum for women-borrower ratio should not be a source of concern as the histogram plot of the variable shows a relatively normalized curve centered on 0.65. The negative capital cost is possible as for-profit MFIs may be financially insolvent but remain in business due to subsidies and donations.

Table 1 provides summary statistics for the sample, restricted to the dates and variables we study. The data show that nearly 30% of all MFIs have for-profit status, with the average interest rate³⁰ charged across all MFIs being 34.5%. Capital costs average around 1.28 cents per dollar loaned, while labor costs are heftier at 27.2 cents per dollar loaned. Of all of the borrowers, close to 65% are women. The variables for j firms are an average of all of other MFIs within a country. Definitions of each variable can be found in the appendix.

²⁷ In determining the opportunity cost, we used the annual one-month US T-bill rates. This assumes that US T-bills are the alternative investment of choice for MFIs.

²⁸ If higher marginal costs occur uniformly across all firms in the competitive market, prices will instead rise until price equals marginal cost again.

²⁹ Chirinko et. al, (2004) estimated the elasticity of capital-labor substitution using an a panel containing 1,860 manufacturing and non-manufacturing firms.

³⁰ Interest rate or yield on gross loan portfolio will be used as interchangeable terms.

Table 1: Descriptive Statistics Annual averages, 2003-2009

	Observations	Mean	Standard deviation	Minimum	Maximum
Interest rate (%) (Firm i)	3367	34.5	18.1	0	188
Interest rate (%) (Firm j)	3367	36.7	15.2	5	202
Marginal cost (Firm i)	3301	0.483	0.592	0.000632	22.4
Marginal cost (Firm j)	3300	0.483	0.293	0.0817	4.86
Capital cost	3367	0.0128	0.0184	-0.0938	0.417
Labor cost	3367	0.272	0.429	0	19.4
For-profit dummy (Firm i)	3367	0.298	0.457	0	1
For-profit dummy (Firm j)	3367	0.299	0.273	0	1
Women-borrower ratio (Firm i)	3367	0.648	0.262	0	1
Women-borrower ratio (Firm j)	3367	0.648	0.180	0.0212	1

4. Results

Table 2 reports the estimation results of four models based on of the reduced form equation, 1.8.

Table 2: Estimated Interest Rate Effects

Variable	(1) OLS	(2) Institution RE	(3) Institution RE w/ continent dummies	(4) OLS w/ continent dummies
Marginal cost (Firm i)	10.6*** (0.56)	4.19*** (0.37)	4.08*** (0.37)	8.45*** (0.44)
Marginal cost (Firm j)	31.3*** (1.2)	9.44*** (0.74)	8.81*** (0.74)	19.9*** (0.9)
For-profit dummy (Firm i)	0.718 (0.59)	2.68*** (1.03)	2.77*** (1.00)	0.969* (0.581)
For-profit dummy (Firm j)	6.86*** (0.98)	5.63*** (1.00)	5.45*** (1.00)	8.07*** (0.99)
Women-to-borrower (firm i)	18.0*** (1.13)	11.8*** (1.3)	11.1*** (1.2)	17.4*** (1.1)
Women-to-borrower (firm j)	-0.81*** (0.0019)	1.56 (1.63)	0.783 (1.67)	-0.752*** (0.175)
Constant	11.9*** (0.82)	16.6*** (1.3)	8.30** (3.39)	4.84*** (1.82)
Observations	3300	3300	3300	3300
R-squared	0.37	0.05(within) 0.39(between) 0.33(overall)	0.05(within) 0.40(between) 0.33(overall)	0.40

Notes: Standard errors in parentheses. *significant at 10% **significant at 5% ***significant at 1%

4.1. Estimation of Nash Equilibrium

The first column of Table 2 reports the results of a pooled ordinary least squares (OLS) regression on interest rates. The positive coefficient of the marginal cost of firm i suggests that when marginal costs increase by \$1.00 per gross loan portfolio, interest rates are raised by 10.6% points. This relationship is in line with the expectation that price increase as costs increase. As the marginal cost of firm j increases by \$1.00 per gross loan portfolio, interest rates charged by firm i are expected to rise by 31.3% points. This positive relationship appears to suggest some measure of pricing power by the firms. Due to the symmetry expressed by the best response functions 1.5 & 1.6, we expect that when firm j 's marginal cost increases, it would have to raise the interest rates charged. With all else being equal, the ability to raise prices in response to a competitor raising prices implies an imperfectly competitive market, hence, suggesting firms possess some degree of monopolistic powers.

