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## Emergence of Captive Finance Companies and Risk Segmentation in Loan Markets: Theory and Evidence

A seller with some degree of market power in its product market can earn rents. In this context, there is a gain to granting credit to purchase of the product and thus to the establishment of a captive finance company. This paper examines the optimal behavior of such a durable good seller and its captive finance company. The model predicts a critical difference between the captive finance company's credit standard and that of independent lenders ("banks"), namely, that the captive finance company will adopt 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 United States, and the evidence supports the theoretical prediction.

*JEL* codes: D81, D83, G21

Keywords: monopolistic competition, consumer loan market, captive finance company, differential loan performance.

THIS PAPER PRESENTS a theoretical model and empirical evidence 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

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Received August 4, 2005; and accepted in revised form February 22, 2007.

*Journal of Money, Credit and Banking*, Vol. 40, No. 1 (February 2008)

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goods. The good purchased serves as collateral for collection on borrower's default. Captive finance companies are the subsidiaries that finance the sales of products of their parent manufacturers.<sup>1</sup>

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

Remolona and Wulfekuhler (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. On the other hand, growth occurred for finance companies in market segments for relatively risky credit, where command of specialized information was critical to lending institutions.

Carey, Post, and Sharpe (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 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 that involves two key types of lending institutions, 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 a "captive loan" but also the return from the sale of the product purchased with the captive loan. 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 automobile loans from the two different types of lenders.

The remainder of this paper is organized as follows. Section 1 presents a model where an independent lending institution (a "bank") obtains an imperfect but informative signal on the creditworthiness of a borrower, and makes a credit decision by setting an optimal cutoff signal. Section 2 introduces a simple model of a monopolistically competitive durable good market, assuming that consumers can obtain financing for the purchase of durable goods only from banks.

Section 3 links the analysis of Sections 1 and 2 by noting that the positive gain to the durable good seller from additional sales provides an incentive to establish a

1. Most automobile manufacturers have their own captive finance companies to facilitate financing the purchase of their products. Examples of automobile manufacturers' captive finance companies are General Motors Acceptance Corporation, Ford Credit, and Toyota Financial Services in the United States.

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 loan market by banks and captive finance companies. Section 3 also provides illustrative numerical simulations describing the new equilibrium in monopolistically competitive durable good market with both banks and captive finance companies to contrast with the original equilibrium with only banks.

Section 4 tests the prediction of the theoretical model using a unique data set, *TrenData*<sup>TM</sup>, 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 5 summarizes and concludes.

## 1. A SIMPLE MODEL OF CREDIT EVALUATION AND LENDING

In this section, we present a simple model of interest rate determination and credit rationing when lending institutions obtain an imperfect signal on the creditworthiness of a borrower who seeks financing for 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 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 to the consumer. 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 developing the theoretical model, we simplify by assuming that  $M$  is fixed and that all  $M$  consumers require financing to purchase the durable good.<sup>2</sup> Later, we will consider the implications of relaxing this assumption. 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

2. The 2004 Federal Reserve *Survey of Consumer Finances (SCF)* provides information on the actual use of lending institutions to finance the purchase of a new vehicle in the United States. Specifically, we identified among respondents those who had purchased a new automobile, SUV, minivan/van, or pickup in 2004. For the 4% of such individuals who reported more than one such new car purchase in 2004, we considered their most recent purchase. For this sample, 28% paid “cash,” 37% financed the purchase using a loan from a finance company, and 35% financed the purchase using a loan from a banking institution. As the *SCF* is not an equal-probability design, these figures rely on provided weights to compensate for the unequal probabilities of selection in the original design and for nonresponses. In addition, as the *SCF* provides five imputed values for each observation, we follow the procedure recommended for the estimation of simple statistics, namely, to divide the provided weights by five.

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 repay a loan. Note that  $\gamma$  can be interpreted as the known proportion of low-risk borrowers. For simplicity, we assume that a borrower does not know his own risk type.<sup>3</sup>

Lending institutions receive an imperfect but informative signal,  $s$ , on the creditworthiness of a loan applicant. One way to think of this signal is as a credit score that is available to all lending institutions. If the loan applicant is low-risk, the signal  $s$  is drawn from the normal distribution,  $G_L(s)$  with mean  $\mu_L$  and variance  $\sigma^2$ . If the loan applicant is high-risk, the signal is drawn from the normal distribution,  $G_H(s)$  with mean  $\mu_H$  and variance  $\sigma^2$ . Note that  $\sigma^2$  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 borrowers tend to generate higher signals on average, or  $\mu_L > \mu_H$ .

Lending institutions incur a common cost of funds  $r$ .<sup>4</sup> For a loan applicant with signal  $s$ , lending institutions earn net return  $[i(s) - r]l$ , if the loan of size  $l$  is repaid.<sup>5</sup> Note that the loan interest rate offered to a consumer depends on the information banks have regarding the likelihood the individual will repay the loan, in particular, the signal  $s$ . If the borrower defaults, the lending institution's loss is  $(r - d)l$ , where  $d$  reflects the rate of return from the collection of salvage value of collateral, net of collection costs.<sup>6</sup> Thus, a bank's profit from a loan of size  $l$  to an applicant with signal  $s$  who pays interest rate  $i(s)$  given processing cost per loan dollar  $c$  is

$$\pi_B(s)l = [\Pr(L | s)[i(s) - r] - [1 - \Pr(L | s)](r - d) - c]l, \quad (1)$$

where  $\pi_B(s)$  is the profit per dollar loaned by a bank to an individual with creditworthiness signal  $s$  and  $\Pr(L | s)$  denotes the probability an individual is low-risk given signal  $s$ .

