The Emergence of Captive Finance Companies and Risk Segmentation of the Consumer Loan Market: Theory and Evidence

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Abstract

A seller with market power to some degree in its product market can earn rents. In this context, there is a gain to granting credit for the purchase of the product and thus the establishment of captive finance company for expanding the sales by offering loans to consumers who need financing for purchase of durable good. This paper examines the optimal behavior of such a durable good seller and its captive finance company when the consumer loan market is segmented into captive and independent lending institutions given imperfect but informative signals on borrower's creditworthiness. The model predicts a critical difference for the captive finance company will be its credit standard, namely, that the captive finance company will follow a more lenient credit standard. Thus, we should expect the likelihood of repayment of a captive loan to be lower than that of a bank loan, other things equal. This prediction is tested using a unique data set drawn from a major credit bureau in the U.S., and the evidence supports the theoretical prediction.

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1. Introduction

This paper presents a theoretical model and empirical analysis of risk segmentation of the secured consumer installment loan market by two different types of lending institutions – independent lending institutions and captive finance companies. A consumer installment loan is a credit arrangement repaid through periodic installment payments over a specific length of time. In general, consumer installment loans are used for financing the purchase of expensive durable goods. The good purchased serves as collateral for collection upon borrower's default. Captive finance companies are the subsidiaries that finance the sales of products of their parental manufacturers[1].

Several empirical papers have examined market segmentation issues related to finance companies. Boczar (1978) empirically studied risk segmentation of consumer loan market on the basis of borrower risk characteristics. Data from a national survey of households are used to determine socio-economic and life-cycle characteristics of borrowers at banks and finance companies. Boczar finds substantial overlap in borrower risk characteristics for the sampled households.

Remolona *et al*. (1992) examine the differential performances of banks and finance companies in credit markets. They find that, in consumer loan markets, finance companies lost market share to banks and their affiliates while much of the finance company's growth took place in niches, market segments of relatively risky credit where command of specialized information was critical to lending institutions.

Carey *et al.* (1998) empirically examine the existence of specialization in the private corporate loan market, extending the research on the public versus private debt distinctions. Comparing corporate loans made by commercial banks and finance companies, they find that the

[1] Examples are captive finance companies of automobile manufacturers such as General Motors Acceptance Corporation, Ford Credit, and Toyota Financial Services in the U.S. Most of domestic and foreign automobile manufacturers in the US have their own captive finance companies to facilitate financing for the purchase of their products.

two types of lending institutions are equally likely to finance information-problematic firms. However, finance companies tend to serve observably high-risk borrowers. They find that both regulatory and reputation-based explanations are significant for this specialization.

Our paper differs from the above papers in its focus on the secured automobile installment loan market, a market in which two types of lending institutions are involved in servicing such loans, banks (including commercial banks, credit unions, and other depository institutions) and captive finance companies. A key feature of a captive finance company is that its credit decision takes into account not only the return from granting captive loans, but also the return from the sale of products purchased with captive loans. We develop a theoretical model that incorporates this feature, and in doing so provide an explanation for the emergence of captive finance companies as well as a prediction regarding the risk segmentation of the automobile loan market. We then provide an empirical test of our theory using a unique data set that allows us to consider the differential performance of auto loans by the two different types of lenders.

The remainder of this paper is organized as follows. Section 2 presents a model where a bank (an independent lending institution) obtains an imperfect signal on the creditworthiness of a borrower, and makes a credit decision by setting an optimal cutoff signal. Section 3 introduces a simple model of a firm's expected demand for a product in a monopolistically competitive durable good market, assuming that consumers do not need financing for the purchase of durable goods.

Section 4 links the analysis of Sections 2 and 3 by noting that the positive gain to the durable good seller from additional sales provides an incentive to establish a captive finance company that offers loans to individuals who would not be provided such loans by independent lenders due to their (higher) risk of default. In other words, the existence of positive rents for the durable good seller induces its captive finance company to set an optimal credit standard (cutoff signal) below the level of banks in equilibrium, resulting in risk segmentation of the consumer loan market by banks and captive finance companies. In essence, the captive finance company functions as a lender of last resort. Section 4 also provides the numerical examples which implement the theoretical model of this paper, and those numerical examples describe the new equilibrium in monopolistically competitive durable good market with both banks and captive finance companies in contrast with the old equilibrium with only banks.

Section 5 tests the prediction of the theoretical model using a unique data set, *TrenData™*, drawn from Trans Union LLP, a major credit bureau in the United States. The analysis of credit bureau data shows that, as expected, a captive automobile loan is less likely to be repaid than a bank automobile loan. Section 6 summarizes and concludes.

2. A Simple Model of Credit Evaluation and Lending

In this section, we present a simple model of credit rationing when a lending institution obtains an imperfect signal on the creditworthiness of a borrower who seeks financing of the purchase of a durable good. For simplicity, we consider a two-period model. In the first period, a consumer applies for a loan at a lending institution of a particular type k to finance the purchase of a durable good. If approved, the loan of amount l at loan rate i is offered by the lending institution. In the second period, the consumer pays off the loan or defaults. We consider two types of lending institutions – independent lending institutions or "*banks*" (denoted by the subscript B) and captive finance companies (denoted by the subscript F).

We assume that there is a fixed number, M, of potential consumers of the durable goods, each planning to purchase one unit. In the entire discussion of this paper, we assume that M is fixed, that all M consumers require financing to purchase the durable good, and that the durable good purchased serves as collateral. If a borrower defaults, the durable good has salvage value, and the lending institution takes collection activity to recover the remaining value of the collateral.

We assume that there are two types of consumers seeking a loan: consumers who will pay off the loan – the *low-risk* loan applicants (denoted by subscript *L)* and consumers who will default – the *high-risk* loan applicants (denoted by subscript *H*). Let $\gamma \in (0,1)$ denote the exogenous and known probability that a consumer seeking a loan from a lending institution will not default on a loan and $(1-\gamma) \in (0,1)$ denotes the exogenous and known probability that a consumer seeking a loan from a lending institution will default on a loan. Note that γ and $(1-\gamma)$ can be interpreted as the known proportions of low- and high-risk borrowers, respectively.

A lending institution receives an imperfect but informative signal[2] on the creditworthiness of a borrower, s. This signal summarizes observable characteristics of potential borrowers, mainly a borrower's income and other factors such as asset holding, debt levels, type of debt, credit history, marital status, and employment status – all of which can be linked to the likelihood of loan repayment. If the loan applicant is low-risk, the signal s is drawn from the normal distribution, $G_L(s)$ with mean μ_L and variance σ^2. If the loan applicant is high-risk, the signal is drawn from the normal distribution, $G_H(s)$ with mean μ_H and variance σ^2. Note that the variance, σ^2, is assumed to be fixed and identical in both distributions. We assume that $G_L(s)$ first-order stochastically dominates $G_H(s)$, such that low-risk loan applicants tend to generate higher signals on average, or $\mu_L > \mu_H$.