Although firm i 's for-profit dummy is not significant at 10%, robustness checks in models (2), (3) & (4)³¹ verify the positive relationship of this explanatory variable on interest rates. This positive relationship supports the stylized fact presented in Figure 5. This also suggests that for-profit MFIs charge a 0.718% point higher interest rate than non-profit MFIs.

Comparing a firm with all female borrowers to a firm with an all-male customer base, we find a one percentage point increase in the women-to-borrower ratio increases the interest rate charged per loan by 0.18% points. This may suggest that firms perceive women borrowers as being less sensitive to changes in interest rates as compared to their male counterparts. Further evidence can be found from firm j 's women-to-borrower coefficient, which suggests an opposite effect of 0.081% points on the interest rate. Since the number of women borrowers in any given market is finite, a negative coefficient on j 's borrower composition may imply that as the competitor services more women borrowers, firm i is left with customers who are more sensitive to prices and must therefore charge a lower price in order to maximize profits.

Table 3 reports the Breusch-Pagan Lagrangian multiplier test on model (2). We reject the hypothesis that random effects do not exist. Although the random effects model provides for more efficient estimators than the OLS model (1), our demand parameters must be determined via the OLS model due to the theoretical design discussed in the previous section. A potential extension of this research may be to incorporate the random effects and continental dummies into the initial demand function, which then enable us to use models (2)-(4) for structural estimation.

³¹ The second column reports estimates from panel regressions with random effects on interest rates. The third column reports a panel random effects regression on interest rates with the inclusion of the continental dummies. The fourth column involves estimates of the Nash equilibrium including the same explanatory variables as model (1) with the addition of continental variables.

Table 3: Breusch-Pagan Lagrangian Multiplier Test

	Variance	Standard Deviation
Interest Rates (%)	326.1	18.1
e	46.4	6.8
u	177.0	13.3
χ^2	2033.75	
Prob> χ^2	0.0000	

As seen in Table 2, model (1) is relatively robust as statistically significant variables in models (2) thru (4) have similar magnitudes and direction. Using the results from column (1), we proceed to estimate the demand parameters structurally.

4.2. Structural Estimation of the Demand Parameters

Given the reduced form estimates in model (1) on Table (2), we determine the coefficients of the demand equation by setting up a system of equations as shown below:

$$\widehat{\beta}_0 = \frac{\left[\frac{\mu}{4\eta^2} - \frac{1}{2\eta} \right] \tau}{1 - \frac{\mu^2}{4\eta^2}} = 11.9 \quad (2.1)$$

$$\widehat{\beta}_1 = \frac{1}{2 \left(1 - \frac{\mu^2}{4\eta^2} \right)} = 10.6 \quad (2.2)$$

$$\widehat{\beta}_2 = \frac{-\frac{\mu}{4\eta^2}}{1 - \frac{\mu^2}{4\eta^2}} = 31.3 \quad (2.3)$$

$$\widehat{\beta}_3 = \frac{\frac{\psi\mu}{4\eta^2} - \frac{\phi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} = 0.718 \quad (2.4)$$

$$\widehat{\beta}_4 = \frac{\frac{\phi\mu}{4\eta^2} - \frac{\psi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} = 6.86 \quad (2.5)$$

$$\widehat{\beta}_5 = \frac{\frac{\zeta\mu}{4\eta^2} - \frac{\omega}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} = 18.0 \quad (2.6)$$

$$\widehat{\beta}_6 = \frac{\frac{\omega\mu}{4\eta^2} - \frac{\zeta}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} = -0.81 \quad (2.7)$$

Simultaneously solving 2.1-2.7 generates non-unique estimates of the demand structural parameters. Therefore, a μ value needs to be assigned for us to solve for a unique solution. Hollo (2010) determined that the mean cross price elasticity on non-collateralized consumer lending in Hungary was 0.25. Using this estimate, we can estimate the μ value to be 7.94 (See Appendix 8.2 for derivation). In addition, we can conduct sensitivity analysis to determine how our estimates will change over a range of μ values.

$$\eta = \frac{-\mu\beta_1}{2\beta_2}. \quad (2.8)$$

Using 2.8, we substituted $\mu = 7.94$ & η in to 2.1, 2.4, 2.5, 2.6 and 2.7. Solving this system of equations generates unique solutions for $\tau, \phi, \psi, \omega, \zeta, \eta, \mu$, given in Table 4 and Table 5³².