We assume banks operate in a perfectly competitive consumer loan market, such that loan applicants with signal  $s$  who are offered a loan obtain the same loan rate  $i(s)$  from all banks, and this loan rate results in zero expected profits. Setting  $\pi_B(s) = 0$ , we obtain the following expression for the interest rate charged on loans granted to a potential borrower with creditworthiness signal  $s$ :

3. If borrowers possess private information on their type, a lending institution may offer a menu of loan contracts (screening/sorting devices) through which a low-risk borrower can signal his type. We abstract from such considerations.

4. The marginal cost of funds appears to have been very similar for banks and finance companies. Finance companies raise funds largely by issuing commercial papers (CPs) and corporate bonds, while banks raise funds by issuing large certificates of deposit (CDs). 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 CDs at an average 3-month interest rate of 4.540%.

5. Later, we assume that the loan amount,  $l$ , equals the price of the durable goods 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.

6. 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 purchased unpaid debts.

$$i(s) = \frac{c + r - d[1 - \Pr(L | s)]}{\Pr(L | s)}. \quad (2)$$

Equation (2) implies interest rates that vary across loan applicants depending on their creditworthiness. In particular, given that  $\partial \Pr(L | s) / \partial s > 0$  (a higher signal increases the probability that the individual is a low-risk borrower), we have

$$\frac{\partial i(s)}{\partial s} = \frac{-[\partial \Pr(L | s) / \partial s](c + r - d)}{[\Pr(L | s)]^2} < 0. \quad (3)$$

That is, a potential borrower with a higher signal will pay a lower “competitive” interest rate, given that interest rates across different consumers reflect zero expected profits. We assume that the surplus value to consumers from the purchase of the durable good financed by the loan is sufficiently high across all borrowers so that the decision to accept a loan does not depend on the interest rate charged for the range of equilibrium rates that emerge.

It is typically the case that not all loan applicants are approved for a loan. In the context of our analysis, this suggests that there is an upper bound on the interest rate a lending institution can charge. This could arise from usury laws, or from the introduction of a probability of loan repayment that is affected adversely by an increase in the interest rate in the sense of Stiglitz and Weiss (1981). Let this upper bound on the loan interest rate be denoted by  $\bar{i}$ . With such an upper bound, there arises a minimum signal level, or cutoff signal, below which a loan applicant will be denied a loan because profits will be negative at interest rate  $\bar{i}$ . The signal where profits are zero at interest rate  $\bar{i}$  defines this “cutoff” signal for banks  $\hat{s}_B$ . That is, from equation (2),  $\hat{s}_B$  is defined by

$$\Pr(L | \hat{s}_B) = \frac{c + r - d}{\bar{i} - d}. \quad (4)$$

The decision of a bank to approve or reject a loan applicant depends on its optimal cutoff signal,  $\hat{s}_B$ . We will refer to  $\hat{s}_B$  as indicative of the credit standard of banks. If a consumer is not approved for a loan, it is assumed the consumer cannot buy the durable good.

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

$$\delta(\hat{s}_B) = \frac{(1 - \gamma)[1 - G_H(\hat{s}_B)]}{\gamma[1 - G_L(\hat{s}_B)] + (1 - \gamma)[1 - G_H(\hat{s}_B)]}. \quad (5)$$

Note that a decrease in  $\hat{s}_B$  tends not only to increase the number of consumers approved for loans but also to increase the probability of default,  $\delta(\hat{s}_B)$ , for those who are given a loan; that is,  $\partial \delta(\hat{s}_B) / \partial \hat{s}_B < 0$ . Note that, given the optimal cutoff signal,  $\hat{s}_B$ , an increase in the proportion of low-risk borrowers also reduces the probability of default or  $\partial \delta(\hat{s}_B) / \partial \gamma < 0$ .<sup>7</sup>

7. This comparative static result has an implication for the empirical analysis: regional average credit scores could be used as a proxy for the relative proportions of  $\gamma$  and  $(1 - \gamma)$ .

## 2. 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 durable good consumers require financing. When only banks operate in the consumer loan market, the likelihood a consumer is approved for a loan at a bank is denoted as  $A(\hat{s}_B)$ , where

$$A(\hat{s}_B) = \gamma[1 - G_L(\hat{s}_B)] + (1 - \gamma)[1 - G_H(\hat{s}_B)] \quad (6)$$

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

$$M_B = A(\hat{s}_B)M. \quad (7)$$

We assume that there are  $N$  firms selling differentiated products in a monopolistically competitive durable goods market, and that these firms incur identical marginal production cost,  $\kappa$ , and fixed cost,  $K$ . Following Perloff and Salop (1985), we assume that each consumer's valuation of the product of each firm can be viewed as independently and identically drawn from the common distribution function  $F(v)$  with density function  $f(v)$ . Given prices  $p = (p_1, \dots, p_N)$  for the  $N$  available differentiated products, each consumer will choose the product for which his surplus is maximized.