The decision of a lending institution of type *k* to approve or reject a loan applicant depends on its optimal cutoff signal, $\hat{s}_k$. If the signal obtained for the loan applicant is above the chosen cutoff signal, $\hat{s}_k$, the lending institution grants the loan. If the signal obtained is less than $\hat{s}_k$, the

[2] If borrowers possess private information distinguishing their own types and observe the differences in the loan approval rates of banks and captive finance companies, high-risk borrowers will choose the type of lending institutions offering higher loan approval rate. Then, the lending institutions will offer a menu of loan contracts that can separate the types of borrowers. Barron and Chong (2003) models risk segmentation of loan market by banks and captive finance companies under asymmetric information.

lending institution rejects the loan applicant. We will refer to $\hat{s}_k$ as indicative of the credit standard of a lending institution of type k, and assume that this cutoff signal is not publicly observable. If a consumer is not approved for a loan, it is assumed that this rejection precludes the consumer from obtaining a loan at other lending institutions, and thus the consumer does not buy the durable good[3].

A lending institution can err in evaluating a loan applicant in two ways - it can reject a low-risk loan applicant who will repay the loan or it can approve a loan to a high-risk loan applicant who will subsequently default. The rejection of a low-risk loan applicant is a *type I error* and the granting a loan to a high-risk loan applicant is a *type II error*. For a given cutoff signal, $\hat{s}_k$, the lending institution of type k rejects a low-risk loan applicant with probability $G_L(\hat{s}_k)$ and grants a loan to a high-risk borrower with probability $1 - G_H(\hat{s}_k)$. Thus, an increase in $\hat{s}_k$ raises the likelihood of type I errors, but reduces the likelihood of type II errors.

We assume that lending institutions operate in a perfectly competitive consumer loan market and hence take the loan rate i as given. Lending institutions incur a common cost of funds r.[4] Lending institutions earn net return $(i - r)$ for each borrower who pays off the loan. If the borrower defaults, the lending institution obtains the return $(r - d)$, where d reflects the return from the collection of salvage value of collateral, net of collection costs[5].

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[3] This assumption is strong, and is adopted to simplify the analysis. We could instead assume that a consumer who is denied for a loan at a lending institution of a particular type can apply, at some cost, for a loan at a second lending institution. The result would be a type of "winner's curse" in lending. In particular, if credit evaluation is imperfectly correlated across lending institutions and each lending institution is unaware of whether a borrower has been rejected by other lending institution(s), then the pool of borrowers will worsen. If lending institutions do know whether a borrower has been rejected at other lending institution(s), lending institutions may not be willing to lend to borrowers who have been previously rejected, and the result would be similar to our assumption that a consumer not approved for a loan does not buy the good.

[4] The cost of funds appears to have been very similar for banks and finance companies. Finance companies raise funds largely by issuing commercial paper (*CP)* and corporate bonds, while banks raise funds by issuing large certificates of deposit (*CD*s). To illustrate, the average interest rate on 3-month *CP* over 1998-2002 period is 4.454%. During the same period, commercial banks issued their *CD*s at an average 3-month interest rate of 4.540%.

[5] We assume that the collection rates are identical for both types of lending institutions. This assumption is reasonable in that lending institutions usually sell the unpaid debts to collection companies. The collection companies conduct the identical collection activities regardless of the types of lending institutions from which they

The expected profits from granting a loan of amount l to a borrower is then given by[6]:

(1) $$\pi_B(\hat{s}_k) = \gamma(i-r)l - \gamma G_L(\hat{s}_k)(i-r)l - (1-\gamma)[1-G_H(\hat{s}_k)](r-d)l.$$

According to equation (1), the best possible outcome, $\gamma(i-r)l$, is reduced by expected losses associated with type I errors, $\gamma G_L(\hat{s}_k)(i-r)l$, and by expected losses associated with type II errors, $(1-\gamma)[1-G_H(\hat{s}_k)](r-d)l$. This setup makes it clear that the return to evaluating a loan applicant and making a loan is the expected returns of making the best decision minus the costs of errors. In the analysis to follow, we assume that the costs of these errors are such that it would not be optimal for the lender to adopt the simple rule of not evaluating loan applicants in favor of either always rejecting or always accepting loan applicants.

The optimal cutoff signal is given by:

(2) $$\hat{s}_k = \frac{\ln\left[\left(\frac{1-\gamma}{\gamma}\right)\left(\frac{r-d}{i-r}\right)\right]}{\left(\frac{1}{\sigma^2}\right)(\mu_L - \mu_H)} + \frac{(\mu_L + \mu_H)}{2}$$

The optimal cutoff signal equates the expected gain to increasing $\hat{s}_k$ in terms of decreasing the likelihood of approving a high-risk loan applicant with the expected costs of becoming more selective in terms of increasing the likelihood of rejecting a low-risk loan applicant. That is, the optimal cutoff signal is determined by the expected losses from type I and type II errors.

An important feature of the optimal cutoff signal $\hat{s}_k$ is its relationship to the probability of default, $\delta(\hat{s}_k)$, where the probability of default among approved loan applicants for lending institution of type k is given by:

(3) $$\delta(\hat{s}_k) = \frac{(1-\gamma)[1-G_H(\hat{s}_k)]}{\gamma[1-G_L(\hat{s}_k)] + (1-\gamma)[1-G_H(\hat{s}_k)]}$$

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purchased unpaid debts. In Besanko and Thakor (1987), collateral is used as a screening device under asymmetric information. This paper does not model the potential use of collateral as a screening device.

[6] Later, we assume that the loan amount, l, equals the price of the durable goods, *p*, for which the consumers obtain financing. No down payment is assumed in the model, although inclusion of a common down payment would not change the conclusions of the model.

Note that an increase in $\hat{s}_k$ tends not only to reduce the number of consumers approved for loans, but also to reduce the probability of default, $\delta(\hat{s}_k)$, for those who are given a loan or $\partial\delta(\hat{s}_k)/\partial\hat{s}_k < 0$. Note that, given the optimal cutoff signal, $\hat{s}_k$, the increase in the proportion of high-risk borrowers will reduce the probability of default or $\partial\delta(\hat{s}_k)/\partial\gamma < 0$ [7].