Table 4: Estimation of demand parameters varying μ

	Values $\sigma=0.4$ & $\mu=7.943$ (baseline)
τ	168.8
ϕ	0.314
ψ	-0.075
ω	-0.672
ζ	0.984
η	-1.33
μ	7.94

Explicitly we can write the baseline estimated demand equation for each firm i as,

$$\widehat{q}_i = 168.8 + 0.314a_i - 0.075a_j - 0.672b_i + 0.984b_j - 1.33p_i + 7.94p_j. \quad (2.9)$$

Demand equation 2.9 suggests that when the interest rate charged increases by 100%, the quantity demanded decreases by \$133. This reflects low demand elasticity, which contradicts Dehejia et al. (2005). Instead, this reflects what Karlan and Zinman (2008) find in the South African MFI market.

³² Table 4 shows the results of sensitivity analysis on μ while Table 5 shows the sensitivity analysis results of σ . The baseline model will use $\sigma=0.4$ and $\mu=7.943$.

The positive coefficient of the for-profit variable is in accordance with the expectations discussed earlier. It may appear that a \$0.314 increase in demand when the firm is for-profit has no practical significance. However, it must be noted that equation 2.9 represents the demand function for a single loan. Therefore, the effect of the \$0.314 increase when aggregated across the entire gross loan portfolio has both statistical and practical significance. This result lends credence to our theory that the for-profit dummy variable serves as a proxy for consumers' preferences related to the acquisition of a loan.

A value of 1 for a_j reflects the fact that all competing firms in the country are for-profit. This implies that the quantity demand from firm i will decrease by \$0.075 if all the competing firms are for-profit MFIs. This again is in accordance to our expectations stated in the theoretical section. Similarly, the practical significance can only be appreciated when summed across the entire gross loan portfolio.

The coefficient for the effect of the women-to-borrower ratio has an opposite sign from our *a priori* expectation. A possible explanation is that the proportion of women borrowers may not be proxying for the unobservable attribute of image, but instead it may be proxying for the loan structure. Borrowers may have an unobservable preference for individual lending instead of seeking out more partners in order to obtain a loan. Literature supports this anecdotally, as evidenced by Kwon (2010). Kwon (2010) finds that it is common practice in village MFIs where loans are mainly given to women to use a group lending approach. If firm i increases the women-to-borrower ratio by 1%, our results suggest that the demand for loans will experience a decrease of 0.67 cents.

The attribute, b_j captures the unobserved effect of group lending by i 's competitors. If firm i 's competitors exhibit an increase use of group lending model (proxied by an increase in women-to-borrower ratio), our results suggest that loan demand of firm i will decrease. Therefore, if the competitor firm serves only women (*i.e.* the women-to-borrower ratio equals 1), we expect the demand for firm i 's loans will increase by \$1.33. This occurs as customers' now flock to firm i for loans as they prefer the individualized loans offered by firm i .

4.3 Sensitivity Analysis

Table 5: Estimation of demand parameters varying σ & μ

	Values $\sigma=0.4$ & $\mu=7.943$ (baseline)	Values $\sigma=0.1$ & $\mu=7.943$	Values $\sigma=0.25$ & $\mu=7.943$	Values $\sigma=0.4$ & $\mu=1$	Values $\sigma=0.4$ & $\mu=10$
τ	168.8	174.7	174.1	21.3	213
ϕ	0.314	0.256	0.276	0.04	0.4
ψ	-0.075	-0.057	-0.064	-0.009	-0.09
ω	-0.672	-0.569	-0.606	-0.085	-0.85
ζ	0.984	0.828	0.883	0.124	1.24
η	-1.33	-1.26	-1.29	-0.168	-1.68
μ	7.94	7.94	7.94	1	10