Consumer  $j$ 's net surplus to purchasing from firm  $i$ ,  $b_{ij}$ , is given by:

$$b_{ij} = v_{ij} - p_i, \quad (8)$$

where  $v_{ij}$  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 of  $b_{ij} \geq b_{kj}$  is  $F(p_k - p_i + v_{ij})$ .

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

$$\Pr \left( b_{ij} \geq \max_{k \neq i} b_{kj} \right) = \int \prod_{k \neq i} [F(p_k - p_i + v)] f(v) dv. \quad (9)$$

It follows that the expected demand for the durable good sold by firm  $i$ ,  $d_i(p_1, \dots, p_N)$ , equals the proportion of consumers who buy that product given by equation (9) times the effective number of consumers  $M_B$ . That is, expected demand is given by

$$\begin{aligned}
D_i(p_1, \dots, p_N) &= M_B \Pr \left( b_{ij} \geq \max_{k \neq i} b_{kj} \right) \\
&= M_B \int \prod_{k \neq i} [F(p_k - p_i + v)] f(v) dv.
\end{aligned} \tag{10}$$

Under the assumption that each firm has the identical constant marginal cost,  $\kappa$ , and fixed costs,  $K$ , the expected profit of firm  $i$  is given by

$$\Pi_i(p_1, \dots, p_N) = (p_i - \kappa)D_i(p_1, \dots, p_i, \dots, p_N) - K. \tag{11}$$

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

$$D_i(p_1, \dots, p_N) = M_B \int [F(p - p_i + v)]^{N-1} f(v) dv. \tag{12}$$

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

$$p_i = \kappa - \frac{D_i(p_1, \dots, p_N)}{\left[ \frac{\partial D_i(p_1, \dots, p_N)}{\partial p_i} \right]}. \tag{13}$$

When only banks operate in the loan market, we denote the symmetric equilibrium durable good price and number of firms by  $\bar{p}$  and  $\bar{N}$ , respectively. Given the form of expected demand (12), we obtain the following characterization for the optimal price from (13)<sup>8</sup>:

$$\begin{aligned}
\bar{p} &= \kappa + \frac{M_B \int [F(v)]^{\bar{N}-1} f(v) dv}{(\bar{N} - 1)M_B \int [F(v)]^{\bar{N}-2} [f(v)]^2 dv} \\
&= \kappa + \frac{1}{\bar{N}(\bar{N} - 1) \int [F(v)]^{\bar{N}-2} [f(v)]^2 dv}.
\end{aligned} \tag{14}$$

Since all firms are assumed to be identical in their marginal and fixed costs of producing differentiated products, the expected demand of each firm is given by  $A(\hat{s}_B)(M/\bar{N}) = M_B/\bar{N}$  and the zero-profit condition is

8. If  $v$  is assumed to be uniformly distributed, that is,  $f(v) = 1/q$  over the finite support,  $[0, q]$ , and 0 otherwise, then  $\int_0^q [F(v)]^{N-2} [f(v)]^2 dv = \int_0^q (v/q)^{N-2} (1/q)^2 dv = (1/q)[1/(N-1)]$ . Hence,  $p = \kappa + q/N$ . Note that  $q$  and  $1/N$  indicate the degree of product differentiation and degree of market concentration, respectively.

$$A(\hat{s}_B) \left( \frac{M}{\bar{N}} \right) (\bar{p} - \kappa) - K = 0. \quad (15)$$

Equations (14) and (15) characterize the unique zero-profit symmetric equilibrium price,  $\bar{p}$ , which lies strictly above the competitive price,  $\kappa$ , and the number of durable good sellers,  $\bar{N}$ , for the monopolistically competitive durable goods market when only banks exist to finance consumer purchases.

### 3. EMERGENCE OF CAPTIVE FINANCE COMPANIES

In this section, we model the emergence of captive finance companies and the resulting risk segmentation by banks and captive finance companies in the loan market for durable goods. 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 loans is lower than that of bank loans.

To model the coexistence of banks and captive finance companies in the durable-good 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 loans to consumers who are not 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. We assume that there are no additional fixed costs for establishing a captive finance company. Given the equilibrium zero-profit number of firms,  $\bar{N}$ , and the symmetric equilibrium price of durable goods,  $\bar{p}$ , the initial deviant firm maximizes its expected combined profits from selling product and granting captive loans by choosing an optimal cutoff signal. Let  $\hat{s}_D$  define the cutoff signal for loan approval by the captive finance company of the deviant durable good seller. Of the  $M/\bar{N}$  consumers who demand the product of this durable good seller, let the fraction  $\alpha \in (0, 1)$  select the captive finance company for a loan. Then the deviant durable good seller has  $(1 - \alpha)A(\hat{s}_B)(M/\bar{N})$  consumers approved by banks and  $\alpha A(\hat{s}_D)(M/\bar{N})$  consumers approved by its captive finance company.