3. A Monopolistically Competitive Durable Goods Market with Only Banks

In this section, we define a firm's expected demand in a monopolistically competitive durable good market under the assumption that consumers finance the purchase of durable goods only through banks. Recall that we assume a fixed number, M, of consumers that require financing for the purchase of the durable goods. When only banks operate in the consumer loan market, the likelihood a consumer is approved for a loan at a bank is $A(\hat{s}_B)$, where:

(4) $$A(\hat{s}_B) = \gamma[1 - G_L(\hat{s}_B)] + (1-\gamma)[1 - G_H(\hat{s}_B)]$$

and $\partial A(\hat{s})/\partial\hat{s} < 0$. Thus, the total number of consumers who can finance the purchase of a durable good, given only bank lending is available, is given by:

(5) $$M_B = A(\hat{s}_B)M .$$

We assume that there are N firms selling differentiated products in a monopolistically competitive durable good market, and that these firms incur identical marginal production cost κ, and fixed cost, F. Each of the M_B effective purchases of the durable good, $j = 1, 2, ..., M_B$, attaches different relative values to these products. Following Perlof and Salop (1985), we assume that each consumer's valuation of the product of each firm can be viewed as independently drawn from the common distribution function $F(v)$ with density function $f(v)$. Given prices $\boldsymbol{p} = (p_1, p_2, ..., p_N)$ for the N available differentiated products, each consumer will choose that the product for which his surplus is maximized – his best buy.

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[7] This comparative static result has an implication on the empirical analysis. Noting that the relative proportions of low- or high-risk borrowers in a region indicate the regional average riskiness of borrowers, regional average credit score can be a proxy for the relative proportions of γ and $(1-\gamma)$.

A particular consumer *j*'s net surplus to purchasing from firm *i* given the consumer's valuation is given by:

(6) $$b_{ij} = v_{ij} - p_i .$$

where b_{ij} is *j*'s surplus from purchasing firm i's product, v_{ij} is *j*'s valuation of firm i's product, and p_i is the price of firm i's product. If $b_{ij} \geq b_{kj}$ for a given consumer, then $v_{kj} \leq p_k - p_i + v_{ij}$, and the consumer will choose to purchase from firm *i* over firm *k*. The probability that this occurs (i.e., $b_{ij} \geq b_{kj}$) is $\Pr\left(b_{ij} \geq b_{kj}\right) = F\left(p_k - p_i + v_{ij}\right)$.

Since valuations are identically and independently distributed for consumers and firms, the proportion of consumers who purchase firm i's durable good is given by:

(7) $$\Pr\left(b_i \geq \max_{k \neq i} b_k\right) = \int \prod_{k \neq i} \left[F\left(p_k - p_i + v\right)\right] dF(v)\, dv$$

It follows that the expected demand for durable good sold by firm i, $D_i\left(p_1, p_2, ..., p_i, ..., p_N\right)$, equals the proportion of consumers who buy that product given by equation (7) times the number of consumers M_B, or:

(8) $$\begin{aligned} D_i\left(p_1, p_2, ..., p_i, ..., p_N\right) &= M_B \Pr\left(b_i \geq \max_{k \neq i} b_k\right) \\ &= M_B \int \prod_{k \neq i} \left[F\left(p_k - p_i + v\right)\right] dF(v) \end{aligned}$$

Under the assumption that each firm has the identical and constant marginal cost, κ, its expected profits of firm i are given by:

(9) $$\Pi_i\left(p_1, p_2, ..., p_i, ..., p_N\right) = \left(p_i - \kappa\right) D_i\left(p_1, p_2, ..., p_i, ..., p_N\right) - F$$

where F is the common level of fixed costs (entry costs) of each firm.

We consider the case where a single symmetric equilibrium price exists such that $p_i = p$, $\forall i = 1,2,...,N$ [8]. Following Perlof and Salop (1985), this implies an expected demand of firm i given by:

(10) $$D_i\,(p, p, ..., p_i, ..., p) = M\int [F(p - p_i + v)]^{N-1} f(v)\,dv$$

Under the Bertrand-Nash assumption that firms choose price to maximize expected profits, taking other firms' prices as given, firm *i*'s first-order condition with respect to p_i is given by:

(11) $$p_i = \kappa - \frac{D_i\,(p_1, p_2, ..., p_i, ..., p_N)}{\left[\dfrac{\partial D_i\,(p_1, p_2, ..., p_i, ..., p_N)}{\partial p_i}\right]}$$

Given the form of expected demand (10), we obtain the following characterization for the optimal price at durable good seller i :

(12) $$p = \kappa + \frac{M_B \int [F(v)]^{N-1} f(v)\,dv}{(N-1)\,M_B \int [F(v)]^{N-2}\,[f(v)]^2\,dv} = \kappa + \frac{1}{N(N-1)\int [F(v)]^{N-2}\,[f(v)]^2\,dv}$$ [9]

Equation (12) characterizes the symmetric optimal price for durable goods which lies strictly above the competitive price ($p_i = \kappa, \forall i = 1,2,...,N$). In monopolistically competitive durable good market, a zero-profit equilibrium is characterized by the usual tangency of demand curve with average cost. Since all firms are identical, the expected demand at each firm is given by $A(\hat{s}_B)(M / N) = M_B / N$ and the zero-profit condition is:

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[8] Perlof and Salop (1985) show that, given identical marginal and fixed costs of firms, the market equilibrium has all firms charging a unique single-price equilibrium. See Perlof and Salop (1985) for details regarding the form of the demand function and further discussion characterizing the market equilibrium.

[9] For instance, when v is assumed to be uniformly distributed, i.e., $f(v) = 1/q$ over the finite support, [0,*q*], and 0 otherwise, we can easily show that $\int_0^q [F(v)]^{N-2} [f(v)]^2\,dv = \int_0^q (v/q)^{N-2} (1/q)^2\,dv = (1/q)(1/(N-1))$. Hence, $p = \kappa + q/N$. Note that q and $1/N$ indicate the degree of product differentiation and degree of market concentration, respectively.

(13) $$p = \kappa + \frac{F}{\left(\frac{M_B}{N}\right)}.$$

Equations (12) and (13) characterize the unique zero-profit symmetric equilibrium price of durable goods and number of sellers in the monopolistically competitive durable good market when only banks exist to finance consumer purchases. We denote the equilibrium price and number of firms by $\overline{p}$ and $\overline{N}$, respectively. Finally, a perfectly competitive loan market among banks implies an interest rate such that the expected incremental net return to a consumer loan for a bank is zero. The equilibrium bank loan rate $\overline{i}$ thus satisfies the following zero-profit condition of each bank in the perfectly competitive consumer loan market:

(14) $$\pi_B(\hat{s}_B) = l\left[\gamma(\overline{i} - r) - \gamma G_L(\hat{s}_B)(\overline{i} - r) - (1-\gamma)[1 - G_H(\hat{s}_B)](r - d)\right] = 0$$

4. Emergence of Captive Finance Companies

In this section, we consider the emergence of captive finance companies and risk segmentation by banks and captive finance companies in the automobile loan market. In doing so, we explain why the credit standard of a captive finance company is lower than that of a bank, leading to the prediction that the likelihood of repayment of captive finance loans is lower than that for bank loans.

To model the co-existence of banks and captive finance companies in the consumer loan market where banks are already established, we first need to examine why captive finance companies would emerge. One incentive for a captive finance company to emerge in the consumer loan market is that a durable good firm can increase expected combined profits if it grants captive loans to consumers who might not be able to get loans from banks.