As σ and μ are values chosen based on existing literature that is not specific to the microfinance industry, sensitivity analysis is required to determine the impacts on demand if σ and μ are varied. In Table 5, we vary μ by selecting $\mu=1$ and $\mu=10$ and comparing it to the baseline model. The results suggest that as cross price elasticity increases (i.e. μ increases, see appendix 8.2), it acts as a scaling factor. This therefore implies that a carefully chosen μ is critical to getting the correct magnitude of the explanatory coefficients. We vary the elasticity of substitution, σ , by choosing $\sigma=0.1$ and $\sigma=0.25$. The result of the sensitivity analysis shown in Table 5 suggests that as elasticity of substitution increases, the magnitude of $\phi_1, \phi, \omega, \zeta, \eta$ increases. This result implies that as capital and labor become more substitutable, we find that the effects of the explanatory variables become more pronounced. However, the change in magnitude is small.

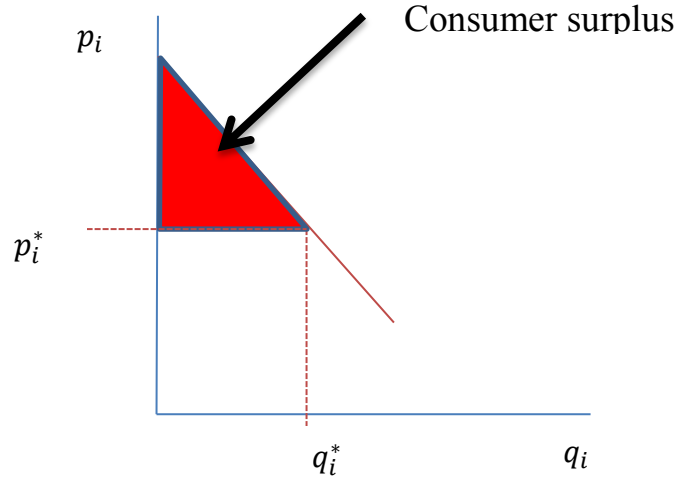
Since we are able to determine the signs on the coefficients in the baseline demand function, we perform a one-tailed non-linear hypothesis test, where $H_0: \{\tau, \phi, \phi, \omega, \zeta, \eta, \mu, \} > \text{or} < 0$, depending on the signs found in equation 1.10. Table 6 shows that H_0 is rejected for all baseline demand parameters at the 10% level.

Table 6: p-values of non-linear test of significance for demand parameters

	p-values
τ	< 0.001
ϕ	0.89
ψ	< 0.001
ω	< 0.001
ζ	< 0.001
η	< 0.001
μ	< 0.001

5. Welfare Analysis

With the estimated demand function, given in equation 2.9 we estimate the firm-level consumer surplus. This is then aggregated across all for-profit and non-profit firms. Using the values of the explanatory variables for each firm, we estimate the demand functions for microfinance loans given by for-profit ($a_i = 1$) and the non-profit ($a_i = 0$) institutions. The estimated demand functions allow us to calculate both consumer and producer surplus. Consumer surplus is defined as the consumer's willingness to pay versus the actual price paid by the consumer. This difference provides us with an estimation of how much better off a consumer is based on the price he paid. The analysis of consumer surplus allows us to determine the changes in consumer welfare in the microfinance industry due to the growth of for-profit MFIs. The demand curve for a representative MFI is represented in figure 7.

Table 7: Demand curve of a representative MFI

To determine the consumer surplus for both for-profit MFIs and non-profit MFIs by year, we first aggregate the consumer surplus for each firm by multiplying the per loan consumer surplus by the number of borrowers.³³ Thereafter, we aggregate the total consumer surplus for all for-profit and non-profit MFIs separately by year. Table 7 shows the average consumer surplus for a for-profit firm versus a non-profit firm from 2003-2009.

Table 8: Average consumer surplus per firm in \$'000, 2003-2009

Year	For-profit (1)	Non-profit (2)
2003	84.9	81.8
2004	86.5	82.9
2005	81.5	80.1
2006	83.4	79.3
2007	82.9	77.0
2008	86.2	79.2
2009	83.7	78.2

The for-profit MFIs consistently exhibit greater consumer surplus than the non-profit MFIs from 2003-2009. The greater consumer surplus generated by the for-profit MFIs may suggest that consumers have an increased preference for for-profit MFIs and this could be a consequence of the reduced transactions cost when borrowing from for-profit MFIs.