For a potential customer with signal  $s \geq \hat{s}_B$ , the captive finance company will grant a loan to consummate the sale of the durable good. Competing against banks, the finance company will set an interest rate  $i(s)$  on such loans equal to that set by banks. Recall that, at these interest rates, expected profits are zero.<sup>9</sup> Now consider potential customers visiting the captive finance with creditworthiness signal  $s < \hat{s}_B$ . Had these individuals applied to a bank, their loan application would have been denied as expected profits from the loan are negative even at the highest feasible interest rate.

9. Later, we will discuss the implications of allowing finance companies to charge interest rates different from banks, which is possible given the bundling of financing and the purchase of the durable good.

However, given the profits from the marginal sale of the durable good at the current price, the deviant durable good seller's captive finance company has an incentive to make loans to some of these individuals, implying a lower cutoff signal than banks ( $s_D < \hat{s}_B$ ). For these high-risk individuals, we assume the captive finance company sets an interest rate equal to the highest feasible rate,  $\bar{i}$ .

The likelihood of default on a loan the captive finance company makes to a borrower who would have been turned down by bank is given by

$$\delta(\hat{s}_D, \hat{s}_B) = \frac{(1 - \gamma)[G_H(\hat{s}_B) - G_H(\hat{s}_D)]}{\gamma[G_L(\hat{s}_B) - G_L(\hat{s}_D)] + (1 - \gamma)[G_H(\hat{s}_B) - G_H(\hat{s}_D)]}. \quad (16)$$

It follows that the average (negative) profit per dollar loaned for such a "high-risk" loan made by the captive finance company of the deviant durable goods seller,  $\pi_F(\hat{s}_D)$ , is

$$\pi_F(\hat{s}_D) = [1 - \delta(\hat{s}_D, \hat{s}_B)](\bar{i} - r) - \delta(\hat{s}_D, \hat{s}_B)(r - d) - c. \quad (17)$$

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

$$\begin{aligned} \Pi(\hat{s}_D) &= A(\hat{s}_B) \left( \frac{M}{N} \right) (\bar{p} - \kappa) \\ &\quad + \alpha [A(\hat{s}_D) - A(\hat{s}_B)] \left( \frac{M}{N} \right) [(\bar{p} - \kappa) + \bar{p}\pi_F(\hat{s}_D)] - K. \end{aligned} \quad (18)$$

For loans by the captive finance company to individuals with  $\hat{s}_D \leq s < \hat{s}_B$ , the highest interest rate that can be charged,  $\bar{i}$ , is not sufficient to compensate a lender for the high likelihood of default by such high-risk potential borrowers. Thus,  $\pi_F(\hat{s}_D) < 0$  if  $\hat{s}_D < \hat{s}_B$ .

The deviant firm will establish a captive finance company and grant captive loans if and only if its expected combined profits as defined by (18) are larger than the expected profits from selling the durable good product when all consumers obtain loans only from banks. Given zero profits for their original set of customers, this holds for the deviant durable good seller if and only if positive profits are generated from the additional customers with a creditworthiness signal  $\hat{s}_D \leq s < \hat{s}_B$ , such that

$$\alpha [A(\hat{s}_D) - A(\hat{s}_B)] \left( \frac{M}{N} \right) [(\bar{p} - \kappa) + \bar{p}\pi_F(\hat{s}_D)] > 0. \quad (19)$$

At  $\hat{s}_D = \hat{s}_B$ ,

$$\left. \frac{\partial \Pi(\hat{s}_D)}{\partial \hat{s}_D} \right|_{\hat{s}_D = \hat{s}_B} = \alpha \left( \frac{M}{N} \right) \left[ \frac{\partial A(\hat{s}_D)}{\partial \hat{s}_D} \right] (\bar{p} - \kappa) < 0. \quad (20)$$

Equation (20) indicates a gain to reducing the optimal cutoff signal for the captive finance company of the initial deviant below the optimal cutoff signal of a bank. A

lower cutoff signal will increase the sales of the deviant ( $\partial A(\hat{s}_D)/\partial \hat{s}_D < 0$ ), and each additional sale generates positive profits given the positive markup on the durable good,  $(\bar{p} - \kappa) > 0$ . Of course, at some point, the gains to the additional sales are offset by loan losses, and this limits the size of the reduction in the cutoff signal for the captive finance company.

The above discussion supports the emergence of deviant captive finance companies of durable good sellers. We now characterize an equilibrium in the monopolistically competitive durable goods market when all durable good sellers operate captive finance companies, taking as given the proportion of consumers applying to the captive finance company for a loan,  $\alpha$ . Note that we assume for simplicity that the optimal cutoff signals of different types of lending institutions (banks versus captive finance companies) do not affect the composition of or number of loan applicants. We discuss implications of relaxing this assumption later.

