

Information Asymmetry and Competition in Credit Markets: The Pricing of Overdraft Loans in Brazil

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Abstract

This paper evaluates how information asymmetry affects the strength of competition in credit markets. A theory is presented in which adverse selection softens competition by decreasing the incentives creditors have for competing in the interest rate dimension. In equilibrium, although creditors compete, the outcome is similar to collusion. Three empirical implications arise. First, interest rate should respond asymmetrically to changes in the cost of funds: increases in cost of funds should, on average, have a larger effect on interest rates than decreases. Second, aggressiveness in pricing should be associated with a worsening in the bank level default rates. Third, bank level default rates should be endogenous. We then verify the validity of these three empirical implications using Brazilian data on consumer overdraft loans. The results in this paper rationalize seemingly abnormally high interest rates in unsecured loans.

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1 Introduction

Informational imperfections are pervasive in credit markets: relevant information about borrowers is not observable to creditors. Furthermore, lenders differ on the amount of information they have about a particular borrower. This determines not only the pricing and availability of credit, but how competitors interact in the market. See Berger & Udell (1995), Petersen & Rajan (1995) and Dell'Arricia (2001). Extending the work of Ausubel (1991) for explaining high spreads on credit card loans in the US, we propose a theory in which the incentives to compete aggressively in the interest rate dimension are dampened by adverse selection. Additionally, we evaluate whether this theory has empirical merit using data on overdraft loans in Brazil.

The central idea is that worse borrowers, i.e., with higher default probability, respond more to price aggressiveness. In this case, banks' return to undercutting competitors is lower, and high spreads arise even under highly competitive regimes such as price competition. This theory is seemingly similar to switching costs theories (see Klemperer (1987a), (1987b)) in the sense that suppliers are competing but mark-ups are similar to those under collusion. It differs, however, because here the incentives to undercut are dampened by the worsening of the quality of loans. Therefore the two theories have different empirical implications. For example, the theory proposed here implies that price aggressiveness and default rates are positively correlated, while such implication does not arise in pure switching cost models.

Testing the empirical relevance of the adverse selection hypothesis is interesting and important because it rationalizes the high observed mark-ups in the pricing of unsecured loans, apparently incompatible with the competitive structure of some industries, especially in banking. Therefore it helps explaining the puzzling high spreads on unsecured loans, such as credit cards loans in the US and overdraft loans in Brazil. This paper's main contribution is testing, using real world data, the adverse selection hypothesis with a completely specified empirical model that captures the implications of the adverse selection for the incentives to compete aggressively. Using different empirical methods, previous work has convincingly shown evidence that adverse selection is relevant in credit markets. Ausubel (1991), for example, provides evidence for the US credit card market. Using interest rate and cost data for a few US banks, he shows that credit card interest rates are persistently higher than marginal cost (including default rates) and

respond asymmetrically to changes in the cost of funds. Using experimental data, Ausubel (1999) finds that borrowers with observable demographics generally associated with a higher probability of defaulting respond more to credit cards offers with lower interest rates. By tracking the respondents account histories, he also found a significant association between the propensity to respond to lower interest rates and higher subsequent delinquency and bankruptcy rates. This paper also makes a theoretical contribution. We present a theory in which different borrowers have different interest rate sensitivities. Although built on Ausubel (1991), the theory here does not rely on myopic behavior on part of borrowers. In this sense we integrate adverse selection, search costs and switch costs theories of pricing of unsecured consumer loans. See Calomiris & Mester (1995). Additionally, we explicitly derive the consequences of adverse selection has on the incentives to compete aggressively.

The paper contains 6 sections including this introduction. Section 2 contains the theoretical ideas and its empirical implications. In section 3, an empirical model that accounts for the potential endogeneity of the average quality of borrowers is presented. In section 4, the data and the empirical application are described. In section 5 the main empirical findings are presented. Finally, section 6 concludes and presents policy implications both for bank regulators and the competition authorities.

2 Theory

High mark-up equilibria can arise for two main reasons: lack of competition and asymmetry of information. In this paper we explore the second possibility, assuming banks are competing. When we say banks are competing, we mean that the conduct is competitive, but the outcome may look collusive. This distinction is important because, from a policy perspective, the correct remedy depends on whether the conduct is competitive.