Additionally, Table 8 provides us with a comparison between for-profit and non-profit MFI's producer surplus per dollar loaned. Producer surplus is defined as the difference between the price charged by a firm and the cost of production. It is calculated by finding the difference

³³ We assume that each firm is only willing to give out one loan to each customer. Hence, the number of customers will equal the number of loans.

in price that each firm charged and subtracting from that the marginal cost of production. This gives us the marginal profit generated by each firm on a per loan basis. Similar to consumer surplus, analysis of producer surplus therefore allows us to determine the difference in producer surplus generated by both for-profit and non-profit MFIs.

Table 9: Average producer surplus (\$) per \$ loaned, 2003-2009

Year	For-profit (1)	Non-profit (2)
2003	0.151	0.139
2004	0.121	0.139
2005	0.141	0.149
2006	0.191	0.166
2007	0.165	0.129
2008	0.196	0.173
2009	0.136	0.114

Table 8 suggests that prior to 2006, there is an absence of a clear trend that either for-profit or non-profit MFIs are generating higher producer surplus. However, from 2006, it is evident that for-profit MFIs consistently generate higher producer surpluses than non-profit MFIs. The occurrence of for-profit MFIs generating higher consumer surpluses coincides with the beginning of allegations against for-profit MFIs in 2006.

6. Conclusion

The Bertrand differentiated product model provides us with insights into the current debate about for-profit and non-profit MFIs. It is evident from our results that allegations against for-profit MFIs by critics are partially true, but a more extensive and parsimonious analysis uncovers more subtle issues for discussion. Even after controlling for the interactions between firms and the different costs each firm faces, the demand of for-profit MFIs is higher due to the consumer's unobserved preference for ease of getting a loan. However, the interest rate charged by for-profit MFIs generates less consumer surplus than non-profit MFIs. The own price elasticity was found to be -0.15.

Our model helps explain why interest rates differ between firms in the same market through the use of product attributes. The for-profit status of a firm and the women-to-borrower capture a portion of the unobservable preference of consumers, ease of getting a loan and loan structure respectively. Using our estimates, we believe that consumers have a positive preference for a higher ease of obtaining a loan and prefer individualized loans rather than group loans. Additionally, this model allows us to analyze the effects of price setting alone as compared to existing empirical models that do not differentiate between the effects of firms setting prices and choosing quantity. Existing models do not take into account the unobservable attributes in the demand equation and instead rely only on the differences in cost and prices. This results in an omitted variable bias that we address in this thesis using product attributes. A possible extension

to the research would be to estimate the impact of other attributes, strengthening the robustness checks of the model.

One possible policy recommendation is for governments to set up credit agencies that collect data on consumers' credit worthiness and share this with other MFIs. This could help overcome the lack of information on the consumer's credit worthiness, thereby enabling MFIs to offer lower interest rates to customers while reducing the risk level due to unknown customer credit. This could potentially increase both the consumer and producer surpluses. Although for-profit MFIs are currently able to generate higher consumer and producer surpluses than non-profit MFIs, the Nash equilibrium occurs only as a result of the strategic interaction between firms.

Consequently, policies should not focus on just promoting the for-profit MFIs, but should instead focus on promoting both types of MFIs as increased competition will help lower the equilibrium interest rates and potentially increase consumer surplus. Additionally non-profit MFIs are critical as noted by Hansmann (1980), that non-profit organizations can act as insurance from stochastic shocks to the market that may see for-profit MFIs reduce their supply of loans. Non-profit MFIs therefore play a critical role in ensuring that the poor receive continued access to financial services in an event that for-profit MFIs are unwilling to do so.

A potential empirical improvement would be to obtain consumer-level data since that allows us to have the exact loan structure instead of having to rely on proxied information. A further extension to the research would use data on the value of subsidies provided to some non-profit firms. These subsidies could potentially impact a firm's marginal cost which would impact both producer and consumer surplus provided by loan generated by the firm. Taking away subsidies from non-profit MFIs could result in these MFIs having to raise prices, this would result in higher Nash equilibrium prices due to the strategic interactions between firms seen in Figure 5. An additional avenue of future research can use spatial analysis to refine the model accounting for the effects of firm size and location on the interest rates.