For this new equilibrium with both banks and captive finance companies attached to each durable good seller, let the symmetric equilibrium price of durable goods be denoted by  $\hat{p}$ , the zero-profit equilibrium number of durable good sellers be denoted by  $\hat{N}$ , and the optimal cutoff signal of a captive finance company be denoted by  $\hat{s}_F$ . In this new equilibrium, the expected profit of a firm with a captive finance company includes not only profits from selling the product but also the losses to granting captive loans. Thus the zero-profit condition is

$$\begin{aligned} \Pi(\hat{s}_F) = & A(\hat{s}_B) \left( \frac{M}{\hat{N}} \right) (\hat{p} - \kappa) \\ & + \alpha [A(\hat{s}_F) - A(\hat{s}_B)] \left( \frac{M}{\hat{N}} \right) [(\hat{p} - \kappa) + \hat{p}\pi_F(\hat{s}_F)] - K = 0. \end{aligned} \quad (21)$$

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. The optimal cutoff signal of a captive finance company,  $\hat{s}_F$ , is such that the profits from the sale of the durable good exactly offset the expected losses from granting the loan to this marginal customer. This optimal cutoff signal is defined by

$$(\hat{p} - \kappa) + \hat{p}[\Pr(L | \hat{s}_F)(\bar{i} - r) - [1 - \Pr(L | \hat{s}_F)](r - d) - c] = 0. \quad (22)$$

Rearranging the above, and comparing it to (4),

$$\Pr(L | \hat{s}_F) = \frac{c + r - d - (\hat{p} - \kappa)/\hat{p}}{\bar{i} - d} < \Pr(L | \hat{s}_B) = \frac{c + r - d}{\bar{i} - d}, \quad (23)$$

given the positive markup on the sale of a durable good,  $(\bar{p} - \kappa) > 0$ . Thus, the durable good seller will have a lower optimal standard for credit approval than that of a bank, that is,  $\hat{s}_F < \hat{s}_B$ , in the new equilibrium. Given the inherent relationship between the optimal cutoff signal and the likelihood of default, we have the following proposition from (23).

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

When consumers obtain financing only from banks, each durable good seller has expected demand  $A(\hat{s}_B)(M/\hat{N})$ . However, when banks and captive finance companies coexist in the consumer loan market and consumers are randomly allocated across lending institutions, with proportion  $\alpha$  visiting captive finance companies and proportion  $(1 - \alpha)$  visiting banks, the expected demand of a durable good seller for its differentiated products is

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

where  $M_F = A(\hat{s}_F)M > M_B = A(\hat{s}_B)M$  since  $\hat{s}_F < \hat{s}_B$ . Thus, with the introduction of captive finance companies, more consumers are approved for loans than when only banks operate, and the total number of durable good buyers increases.

With the larger aggregate number of consumers purchasing the durable goods, under an economywide operation of both banks and captive finance companies, we obtain the following characterization of the optimal price for durable good sellers:

$$\hat{p} = \kappa + \frac{1 + z\pi_F(\hat{s}_F)}{\hat{N}(\hat{N} - 1) \int [F(v)]^{\hat{N}-2} [f(v)]^2 dv}, \quad (25)$$

where  $z = \alpha[A(\hat{s}_F) - A(\hat{s}_B)]/[\alpha A(\hat{s}_F) + (1 - \alpha)A(\hat{s}_B)]$  denotes the proportion of durable good purchasers who are “high risk,” in the sense that expected profits from the loan transaction by itself are negative.<sup>10</sup> Equations (21), (22), and (25) characterize the zero-profit equilibrium number of sellers,  $\hat{N}$ ; the optimal cutoff signal of a captive finance company,  $\hat{s}_F$ ; and the symmetric equilibrium price of differentiated durable goods,  $\hat{p}$ , when both banks and captive finance companies finance consumer purchases.<sup>11</sup>

It is worthwhile to compare the new equilibrium with both banks and captive finance companies with the old equilibrium with only banks in terms of the unique symmetric equilibrium price of durable goods and zero-profit number of durable good sellers. Tables 1 and 2 provide such comparisons using numerical simulations. Table 1 reports the parameter values used in the simulations. Given the simple nature of the model, these parameter values are not chosen in an attempt to calibrate the model to the

10. In the price expression (25), there is an additional term  $z\pi_F(\hat{s}_F)$  compared to the price expression (14). This additional term results in a lower price holding constant the number of firms given that  $\pi_F(\hat{s}_F) < 0$ . The reason for this is that the prior marginal gain to raising price is now tempered by loss arising from the increase in loan size given that the expected profits to lending for the captive finance company, given by  $\pi_F(\hat{s}_F) = [1 - \delta(\hat{s}_F, \hat{s}_B)](\hat{i} - r) - \delta(\hat{s}_F, \hat{s}_B)(r - d) - c$ , are negative.

11. Although neither (14) nor (25) indicates a direct effect of fixed costs on prices, a decrease in fixed costs will lower equilibrium prices. Specifically, a lower fixed cost will increase the equilibrium number of firms given the zero-profit condition, and both (14) and (25) indicate that an increase in the number of firms will reduce prices.