Suppose that initially there are no captive finance companies. Now let there be a deviant durable good seller that institutes a captive finance company and offers the same interest rate as banks. We assume that there are no additional fixed costs for establishing a captive finance company. Given the perfectly competitive loan rate, $\overline{i}$, the equilibrium number of firms, $\overline{N}$, and the symmetric zero-profit equilibrium price of durable goods, $\overline{p}$, the initial deviant firm maximizes its expected combined profits from selling product and granting captive loans by choosing an optimal cutoff signal.

We assume that the optimal cutoff signals of different types of lending institutions are not publicly observable, and that consumers randomly select the types of lending institutions of different types - $\alpha \in (0,1)$ of the M consumers who demand the product of this durable good seller would select the captive finance company and $(1-\alpha) \in (0,1)$ of M consumers would select a bank for financing. Thus, there are $(1-\alpha)A(\hat{s}_B)\left(M / \overline{N}\right)$ consumers approved by banks and $\alpha A(\hat{s}_{DEV})\left(M / \overline{N}\right)$ consumers approved by the captive finance company, where $\hat{s}_{DEV}$ is the optimal cutoff signal for loan approval for the captive finance company of the deviant durable good seller.

The expected combined profits of the initial deviant seller which establishes its own captive finance company is given by:

(15) $$\Pi(\hat{s}_{DEV}) = (1-\alpha)A(\hat{s}_B)\left(\frac{M}{\overline{N}}\right)(\overline{p}-\kappa) + \alpha A(\hat{s}_{DEV})\left(\frac{M}{\overline{N}}\right)[(\overline{p}-\kappa) + \pi_F(\hat{s}_{DEV})] - F$$

where $\pi_F(\hat{s}_{DEV}) = \overline{p}\left[\gamma\left(\overline{i}-r\right) - \gamma G_L(\hat{s}_{DEV})\left(\overline{i}-r\right) - (1-\gamma)[1-G_H(\hat{s}_{DEV})](r-d)\right]$ denotes the profits of the captive finance company given the optimal cutoff signal of the initial deviant $\hat{s}_{DEV}$.

The initial deviant will establish a captive finance company and grant captive loans if and only if its expected combined profits as defined by (15) are larger than the expected profits from selling the products when all consumers obtain loans only from the banks. By taking a difference between (13) and (15), this holds if and only if:

(16) $$(\overline{p}-\kappa)[A(\hat{s}_{DEV}) - A(\hat{s}_B)] + A(\hat{s}_{DEV})\pi_F(\hat{s}_{DEV}) > 0$$

Note that if $\hat{s}_{DEV} = \hat{s}_B$, such that the captive finance company mimics the acceptance criterion of banks, then given $\pi(\hat{s}_B) = 0$ (zero-profit condition for banks) and $\partial\pi(\hat{s}_B)/\partial\hat{s}_B = 0$ (optimal-cutoff condition for banks), it follows that there would be gains to the deviant having a less restrictive cutoff signal. In particular, at $\hat{s}_{DEV} = \hat{s}_B$:

(17) $$\left.\frac{\partial\Pi(\hat{s}_{DEV})}{\partial\hat{s}_{DEV}}\right|_{\hat{s}_{DEV}=\hat{s}_B} = \alpha\left(\frac{M}{\overline{N}}\right)\left[\frac{\partial A(\hat{s}_{DEV})}{\partial\hat{s}_{DEV}}\right](\overline{p}-\kappa) < 0\,.$$

Equation (17) indicates that the optimal cutoff signal for the captive finance company of the deviant is below the optimal cutoff signal of a bank or $\hat{s}_{DEV} < \hat{s}_B$. Given the zero-profit loan interest rate, $\overline{i}$, $\hat{s}_{DEV} < \hat{s}_B$ implies $\pi_F(\hat{s}_{DEV}) < 0$. A lower cutoff signal will increase sales of the deviant, and each additional sale generates positive profits given the positive markup on the durable good, $(\overline{p}-\kappa) > 0$. Of course, at some point the gains to the additional sales are countered by losses on loans, and this limits the size of the reduction in the cutoff signal for the captive finance company.

At the optimal cutoff point, the increase in expected profits derived by granting additional loans, $(\overline{p}-\kappa)[A(\hat{s}_{DEV}) - A(\hat{s}_B)] > 0$, outweighs the expected losses from the captive loans, $A(\hat{s}_{DEV})\pi_F(\hat{s}_{DEV}) < 0$, resulting in the increase in expected combined marginal profits:

(18) $$[(\overline{p}-\kappa)[A(\hat{s}_{DEV}) - A(\hat{s}_B)] + A(\hat{s}_{DEV})\pi_F(\hat{s}_{DEV})] > 0$$ [10].

Note that (18) implies:

(19) $$[(\overline{p}-\kappa) + \pi_F(\hat{s}_{DEV})] > 0\,.$$

The above discussion supports the emergence of captive finance companies for durable good sellers. We now characterize the equilibrium in monopolistically competitive durable goods market when all of the symmetric durable good sellers operate their captive finance companies in

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[10] Gilligan and Smirlock (1983) show that, in order to maximize the value of the firm, a multiproduct firm can obtain revenues in excess of production costs on goods sold in monopolized market and uses these rents to subsidize the production of goods sold in competitive markets.

the consumer loan market, taking as given the proportion of consumers who apply to the captive finance company for a loan, α, the proportion of consumers who apply to banks for a loan, $(1-\alpha)$, cost of funds, r, and net return on collection, d, associated with a competitive banking sector. Both banks and captive finance companies take the zero-profit equilibrium interest rate, $\overline{i}$, as given and fixed in the perfectly competitive consumer loan market.

In this new equilibrium with both banks and captive finance companies operating in the perfectly competitive consumer loan market, the symmetric zero-profit equilibrium price of durable goods, $\hat{p}$, the symmetric zero-profit equilibrium number of durable sellers, $\hat{N}$, and the optimal cutoff signal of a captive finance company, $\hat{s}_F$, are related. Further, the Chamberlinian tangency condition does not apply since the expected profits of a firm with a captive finance company include not only profits from selling the product, but also the losses to granting captive loans.

Since the consumers randomly select the types of lending institutions, the zero-profit symmetric equilibrium in the monopolistically competitive durable good market is characterized by:

(20) $$\Pi(\hat{s}_F) = (1-\alpha)A(\hat{s}_B)\left(\frac{M}{\hat{N}}\right)(\hat{p}-\kappa) + \alpha A(\hat{s}_F)\left(\frac{M}{\hat{N}}\right)[(\hat{p}-\kappa) + \pi_F(\hat{s}_F)] - F = 0.$$

Note that $\hat{p}$ and $\hat{s}_F$ are subject to $(\hat{p}-\kappa)[A(\hat{s}_F) - A(\hat{s}_B)] + A(\hat{s}_F)\pi_F(\hat{s}_F) > 0$, which is the necessary and sufficient condition of the emergence and operation of each captive finance company.