If banks are competing in prices and the marginal cost in providing loans is constant, high spread equilibria is difficult to sustain in equilibria. In the extreme case that banks are perceived as homogeneous by borrowers, the unique equilibrium has interest rates equal to marginal cost. Banks have a first-order gain, but only a second-order loss, in undercutting their competitors. If, however, by undercutting their competitors, banks face a worsening in the quality of their borrowers, the returns to aggressive pricing

are lower. In other words, they would also face a first-order loss in costs when undercutting and a positive mark-up can be sustained even under price competition. In this case, the marginal cost in providing loans is not constant, but increasing, and therefore the Bertrand outcome breaks down.

We present these ideas in two different ways. First we outline, verbally, a general theory in which the marginal cost in providing loans is increasing due adverse selection. Banks are then reluctant in competing on the interest rate dimension. Then, we outline a simple model, in which the main features of the theory arise in a formal way.

Consider a market for overdraft loans in which the following four assumptions are satisfied:

Assumption 1 Borrowers differ in two dimensions: their probability of defaulting on their debts and the reason why they use overdraft loans.

Assumption 2 Banks do not observe all relevant characteristics of the borrowers, that is, they cannot tell borrowers' types, at least not without establishing a long term relationship with them.

Assumption 3 Individuals choose to be clients of one, and only one, bank, in which they acquire all banking services. This is made for simplicity. If clients picked different products in different banks, the results would continue to follow.

Assumption 4 Better borrowers face a higher net cost in changing banks. The net cost is the difference between the switch and search costs and what borrowers have to gain when switching, which is economizing on interest rate expenses.

Assumption 5 Private information about borrowers is not portable, i.e., good borrowers cannot credibly carry the information one has about them to a competing bank.

Better borrowers use overdraft loans for convenience. They borrow for short-term liquidity management purposes, that is, to accommodate short-term shocks to their consumption needs. They have also a lower intrinsic probability of defaulting (assumption 1). This has three major implications. First, their demand for overdraft loans is relatively inelastic, given the convenience reason. Second, they are willing to pay a premium for using overdraft

loans: although applying for cheaper forms of credit is possible, transaction costs prevents better borrowers from doing so, to a certain extent. Third, given that they are good borrowers, they face an endogenous high switching cost in going to other banks, because by doing so they are confounded with bad borrowers. As Brito & Hartley (95) argue, this is why it may be optimal to hold positive balances on highly priced overdraft loans even if the transaction costs involved in borrowing on credit card or overdraft loan are relatively low. Therefore better borrowers are willing to pay a further premium for overdraft loans with their *current* banks. This is precisely where this theory differs from Ausubel (1991): good borrowers take overdraft loans and it is rational to do so, given transaction costs and the informational structure.

Worse borrowers use overdraft loans on a longer term, for consumption smoothing reasons. This makes them behave differently from better borrowers. For any given size of debt, worse borrowers have a higher stake at the interest rate being paid, assuming they intend to repay the debt. They, however, do not have incentive to borrow on cheaper lines of credit, such as personal loans, because to do so they would have to disclose information, which is not in their best interest. On the other hand, these clients, again if they intend to pay back the loan at all, have more incentive to shop for better priced overdraft loans. Therefore worse borrowers are more willing to incur in the switch costs and are do not face the additional cost of being confounded with bad types, given that this is what they are in the first place. Furthermore, they might be induced to borrow more if the interest decreases, given that they are borrowing for consumption smoothing reasons. Under these conditions, the bank specific price sensitivity of the demand for overdraft loans is higher for worse than for better borrowers. Now it is not difficult to see how the presence of informational asymmetry and switch costs can create adverse selection in the market for overdraft loans. Assume that all banks are charging the same (and high) interest rate on overdraft loans, above the marginal cost of providing loans. Will banks have an incentive to undercut their competitors? Not necessarily. A particular bank may not have incentive to undercut its competitors because by doing so they would: 1) recruit more worse borrowers; 2) induce relatively more borrowing from worse borrowers. Hence, a high interest rate and a high spread equilibrium may be sustainable in equilibrium even under price competition. Finally, starting from an equilibrium situation, the high spread equilibrium can be very robust to positive shocks to the supply of loans (e.g., a decrease in the

cost of funds). In other words, it would take a non trivial decrease in cost of funds to induce any change at all in interest rates. An increase in interest rates, on the other hand, would more easily be transmitted to interest rates.

We now outline the empirical implications of the theory.

Empirical Implication 1 Interest rates on overdraft loans should present "downward stickiness". This implication is precisely the opposite of the one in Stiglitz & Weiss (1981) credit rationing theory, in which banks do not adjust upwards the rate, and the market does not clear. Here banks are reluctant in undercutting competitors since this produces a deterioration in the quality of their loans.

Empirical Implication 2 Aggressiveness, relative to the market, in pricing should have a negative effect on bank level default rate.