TABLE 1  
PARAMETER SPECIFICATIONS FOR NUMERICAL SIMULATIONS

Variable	Value of variable
<i>Parametric specifications for borrowers, signals, and valuation of durable goods</i>	
Proportions of low-risk borrowers: $\gamma$	$\gamma = 0.5$
Means of the signals of low and high-risk borrowers: $\mu_L$ and $\mu_H$	$\mu_L = 1, \mu_H = -1$
Variance of signals (both low- and high-risk borrowers): $\sigma^2$	2
Support for uniform density function of durable good valuation: $f(v)$	[10000,11000]
<i>Parametric specifications of loan market</i>	
Cost of funds: $r$	0.06
Maximum feasible interest rate: $\bar{i}$	0.12
Net collection rate: $d$	0.01
Cost of processing loan: $c$	0.01
<i>Parametric specifications of monopolistically competitive durable good market</i>	
Number of consumers: $M$	30,000
Constant marginal cost of producing the durable good: $\kappa$	\$9,000
Fixed cost of producing the durable goods: $K$	\$200,000

actual experience of the loan market. Instead, we use these simulations to illustrate some of the comparative static properties of the model, and in particular the effects of increased use of captive finance companies on durable good prices and the number of durable good sellers.

Table 2 provides the equilibrium outcome for different levels of  $\alpha$ , the proportion of consumers who apply to captive finance companies for a loan. The case of  $\alpha = 0$  is the case when only banks exist as lenders. Comparing the numerical simulations reported in the different columns of Table 2, 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. 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.

In general, the existence of loans by captive finance companies increases the size of the market of potential customers. In the short run, the results are positive profits for the existing durable good sellers and a lower price. In the long run, the positive profits will result in the entry of new firms and a further decrease in the durable good price. In particular, the simulations suggest that, in a comparison of the new long-run equilibrium to the one in which captive finance companies did not exist, we find that  $\hat{p} < \bar{p}$  and  $\hat{N} > \bar{N}$  for various parametric specifications of  $\alpha$ , and the numerical simulations indicate that these differences increase as more borrowers select captive finance companies ( $\alpha$  increases). As expected, as more borrowers select captive finance companies, the total number of consumers approved for loans either from banks or from captive finance companies rises, spreading fixed costs more broadly.

We have assumed that the interest rates charged by the captive finance company are equal to the interest rates charged by banks for customers who would qualify

TABLE 2  
EQUILIBRIUM IN MONOPOLISTICALLY COMPETITIVE DURABLE GOOD MARKET: NUMERICAL SIMULATIONS

Variable	Value of variable				
Proportion selecting captive finance companies: $\alpha$	0.00	0.25	0.50	0.75	1.00
Symmetric zero-profit price of durable goods: $\hat{p}$	9,123.6	9,120.7	9,118.1	9,115.7	9,113.6
Symmetric zero-profit number of durable sellers: $\hat{N}$	8.09	8.28	8.46	8.63	8.79
Optimal cutoff signal of banks: $\hat{s}_B$	0.36	0.36	0.36	0.36	0.36
Optimal cutoff signal of captive finance companies: $\hat{s}_F$	NA	-0.60	-0.58	-0.56	-0.55
Loan approval rate of banks: $A(\hat{s}_B)$	0.44	0.44	0.44	0.44	0.44
Loan approval rate of captive finance companies: $A(\hat{s}_F)$	NA	0.61	0.60	0.60	0.60
Probability of default of banks: $\delta(\hat{s}_B)$	0.28	0.28	0.28	0.28	0.28
Probability of default of captive finance companies: $\delta(\hat{s}_F)$	NA	0.35	0.35	0.35	0.34
Average loss per "high-risk" loan for captive finance company: $\pi(\hat{s}_F)\hat{p}$	NA	-60.3	-59.0	-57.8	-56.8
Number of consumers approved by banks: $(1 - \alpha)A(\hat{s}_B)M$	13,082	9,812	6,541	3,271	NA
Number of consumers approved by captive finance companies: $\alpha A(\hat{s}_F)M$	NA	4,538	9,022	13,460	17,858
Total number of consumers approved by both banks and captive finance companies: $(1 - \alpha)A(\hat{s}_B)M + \alpha A(\hat{s}_F)M$	13,082	14,349	15,563	16,730	17,858
Number of high-risk consumers provided loans by captive finance company who would not obtain a loan from banks: $\alpha[A(\hat{s}_F) - A(\hat{s}_B)]M$	NA	1,267	2,481	3,648	4,776

for a loan from a bank. For customers who would only obtain a loan from a captive finance company, we have set the interest rate equal to the highest level,  $\bar{i}$ . Thus, our simple analysis suggests that the average interest rate will be higher among captive finance company customers than among bank customers due to the mass of high-risk individuals granted loans by captive finance companies at the highest interest rate.<sup>12</sup> However, there are offsetting factors that can lead to a lower interest rate for finance company loans, and thus introduce ambiguity in predictions that compare interest rates at banks versus captive finance companies. For instance, it is not uncommon for automobile manufacturers to offer the choice of either low interest rates on captive loans or a cash rebate to increase sales. These two forms of a discount allow the manufacturer to appeal to both those who purchase using loans from the

12. Reinforcing this difference is the sometime use of "hidden" dealer markups on the interest rate charged to individuals who use a captive finance company, markups that are generally shared between the captive finance company and the dealer. Such markups result in the actual interest rate on dealer-originated loans incorporating both the "market" rate that reflects the creditworthiness of the individual and a potential additional amount that increases in size with the relative strength of the negotiating position of the dealer compared to the customer.

captive finance company and to those who purchase using bank financing or cash reserves.<sup>13</sup>

When finance companies offer a “below-market” interest rate, a subsidy is provided to buyers who borrow, a subsidy that increases with the riskiness of the borrower. Mitigating this feature is the fact that captive finance companies typically limit the availability of such low rates to customer with high creditworthiness. Furthermore, according to the Federal Trade Commission, high minimum down payments are sometimes required for such low-interest loans, and such down-payment requirement may also serve to screen out high-risk borrowers.<sup>14</sup> Such limitations on the availability of low-interest-rate loans may explain why the median interest rate reported in the 2004 Federal Reserve’s *Survey of Consumer Finances* for 2004 new car loans is lower for finance company loans than for banking institutions, but the mean interest rate for new car loans is higher for finance company loans than for banking institution loans.