Each durable good firm and its captive finance company jointly set the cutoff signal to maximize the expected combined profits from selling products and granting captive loans to consumers. Given the perfectly competitive loan rate, $\overline{i}$, a symmetric zero-profit equilibrium price of durable goods, $\hat{p}$, and the optimal cutoff signal of a captive finance company, $\hat{s}_F$, are expressed by:

(21) $$\hat{s}_F = \frac{\ln\left[\left(\frac{1-\gamma}{\gamma}\right)\left[\frac{r - \left[\frac{(\hat{p}-\kappa)+\pi_F(\hat{s}_F)}{A(\hat{s}_F)\hat{p}}\right] - d}{\bar{i} + \left[\frac{(\hat{p}-\kappa)+\pi_F(\hat{s}_F)}{A(\hat{s}_F)\hat{p}}\right] - r}\right]\right]}{\left(\frac{1}{\sigma^2}\right)(\mu_L - \mu_H)} + \frac{(\mu_L + \mu_H)}{2}$$

Equation (21) characterizes the optimal cutoff signal of a captive finance company in the equilibrium when both banks and captive finance companies operate in the consumer loan market. The optimal cutoff signal of a captive finance company is determined by the losses from type I and type II errors. For a durable good seller with its captive finance company, the relative cost of a type I error (rejecting a low-risk borrower) compared to a type II error (accepting a high-risk borrower) is higher than for banks, as the durable good seller makes profits on additional sales of the product while the profit from selling additional products subsidizes lending on the side of captive finance company, i.e., $[(\hat{p}-\kappa)+\pi_F(\hat{s}_F)] > 0$ where $\pi_F(\hat{s}_F) < 0$. Thus, the durable good seller will have lower standards for credit approval than that of a bank or $\hat{s}_F < \hat{s}_B$. Given the inherent relationship between the optimal cutoff signal and expected default rate as shown in equation (3), we have the following proposition.

> **Proposition 1**: With $\hat{s}_F < \hat{s}_B$, expected default rate of a captive loan is higher than expected default rate of a bank loan or $\delta(\hat{s}_F) > \delta(\hat{s}_B)$.

Given the optimal cutoff signal of a captive finance company, $\hat{s}_F$, the loan approval rate of a captive finance company is given by:

(22) $$A(\hat{s}_F) = \gamma[1 - G_L(\hat{s}_F)] + (1-\gamma)[1 - G_H(\hat{s}_F)]$$

Thus, the total number of consumers who can finance the purchase of a durable good from captive finance companies is given by:

(23) $$M_F = A(\hat{s}_F)M.$$

Note that $M_F = A(\hat{s}_F)M > M_B = A(\hat{s}_B)M$ since $\hat{s}_F < \hat{s}_B$.

When consumers obtain financing only from banks, each seller has an equal expected demand, $A(\hat{s}_B)\left(M/\bar{N}\right)$. However, when banks and captive finance companies co-exist in the consumer loan market and consumers are randomly allocated across lending institutions (we assume that proportion $(1-\alpha)$ of M consumers select banks while proportion α of M consumers select captive finance companies), each durable good seller has an equal expected demand for its differentiated products:

(24) $[(1-\alpha)A(\hat{s}_B)+\alpha A(\hat{s}_F)]\left(M/\hat{N}\right)=[(1-\alpha)M_B+\alpha M_F]/\hat{N}$.

Thus, since $\hat{s}_F < \hat{s}_B$, more consumers are approved for loans than when only banks operate, and the total number of durable good buyers increases with the introduction of captive finance companies as following:

(25) $M_B = A\left(\hat{s}_B\right)M < (1-\alpha)M_B + \alpha M_F = (1-\alpha)A\left(\hat{s}_B\right)M + \alpha A\left(\hat{s}_F\right)M$.

With the new aggregate number of consumers who can purchase durable goods, $(1-\alpha)M_B + \alpha M_F$, given the economy-wide operation of both banks and captive finance companies in the consumer loan market, we obtain the following characterization for the optimal price at durable good seller *i*:

(26)
$$p = \kappa + \frac{[(1-\alpha)M_B + \alpha M_F]\int [F(v)]^{N-1} f(v)\,dv}{(N-1)[(1-\alpha)M_B + \alpha M_F]\int [F(v)]^{N-2}[f(v)]^2\,dv}$$
$$= \kappa + \frac{1}{N(N-1)\int [F(v)]^{N-2}[f(v)]^2\,dv}$$ [11]

Equations (20), (21), and (26) characterize the unique symmetric zero-profit equilibrium price of differentiated durable goods, $\hat{p}$, the unique symmetric zero-profit equilibrium number of sellers,

[11] As shown in footnote 9, when v is assumed to be uniformly distributed, i.e., $f(v)=1/q$ over the finite support, [0,*q*], and 0 otherwise, $p=\kappa+q/N$, where q and $1/N$ indicate the degree of product differentiation and degree of market concentration, respectively. The optimal price of a durable good is not affected by the number of consumers.

$\hat{N}$, and the optimal cutoff signal of a captive finance company, $\hat{s}_F$, when both banks and captive finance companies operate to finance consumer purchases in the perfectly competitive consumer loan market.

It is worthwhile to discuss the comparison of the new equilibrium with both banks and captive finance companies with the old equilibrium with only banks in terms of the unique symmetric zero-profit equilibrium price of durable goods and number of durable good sellers. Tables 1 through 3 provide the results of numerical examples. Table 1 reports the parameter values used for the numerical simulation. Table 2 provides the equilibrium outcome for the case when only banks exist as lenders. Table 3 provides the equilibrium outcome when there are also captive finance companies. In Table 3, we consider the results for different levels of α, the proportion of consumers who apply to captive finance companies for a loan

In the numerical examples, we restrict our attention to the symmetric zero-profit equilibrium where $(\hat{p} - \kappa)[A(\hat{s}_F) - A(\hat{s}_B)] + A(\hat{s}_F)\pi_F(\hat{s}_F) > 0$ holds, which is the necessary and sufficient condition of the emergence of captive finance companies in our model. Comparing the numerical simulations reported in Tables 2 and 3, the results indicate that, as described in Proposition 1, the optimal credit standard of a captive finance company is more lenient than that of a bank for the symmetric zero-profit equilibrium prices of durable goods corresponding to various parametric specifications of the proportion of borrowers selecting captive finance companies, α. Accordingly, the loan approval rates of a captive finance company and the default probability of its captive loans are higher than that of a bank and its bank loans, respectively.