7. References

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8. Appendix

8.1. Derivation of Nash Equilibrium

From,

$$\begin{aligned} \pi = & p_i(\phi_0 + \phi_1 a_i + \psi a_{-i} + \omega b_i + \zeta b_{-i} + \eta p_i + \mu p_{-i}) \\ & - (\phi_0 + \phi_1 a_i + \psi a_{-i} + \omega b_i + \zeta b_{-i} + \eta p_i + \mu p_{-i}) * \left((v^{1-\sigma} + w^{1-\sigma})^{\frac{1}{1-\sigma}} \right) \end{aligned} \quad (1.4)$$

We find,

$$\frac{\partial \pi}{\partial p} = 0 \quad (1.4.1)$$

Substituting $\left((v_i^{1-\sigma} + w_i^{1-\sigma})^{\frac{1}{1-\sigma}} \right) = c_i$

Solving for

$$\frac{\partial \pi}{\partial p} = 0.$$

Gives us,

$$\frac{\partial \pi}{\partial p} = \phi_0 + \phi_1 a_i + \psi c_j + \omega b_i + \zeta b_j + 2\eta p_i + \mu p_j - \eta(v_i^{1-\sigma} + w_i^{1-\sigma})^{\frac{1}{1-\sigma}} = 0 \quad (1.4.2)$$

$$p_i = \frac{1}{2} c_i + \frac{1}{2\eta} [\phi_0 + \phi_1 a_i + \psi a_{-i} + \omega b_i + \zeta b_j + \mu p_{-i}] \quad (1.5)$$

$$p_j = \frac{1}{2} c_j + \frac{1}{2\eta} [\phi_0 + \phi_1 a_j + \psi a_i + \omega b_j + \zeta b_i + \mu p_i] \quad (1.6)$$

Solving simultaneously for 1.5 & 1.6,

$$\begin{aligned} p_i^* = & \frac{[\frac{\mu}{4\eta^2} - \frac{1}{2\eta}]\phi_0}{1 - \frac{\mu^2}{4\eta^2}} + \frac{1}{2(1 - \frac{\mu^2}{4\eta^2})} A_i + \frac{-\frac{\mu}{4\eta}}{1 - \frac{\mu^2}{4\eta^2}} A_{-i} + \frac{\frac{\psi\mu}{4\eta^2} - \frac{\phi_1}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} a_i + \frac{\frac{\phi_1\mu}{4\eta^2} - \frac{\psi}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} a_{-i} \\ & + \frac{\frac{\zeta\mu}{4\eta^2} - \frac{\omega}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} b_i + \frac{\frac{\omega\mu}{4\eta^2} - \frac{\zeta}{2\eta}}{1 - \frac{\mu^2}{4\eta^2}} b_{-i} \end{aligned} \quad (1.7)$$

8.2. Derivation for μ

Cross price elasticity, $E_{i/j}$, is determined to be 0.25 based on empirical evidence (Hollo, 2010). For purposes of tractability, we also assume that the cross price elasticity is relatively constant. Because we do not have data on the consumer level, we use the mean quantity and interest rates to compute the change in quantity.

Given,

$$E_{i/j} = \frac{\frac{\Delta q_i}{q_i}}{\frac{\Delta p_j}{p_j}}$$

$$0.25 = \frac{\% \Delta q_i}{\% \Delta p_j}$$

When firm j charges 1% higher interest rates based on the mean price of 36.6%,

$$0.25 * \frac{1}{36.6} = \frac{\Delta q_i}{q_i}$$

$$q_i = 1163 \text{ (mean quantity)}$$

$$\Delta q_i = 7.943$$

Therefore at the mean interest rates charged, when interest rates of firm j are raised by 1%, the quantity demanded from firm i increases by 7.943. Hence,

$$\mu = 7.943$$

8.3. Variable Definition

Capital Asset Ratio

Total equity divided by total assets.

Continent Dummies

Five continent dummies, North America, South America, Asia, Europe and Africa were created. These dummies are assigned a “1” if the country corresponding belonged in the specific continent, and “0” for all others.

Cost per Borrower

Operating expense/ number of active borrowers, average.