The above discussion regarding the use of low-interest-rate loans as a marketing tool should be viewed as suggestive, not definitive in scope. Given the bundling of the loan with the purchase of the durable good of some customers, clearly various combinations of interest rates and prices for the durable good can be chosen, and the implications of changes within this bundle for profitable price discrimination across different classes of customers, including across those who seek finance company loans versus cash customers, would have to be considered, as well as the implications of different pricing arrangements on dealers’ negotiations with customers. While such issues can break the simple link between interest rates and the creditworthiness signal of our analysis, our key finding (Proposition 1) remains, namely, that borrowers from captive finance companies will, as a group, be more likely to default on a loan than borrowers from banks.

#### 4. 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 lower optimal credit standard for the captive finance company. To test this main hypothesis, we focus on the analysis of the U.S. automobile loan market. The automobile industry matches our theoretical model in two key respects. First, automobiles can be considered to be a differentiated durable good that typically is financed with a consumer installment loan. Second, most major domestic and foreign automobile

13. Note that by advertising a fixed, low-interest-rate loan for qualified customers who borrow, the manufacturer also limits the ability of the dealer to negotiate hidden markups with respect to the interest rate on captive loans.

14. See the brochure “FTC Facts for Consumers: Buying a New Car,” Federal Trade Commission (FTC), Bureau of Consumer Protection, Office of Consumer and Business Education, April 2006. This brochure is available online at the FTC website. While Besanko and Thakor (1987) consider collateral as a screening device, in our case, since all borrowers offer the automobile as collateral, the potential screening device is the size of the down payment.

manufacturers have developed a captive finance company, and consumers obtain loans mainly from either banks or these captive finance companies.

Our empirical analysis relies on a unique database, *TrenData*<sup>TM</sup>, a product of Trans Union LLP, to empirically examine the repayment performances of bank and captive automobile loans. As a proxy for the expected default rate in our theoretical model, we use delinquency rates for automobile loans to measure loan performance. Previous studies such as DeVaney and Lytton (1995) and Gross and Souleles (2002) show that delinquency rates are an important indicator of the quality of loan performances. Recent studies such as Barron, Staten, and Wilshusen (2002) and Gross and Souleles (2002) indicate that delinquency rates for various types of consumer loans are significantly related to factors such as income, consumer debt burden, change in debt levels, and employment status. We control for those factors in the estimations of the loan performances of automobile loans in our study by panel regression analysis.

*TrenData*<sup>TM</sup> is derived from a large, nationally representative sample of consumer credit reports, drawn annually and quarterly. The variables in *TrenData*<sup>TM</sup> are measured at the county level, covering over 3,000 counties in the United States. The variables include the number of delinquent automobile loans of banks and captive finance companies, as well as the number of automobile loans of banks and captive finance companies. The performances of bank and captive automobile loans are measured as delinquency rates of bank and captive finance company automobile loans. 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.

To construct the variables for borrower characteristics, this paper uses these four-quarter data from *TrenData*<sup>TM</sup> for the 4-year period from 2000 to 2003 as well as the data from various government economic databases. The sources and construction of the variables are described as follows:

*Measure of Income:* Consumer income is a key variable that has positive influence on loan repayment. County-average real per capita personal income is used in the estimations of delinquency rates. Lagged annual income data are obtained from Regional Data from Bureau of Economic Analysis (BEA). The Bureau of Labor Statistics's CPI-U price index series is used to convert income, as well as other variables measures in nominal values, to real values.

*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* (U.S. Bureau of the Census). The 2000 county-level median house values are converted into real house values of a specific year using the consumer price index. Note that the preferred measure of household assets, housing equity, is not available. Thus, we are assuming that the value of a house serves as a proxy for housing equity.

*Unemployment:* An income shock can arise from the loss of employment. The state-level unemployment rates reported by the Bureau of Labor Statistics (*BLS*) are used as a proxy for negative income shocks from unemployment.

*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 the 2000 *Census Data*, U.S. Bureau of Census.

*Measure of Average Borrower Riskiness:* County-average credit score indicates a countywide 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*<sup>TM</sup>.

*Measure of Other Debt:* Past studies have shown that the amount of debt held by a borrower has a strong impact on repayment of loans. Total debt level per borrower, for a given income, indicates a consumer's debt burden. *TrenData*<sup>TM</sup> provides the measure of total debt per borrower.