The numerical examples also show that, for various parametric specifications of α, the unique symmetric zero-profit equilibrium prices of durable goods are lower when both banks and captive finance companies operate in the consumer loan market, as compared to when only banks operate, and that the unique symmetric zero-profit equilibrium numbers of durable good sellers are greater when both banks and captive finance companies operate in the consumer loan market, relative to when only banks operate. We have Proposition 2 as following.

Proposition 2: $\hat{p} < \overline{p}$ and $\hat{N} > \overline{N}$ for various parametric specifications of α.

The numerical simulations indicate that as more borrowers select captive finance companies or α increases, there is a decrease in equilibrium price of durable goods, an increase in equilibrium number of durable good sellers, and an increase in the optimal cutoff signal of a captive finance company

Comparing the results in Tables 2 and 3, we see that, with the economy-wide operation of captive finance companies, the total number of consumers approved for loans either from banks or from captive finance companies is higher than the total number of consumers approved for loans when only bank financing is available.

5. Empirical Analysis

The main prediction of the theoretical model of this paper is that a durable good loan from a captive finance company is less likely to be repaid than a bank loan due to optimal lower credit standards for captive finance companies. In this section, we focus on empirical examination of this theoretical prediction in the automobile loan market. The automobile industry matches our theoretical model in two key respects. First, automobiles can be considered to be a monopolistically competitive (differentiated) durable goods that usually require financing, mainly a consumer installment loan. Second, most of major domestic and foreign automobile manufacturers have developed their captive finance companies, and consumers obtain loans from either banks or these captive finance companies.

Our empirical analysis relies on a unique database, *TrenData™*, a product of Trans Union LLP, to empirically examine the repayment performances of bank and captive automobile loans, controlling for other factors that can also affect delinquency rates. Recent studies such as Barron, Elliehausen, and Staten (2000), Barron, Staten, and Wilshusen (2002), and Gross and

Souleles (2002) show that delinquency rates of various types of consumer loans are significantly related to factors such as income, consumer debt burden, change in debt levels, and employment status. We adopt those determinants for the estimation of the delinquency rates of automobile loans and estimate the statistical significance of those by panel regression analysis.

Note that, different from the measure of loan performances in the theoretical model (the expected default rate), we use delinquency rates of automobile loans to measure loan performances. However, previous studies such as DeVaney and Lytton (1995) and Gross and Souleles (2002) show that delinquency rates are an important indicator of quality of loan performances.

TrenData™ is derived from a large, nationally representative sample of consumer credit reports, drawn annually and quarterly. The variables in *TrenData™* are measured at the county level, covering 3,141 counties in the U.S. The variables include the number of delinquent automobile loans for banks and captive finance companies, as well as the number of automobile loans of banks and captive finance companies. To construct the variables for consumers' characteristics, this paper uses these quarterly data from *TrenData™* for the 4-year period from 1999 to 2002 as well as data from various government economic databases. Table 4 summarizes the sources for selected variables. The construction of the variables is described as follows:

Measure of Performances of Bank and Captive Automobile Loans: Delinquency rates of bank and captive automobile loans are used as measures of loan performance. The delinquency rates are calculated by taking the ratios of the number of delinquencies to the number of outstanding loans each year for each county.

Measure of Income: Consumer income is a key variable that positively influences loan repayment. County average real per capital personal income is used in the estimations of delinquency rates. Lagged annual income data are from *Regional Data from Bureau of Economic Analysis (BEA) 1998-2001*.

Borrower Assets: Borrower assets serve as a cushion against income and expenditure shocks. Household assets also indicate an ability to refinance to repay loans when borrowers are in financial distress because the household assets can be used as collateral for refinancing. Consumer assets enter the estimated equation in the form of the state-level median value of housing as reported by the *2000 Census*. The 2000 state-level median house values are converted into nominal house values of a specific year using the consumer price index.

Unemployment and Job Tenure: An income shock can arise from loss of employment. The unemployment rates of the U.S. states reported by the Bureau of Labor Statistics (*BLS*) are used as a proxy for income shocks from unemployment. Job tenure can also indicate the stability of employment status, which is a cushion against adverse income and expense shocks. We obtain regional job tenure data from *1996 Current Population Surveys (CPS) Displaced Workers, Job Tenure, and Occupational Mobility Survey*.

Measure of Expenditure Shock to Borrowers: Expenditure shocks to borrowers can make it more likely for a household to become delinquent. DeVaney and Lytton (1995) show that divorce/separation is an important factor that impacts the repayment performances of consumer loans. We obtain state-level data for the proportion of adults who are divorced and separated from 1990 and 2000 Census Data, U.S. Bureau of Census.

Measure of Regional Average Borrower Riskiness: County-average credit score indicates a county-wide average riskiness of borrowers. That is, a higher county-average credit score can be interpreted as indicative of a relatively higher proportion of low-risk borrowers. We obtain the county-average credit scores from the *TrenData™*.

Measure of Other Debt*:* Past studies have shown that the amount of debt held by a borrower has a strong impact upon repayment of loans. Total debt level per borrower[12], relative to income, indicates a consumer's debt burden. Given this total debt level per borrower, an increase in revolving debt can dilute a borrower's resources to repay automobile loan. An increase in the proportion of revolving debt to total debt[13] could turn away borrowers' resources from repaying automobile loans to repaying revolving debts. From *TrenData™* we obtain total debt per borrower and change in the proportion of revolving debt to total debt.

Using the variables constructed above, we test the hypotheses as follow:

Hypothesis 1: County delinquency rates of captive consumer automobile loans are higher than those of bank consumer automobile loans.

Hypothesis 2: Counties with higher real per capita personal income will have lower delinquency rates on automobile loans.

Hypothesis 3: Higher delinquency rates on automobile loans are more likely in the counties with higher level of unemployment rate, and higher divorce/separation rates; these indicate the prevalence of income and expense shocks, respectively.

[12] Using *TrenData™*, total debt level per borrower is calculated by dividing the sum of amounts owed on all open accounts which have been verified or reported in the past 12 months (including mortgage accounts) by the total number of consumers (borrowers) with at least one account verified or reported in the past 12 months.

[13] Using *TrenData™*, the proportion of revolving debt to total debt is calculated by dividing the sum of amounts owed on all open revolving accounts which have been verified or reported in the past 12 months by the sum of amounts owed on all open accounts which have been verified or reported in the past 12 months (including mortgage accounts).

Hypothesis 4: Counties with higher total debt per borrower and a higher proportion of revolving debt to total debt are more susceptible to income and expense shocks, and thus are likely to have higher delinquency rates on automobile loans.

Hypothesis 5: A higher county-average credit score indicates a higher proportion of low-risk borrowers; it is thus expected that counties with higher county-average credit scores will have lower delinquency rates on automobile loans.

Table 5 provides the descriptive statistics of the variables for county-wide average borrower characteristics. Table 6 provides the descriptive statistics of the delinquency rates of bank and captive automobile loans and the results of *T*-tests for mean differences between delinquency rates for each year from 1999 to 2002. Table 6 reveals that the delinquency rates of captive automobile loans are higher than those of bank loans. The differences in means of delinquency rates of bank and captive loans are statistically significant.