Cost per gross loan portfolio (\$)

This variable is generated based on the marginal cost function, 1.2. The labor cost was generated by using the cost per borrower*active borrowers and subsequently divided by the gross loan portfolio of the firm. Similarly, the capital cost was generated using capital asset ratio multiplied by the total asset to obtain the total capital. The total capital is then multiplied by the annualize one month treasury rate and divided by the gross loan portfolio of the firm. Treasury rates were obtained from the Board of Governors of the Federal Reserve database that is available online. The marginal is determined using the CES cost function 1.2. We use an elasticity of substitution of 0.6 as evidenced by Chinriko et. al (2004), to determine the marginal cost c .

For-Profit Dummy

The binary dummy variable that assigns a “1” for for-profit MFIs and a “0” for non-profit MFIs. The data was obtained from the 2008 WDI benchmark report by the Microfinance Information Exchange. The for-profit status of a MFI was determined based on the type of business that was declared upon registration.

Gross Loan Portfolio (\$)

The sum of all outstanding principals due for all outstanding client loans. This includes current, delinquent, and renegotiated loans, but not loans that have been written off. It does not include interest receivable. The gross loan portfolio is denominated in nominal US\$.

Operating Expense

Expenses related to operations, including all personnel expense, depreciation and amortization, and administrative expense.

Women-to-Active Borrower Ratio

The number of women borrowers/active borrowers. Active borrowers refer to the number of individuals or entities who currently have an outstanding loan balance with the MFI or are primarily responsible for repaying any portion of the gross loan portfolio. Individuals who have multiple loans with an MFI should be counted as a single borrower.

Yield on gross loan portfolio

The nominal interest and fees charged on the gross loan portfolio.

8.4. Glossary

Bertrand Model with Product Differentiation

A *Bertrand model with product differentiation* is an economic model that assumes firms are price setters. However, the firms are able to charge different prices in the same market due to slight differences in the products sold which leads to a difference in consumer preference, ultimately affect demand of the particular product.

Constant Elasticity of Substitution

A *constant elasticity of substitution (CES)* function refers to a function that maintains the same ratio of capital to labor use throughout the entire range of quantity produced.

Consumer Surplus

Consumer surplus refers to the difference in the price a consumer is willing to pay versus the actual price he pays

Elasticity of Demand

Elasticity of demand refers to how sensitive demand is to change in prices of the product. It is calculated by determining the % change in quantity demanded divided by the % change in price of the good, $\left(\frac{\% \Delta q_i}{\% \Delta p_i}\right)$.

Endogenous Variable

An *endogenous variable* refers to a variable that affects not only the dependent variable but also the error term in an estimation model and results in inaccurate estimation results.

For-profit

The *for-profit* status is determined by an MFI's business registration status. *For-profit* should be understood to reflect firms that sacrifice the goal of alleviating poverty via credit access in pursuit of profit maximization for its shareholders.

Group Lending

Group lending requires that borrowers form small groups that share the responsibilities of loan repayments and provide dynamic incentives

Moral Hazard

Moral hazard is an economic phenomenon that occurs when the incentive to repay is diminished due to a lack of punitive actions that banks are able to conduct (e.g. repossession of collateral).

Nash equilibrium

The *Nash equilibrium* refers to the prices both firms set as a result of strategic interactions. It is also the point where no firm has any incentive to change their prices as doing so will only result in a worsening of their profits. At *Nash equilibrium*, all players (firms) in a game (market)

cannot have a better outcome if a player changes strategy while the other players stay unchanged. In this instance, because it is a pure Nash strategy (a unique solution), firm i or j will be worse off if they choose a price other than the Nash price.

Non-Stochastic Model

A *non-stochastic model* refers to the absence of random external shocks such as a financial crisis that is normally present in the real world.

Producer Surplus

Producer surplus refers to the difference between the prices a firm charges and the cost to the firm in producing the product.

Proxy

A *proxy* is a variable that is able to capture the unobservable attributes and must be a variable which we are able to measure.

Unbankables

The term *unbankables* refers to those to whom traditional banks are unwilling to provide financial access. Microfinance provides these *unbankables* with services such as deposits, loans and more recently insurance

Unobservable Attributes

In economics, *unobservable attributes* are consumer's preferences for a certain characteristic of a product that is immeasurable.