We control for the borrower characteristics using the variables constructed above to test the main hypothesis predicted by the theoretical model of this paper—whether captive automobile loans produce a higher delinquency rate than that of bank automobile loans. Table 3 provides the descriptive statistics of the variables for countywide average borrower characteristics. Table 4 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 4 indicates 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 5 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 2001 to 2003. Column 1 of Table 5 lists the predicted signs for the coefficients as discussed in the hypotheses. Column 2 provides estimates for a random effects model specification

TABLE 3  
DESCRIPTIVE STATISTICS OF VARIABLES FOR BORROWER CHARACTERISTICS

Variable	Mean	Standard deviation
County-average real per capita income (2003 dollars)	\$24,772	6,038
State-average median house value (2003 dollars)	\$83,731	43,483
County-average credit score	659.67	37.53
Total debt per borrower (2003 dollars)	\$36,151	16,969
State unemployment rate	4.85%	1.16
State proportion of adults who are divorced/separate	9.23%	1.12

TABLE 4

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 mean (std. dev.)	Bank automobile loan mean (std. dev.)	Captive automobile loan mean (std. dev.)	<i>T</i> -test for mean differences between delinquency rates of bank and captive automobile loans <i>T</i> -statistics
2000	3.36% (2.20)	2.68% (2.42)	3.84% (2.88)	-19.83***
2001	1.32% (0.97)	1.23% (1.51)	1.39% (1.23)	-4.80***
2002	1.35% (1.00)	1.08% (1.25)	1.48% (1.31)	-13.06***
2003	1.28% (0.98)	0.97% (1.18)	1.44% (1.26)	-16.34***
All years: 2000-03	1.83% (1.65)	1.49% (1.80)	2.2601% (2.09)	-27.23***

NOTES: 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. \*\*\*Indicates significance at 1% level.

excluding the credit score measure. Column 3 includes the county-specific credit score measure. For each year and county, the sample includes two observations, one with the delinquency rate for bank automobile loans as the dependent variable and the second with the delinquency rate for captive automobile 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.<sup>15</sup>

The results of random effects models illustrate that delinquency rates on automobile loans are affected by other variables as anticipated. Column 2 indicates that 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.

15. 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 (see Sayers 1989, pp. 10-32).

TABLE 5

PANEL REGRESSION FOR ESTIMATION OF DETERMINANTS OF COUNTY DELINQUENCY RATES OF AUTOMOBILE LOANS: 2001–2003

Independent variables	Predicted sign for effect on delinquency rates of automobile loans	Random effects model for log of delinquency rates of automobile loans Coefficient (z-statistic)	Random effects model for log of delinquency rates of automobile loans Coefficient (z-statistic)
Intercept		1.11*** (11.81)	1.67*** (20.07)
Log of county-average real per capita income (lagged 1 year)	–	–0.265*** (–9.35)	–0.092*** (–3.63)
Log of state-average real house value (lagged 1 year)	–	–0.087*** (–8.99)	0.005 (0.51)
Real total debt per borrower (lagged 1 year)	+	0.219*** (11.14)	0.059*** (3.22)
State unemployment rate (lagged 1 year)	+	0.009*** (4.07)	–0.004** (–2.09)
State proportion of adults who are divorced/separate	+	2.65*** (13.61)	0.160 (0.87)
County-average credit score (lagged 1 year)	–		–0.0019*** (–32.72)
Lender type dummy: 1 if captive loan, 0 if bank loan	+	0.075*** (28.96)	0.075*** (28.93)
Year 2001 dummy	+	0.049*** (9.84)	0.006 (1.29)
Year 2002 dummy	–	0.028 (7.38)	0.020*** (5.37)
Mean of dependent variable: delinquency rates across bank and captive finance companies (%); not log (Std. Dev.)			1.27% (1.31)
$R^2$		0.11	0.18
Number of counties		3,107	3,107
Number of observations (combined samples for bank and for captive finance company delinquency rates on automobile loans)		18,630	18,630

NOTES: Figures in parentheses are z-statistics and *T*-statistics; High Breusch–Pagan LM Statistic favors random effects model against OLS model; \*\*\* indicates significance at 1% level; \*\* indicates significance at 5% level.

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. Higher delinquency rates were observed in the counties with higher unemployment rates, and higher divorce/separation rates, which are proxies for the prevalence of either income or expense shocks. Year dummies are included to account for any trends in delinquency rates for automobile loans during the 1999–2002 time period.

Column 3 in Table 5 indicates that these effects are largely captured by the variation across counties in the aggregate measure of riskiness as measured by average credit scores. In particular, note that including introducing this variable in Column 3 reduces the predicted effects of income and debt differences on the likelihood of default, and in fact leads to a switch in signs for other variables such as the unemployment rate. Note that the county-average credit scores can be a proxy for the relative proportions

of low- and high-risk borrowers in each region ( $\gamma$  and  $(1 - \gamma)$ , respectively, in the analytical model). Note that for both estimations, the dummy variable for lender type captures the higher delinquency rates of captive automobile loans relative to bank automobile loans as reported in Table 4.

## 5. CONCLUSIONS

This paper constructs a simple 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 when captive loans are offered to consumers who are too risky for banks to service. The gains 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 United States is segmented by banks and captive finance companies on the basis of consumers' risk characteristics.

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