Table 7 reports panel regression analysis to estimate the determinants of county-level delinquency rates from 1999 to 2002. The analysis considers delinquency rates of banks and of captive finance companies over the period from 1999 to 2002. Column 1 of Table 7 lists the predicted signs for the coefficients as discussed in the hypotheses. Column 2 provides estimates for a random effects model specification. Finally, column 3 reports estimation results for a fixed effects model specification. For each year and county, the sample includes two observations, one with the delinquency rate for bank auto loans as the dependent variable and the second with the delinquency rate for captive finance auto loans as the dependent variable.

The random effects model for explaining the variation in delinquency rates across counties and over time can be decomposed into two components. One part considers variation in each county's delinquency rate from its average rate; the second part considers variation in the average delinquency rates of automobile loans across counties. The first component of the random effects model is the fixed-effects estimator, also known as the "within estimator". The second component of the random effects model, referred to as the "between estimator", focuses on explaining differences in average delinquency rates across counties. The random effects model considers separate cross-sectional error term, and owing to this intrapanel variation, the random effects model has the distinct advantage of allowing for time-invariant variables to be included among the regressors. The fixed effects model specification explores the correlation between deviations in a county's delinquency rate of automobile loans from the county average and deviations in the independent variables from their county averages over the 4-year time period[14].

The results of random and fixed effects models are very similar and largely consistent with the hypothesized relationships. The random and fixed effects models show similar goodness of fit. As for specification tests, Breusch-Pagan Lagrange multiplier statistic for testing random effects model against classical ordinary least square (*OLS*) regression model shows that the random effects model is better than *OLS* or the fixed effects model. The *F*-statistic for the fixed effects model shows that overall significance of estimated coefficients are jointly significant.

As for local economic factors, counties with higher average real per capita income had lower delinquency rates, and higher housing values reduced the frequency of delinquency in repaying automobile loans. The random and fixed effects models show that higher county-level riskiness indicated by lower county-average credit scores raises delinquency rates of automobile loans. The county-average credit scores can be a proxy for the relative proportions of low- and high-risk borrowers in each region (γ and $(1-\gamma)$ respectively in the analytical model).

Consumer decisions to take on higher debt burdens clearly contributed to the increase in delinquency rates of automobiles loans. Holding income and other factors constant, higher total debt levels per borrower were associated with higher delinquency rates at the county level. In

[14] A constant coefficient model (or pooled regression model) with residual homogeneity and normality can be estimated with ordinary least squares estimation (*OLS*). As long as there is no groupwise or other heteroskedastic effects on the dependent variable, *OLS* may be used for fixed effects model as well (Sayrs, L. Pooled Time Series Analysis, Newbury Park, Ca: Sage (1989), pp. 10 -32).

addition, the type of debt mattered as well. Delinquency rates of automobile loans rose along with the increase in proportion of revolving debt to total debt.

As for other local economic and demographic factors, higher delinquency rates were observed in counties with higher unemployment rates, lower employment tenure, and higher divorce/separation rates, all of which are proxies for the prevalence of either income or expense shocks. Year dummies reflect the actual trends in the change in the delinquency rates of automobile loans for the 1999-2002 time period.

The main test of this paper is on the dummy variables for lender type. Having controlled for other borrower characteristics, the dummy variables for lender type in both the random and fixed effects models have positive signs as expected, and coefficients estimated are statistically significant, implying that captive automobile loans exhibit higher delinquency rates than bank automobile loans. These results are consistent with the results of *T*-tests for mean differences in Table 6. In sum, in both random and fixed effects models, all of the significant explanatory variables have coefficients estimated with the expected signs and most of the coefficients estimated are statistically significant.

6. Conclusions

This paper constructs a unique theoretical model to explain why captive finance companies emerge in the consumer loan market and why the credit standard of captive finance companies is more lenient than that of banks. The explanation relies on the additional rents extracted by durable good sellers operating in a monopolistically competitive industry from offering captive loans to consumers who are too risky for banks to service. The gains to such sellers from the expansion of the sale of the durable good subsidize the losses on the lending side. The model predicts that a captive finance company sets a more lenient credit standard than that of a bank. Consequently, the likelihood of repayment of a captive loan is lower than that of a bank loan.

The empirical analysis provides clear evidence that a captive automobile loan is less likely to be repaid than a bank automobile loan, and that the consumer automobile loan market in the U.S. is segmented by banks and captive finance companies on the basis of consumers' risk characteristics.

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Table 1: Parameter Specification for Simulations Examples

Variables	Value of Variable
Parametric specifications of distribution of consumers, distribution functions of signal, and density function of consumer valuation of durable goods	
Proportions of low- risk borrowers, γ, and high-risk borrowers, $(1-\gamma)$	$\gamma = (1-\gamma) = 0.5$
Means of the signals of low-risk borrowers, μ_L, and high-risk borrowers, μ_H	$\mu_L = 1$, $\mu_H = -1$
Identical variance of distribution functions of signals of low- and high-risk borrowers: σ^2	2
Finite support for uniform density function, $f(v)$, of consumer valuation of durable goods	[0,400]
Parametric specifications of consumer loan market	
Cost of funds: r	0.045
Net collection rate: d	0.01
Parametric specifications of monopolistically competitive durable good market	
Parametrically specified number of consumers: M	30,000
Parametrically specified constant marginal costs of producing a durable good: κ	$9,000
Parametrically specified fixed costs of producing durable goods: F	$50,000

Table 2: Equilibrium in Monopolistically Competitive Durable Good Market With Only Banks: Numerical Examples

Variable	Values of Variable
Symmetric zero-profit equilibrium price of durable goods with only banks operating in consumer loan market: $\overline{p}$	$9047.73
Equilibrium number of sellers with only banks operating in consumer loan market: $\overline{N}$	8.3814
Zero-profit equilibrium lending rate: $\overline{i}$	0.0552
Optimal cutoff signal: $\hat{s}_B$	1.2341
Loan approval rate: $A(\hat{s}_B)$	0.2927
Probability of default: $\hat{\delta}_B$	0.1320

Table 3: Equilibrium in Monopolistically Competitive Durable Good Market with Captive Finance Companies: Numerical Examples

Variable	Value of Variable			
Given proportion of borrowers selecting captive finance companies: α	0.25	0.5	0.75	1
Symmetric zero-profit price of durable goods: $\hat{p}$	$9046.82	$9046.03	$9045.32	$9044.67
Symmetric zero-profit number of durable good sellers: $\hat{N}$	8.5427	8.6905	8.8270	8.9539
Optimal cutoff signal of captive finance company: $\hat{s}_F$	0.3165	0.3270	0.3366	0.3453
Loan approval rate: $A(\hat{s}_F)$	0.4445	0.4426	0.4410	0.4395
Probability of default: $\hat{\delta}_F$	0.2871	0.2864	0.2857	0.2851
Profit from selling durable goods without establishing its captive finance company: $(1-\alpha)A(\hat{s}_B)(\hat{p}-\kappa)\left(M/\hat{N}\right)-F$	-$13,902.7	-$26,746.6	-$38,730.1	-$50,000.0
Losses per loan on lending: $\pi(\hat{s}_F)$	-$11.1958	-$11.0179	-$10.85869	-$10.7147
Necessary and sufficient condition for emergence of captive finance companies: $(\hat{p}-\kappa)[A(\hat{s}_F)-A(\hat{s}_B)]+A(\hat{s}_F)\pi_F(\hat{s}_F)>0$	$2.1302	$2.0238	$1.9303	$1.8473
Number of consumers selecting banks and approved by banks, $A(\hat{s}_B)M$, when only banks operating	8,780.97			
Number of consumers selecting banks and approved by banks, $(1-\alpha)A(\hat{s}_B)M$, when both banks and captive finance companies operating	6,585.72	4,390.48	2,195.24	0
Number of consumers selecting captive finance companies and approved by captive finance companies, $\alpha A(\hat{s}_F)M$, when both banks and captive finance companies operating	3,332.52	6,639.3	9,921.59	13,183.51
Total number of consumers approved by both banks and captive finance companies, $(1-\alpha)A(\hat{s}_B)M+\alpha A(\hat{s}_F)M$, when both banks and captive finance companies operating	9,918.24	11,029.80	12,116.83	13,183.51

Table 4: Sources for Borrower Characteristic Variables

Variable	Source
Annual county-level income	Regional Data, 1998-2001, Bureau of Economic Analysis (BEA), U.S. Dept. of Commerce. BLS CPI-U series is used to covert to real values.
Annual county-level income	Regional Data, 1998-2001, Bureau of Economic Analysis (BEA), U.S. Dept. of Commerce. BLS CPI-U series is used to covert to real values.
State-level median value of house	2000 Census Data, U.S. Bureau of Census. State Census Data adjusted using BLS CPI Iindex
Annual state-level unemployment rates	Local Area Unemployment Statistics, 1998-2002, Bureau of Labor Statistics (BLS).
Annual state-level data on the proportion of adults divorced or separated	1990 and 2000 Census Data, U.S. Bureau of Census.
Job tenure	Average tenure by area, Displaced worker survey, Bureau of Labor Statistics (BLS).
County-average credit score, Change in proportion of revolving debt to total debt, Total debt per borrower	*TrenData™*, 1998 – 2002.

Table 5: Descriptive Statistics of Variables for Borrower Characteristics

Variable	Mean	Standard Deviation
County-average real per capita income	U.S.$ 20,795	5,212
State-average median house value	U.S.$ 106,153	30,171
County-average credit score	679.2174	34.8779
Change in proportion of revolving debt to total debt	-1.0324%	14.9865
Total debt per borrower	U.S.$30,733	14,682
Average job tenure	7.0773 years	2.0114
State unemployment rate	4.4428%	1.4361
State proportion of adults who are divorced/separate	8.7730%	1.5690

Table 6: Descriptive Statistics of Delinquency Rates of Bank and Captive Automobile Loans and *T*-tests for Mean Differences of Delinquency Rates

Delinquency Rates (%): *Ratios of the number of automobile loans with 60+ days past due to the number of active automobile loans*				
Year	**Automobile Loan**	**Bank Automobile Loan**	**Captive Automobile Loan**	***T*-test for mean differences between delinquency rates of bank and captive automobile loans**
	Mean (Std.Dev.)	**Mean (Std.Dev.)**	**Mean (Std.Dev.)**	***T*-statistics**
1999	1.3114% (1.1040)	1.1869% (1.4118)	1.3804% (1.5044)	-5.66***
2000	3.8260% (2.5763)	3.0512% (2.8135)	4.3700% (3.38454)	-19.8417***
2001	1.5054% (1.1754)	1.3939% (1.7308)	1.5858% (1.5341)	-4.9691***
2002	1.5521% (1.1855)	1.2323% (1.4549)	1.7061% (1.5420)	-13.2077***
All Years: 1999-2002	2.0485% (1.9288)	1.7159% (2.0866)	2.2601% (2.4709)	-23.4248***

Note: 1) These *T*-tests consider the differences between the mean of delinquency rate of bank automobile loans minus the mean of delinquency rate of captive automobile loans.
2) ***: significant at 1% level.

Table 7: Panel Regression for Estimation of Determinants of County Delinquency Rates of Automobile Loans: 1999 to 2002

	Predicted sign for effect on delinquency rates of automobile loans	Random-effects model for log of delinquency rates of automobile loans	Fixed-effects model for log of delinquency rates of automobile loans
Independent Variables		Coefficient (z-statistic)	Coefficient (t-statistic)
Intercept		933.8232*** (3.209)	1282.0808*** (7.397)
Log of county-average real per capita income (lagged one year)	–	-131. 7690*** (-2.590)	-40.1173 (-1.288)
Log of state-average house value (lagged one year)	–	-76.8880* (1.822)	-67.5991*** (-2.822)
County-average credit score (lagged one year)	–	-0.7559*** (-8.562)	-2.0057*** (-26.581)
Change in proportion of revolving debt to total debt (lagged one year)	+	0.1246 (1.073)	1.1870*** (10.196)
Total debt per borrower (lagged one year)	+	0.7567*** (20.930)	0.8196*** (37.023)
Average job tenure	–	-4.6382** (-2.291)	-0.5539 (-0.489)
State unemployment Rate (lagged one year)	+	7.1093*** (3.933)	9.5835*** (5.771)
State proportion of adults who are divorced/separate	+	804.0422*** (4.015)	1142.5720*** (7.688)
Lender type dummy: 1 if captive loan 0 if bank loan	+	66.1630*** (18.117)	66.1630*** (4.4325)
Year 2000 dummy	+	109.3776*** (20.538)	100.9151*** (14.927)
Year 2001 dummy	–	9.4767 (1.376)	-46.5424*** (-6.248)
Year 2002 dummy	–	-28.5503*** (-4.447)	-80.2079*** (-11.395)
Mean of dependent variable: delinquency rates across bank and captive finance companies (%); not log (Std.Dev.)		1.9880% (2.3030)	
R-squared		0.1444	0.1448
Breusch-Pagan LM Statisitc for Random Effects Model; F (11,25116) for Fixed Effects Model		8972.52	386.67***
Number of counties		3,141	3,141
Number of Observations (combined samples for bank and for captive finance company delinquency rates on auto loans)		25,128	25,128

Note: 1) Figures in parentheses are z-statistics and t-statistics
2) ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level
3) High Breusch-Pagan LM Statisitc favors random effects model against OLS model.