Empirical Implication 3 The default rate on overdraft loans is endogenous. Normally one thinks the spread as a function of the (expected) default rate. According to our theory, the causality also runs inversely. This implies that a simultaneous equation estimation will yield significantly different results from Ordinary Least Squares. Furthermore, the direction of the bias is known: OLS should underestimate the negative effect of price aggressiveness on the default rate.

2.1 A Model of Adverse Selection in Overdraft Loans

We present a simple model that produces the results outlined verbally in section 2. In this model, two banks compete in prices, borrowers differ in their probability of default and in their cost in switching banks. The results generalize easily to more than 2 banks.

Let P_G and P_B be the probability that good and bad borrowers will repay their debts, respectively, and let c be the (constant) marginal cost of funds. We assume $P_G > c > P_B \geq 0$, that is, it worthwhile to lend to good but not to bad borrowers. We assume banks can charge only one interest rate for all borrowers. Let $d(r)$ be the bad borrowers' demand for overdraft loans, where r the interest rate at which borrowers have to pay. We assume $d(r)$ to be decreasing in r . On the other hand, good borrowers have an inelastic demand equal to d . There is a mass 1 of borrowers, $\lambda \in (0, 1)$ of which are good ones. Finally, good borrowers have a cost s in changing banks, whether bad borrowers have no switch costs. The last two assumptions are crucial.

While good borrowers' demand is insensitive to changes in the interest rate, bad borrowers respond to interest rate. Furthermore good borrowers face a higher cost in switching banks. The fact that bad borrowers have zero switch costs is a normalization. Both assumptions capture the fact that, while good borrowers use overdraft loans for convenience reasons, bad borrowers use it for consumption smoothing.

Assume that borrowers are equally divided between the two banks. Bank 1's specific demand for overdraft loans, as a function of her interest rate (r_1) and of bank 2's interest rate (r_2) is:

$$\text{Bank 1's Good Borrowers: } D_1^G(r_1, r_2) = \begin{cases} \lambda d, & \text{if } d \times (r_1 - r_2) < s \\ \frac{\lambda d}{2}, & \text{if } d \times (r_1 - r_2) = s \\ 0, & \text{otherwise} \end{cases}$$

$$\text{Bank 2's Good Borrowers : } D(r_1, r_2) = \begin{cases} \lambda d, & \text{if } d \times (r_2 - r_1) > s \\ \frac{\lambda d}{2}, & \text{if } d \times (r_2 - r_1) = s \\ 0, & \text{otherwise} \end{cases}$$

$$\text{Bad Borrowers: } D(r_1, r_2) = \begin{cases} (1 - \lambda) d(r_1), & \text{if } r_1 < r_2 \\ (1 - \lambda) d(r_1), & \text{if } r_1 = r_2 \\ 0, & \text{otherwise} \end{cases}$$

The default rate is the ratio of defaulted loans to total loans.

Proposition 1 *Starting at a situation in which both banks charge the same interest rate $r_1 = r_2 = r^*$, if a bank undercuts her competitor, she experiences a worsening in her default rate.*

Proof. *When banks charge the same interest rate r^* , each bank has $\frac{(1-\lambda)P_B d(r^*)}{2} + \frac{\lambda P_G d}{2}$ and $\frac{(1-\lambda)d(r^*)}{2} + \frac{\lambda d}{2}$ of defaulted and total loans, respectively. The default rate is therefore $def1 = \frac{(1-\lambda)P_B d(r^*) + \lambda P_G d}{(1-\lambda)d(r^*) + \lambda d}$. Assume without loss of generality that bank 1 undercuts, that is, now $r_1 < r^* = r_2$. Then all bad borrowers will go to bank 1. The amount of defaulted loans is $P_B(1 - \lambda) d(r_1) + \frac{\lambda P_G d}{2}$ at best. The default rate is now $def2 = \frac{P_B(1-\lambda)d(r_1) + \frac{\lambda P_G d}{2}}{(1-\lambda)d(r_1) + \frac{\lambda d}{2}}$. Clearly, $def2 > def1$ if $P_B > P_G$. ■*

Proposition 1 is equivalent to implication 2 above. Now we derive conditions on the parameters under which a high spread equilibrium is sustained.

Proposition 2 *Any high spread situation is robust against marginal cuts in the interest rate iff $P_B \leq c$.*

Proof. Suppose $r_1 = r_2 = r^*$ and banks make positive profits. Consider bank 1 undercutting bank 2 slightly. By doing so she gets only bad borrowers and has profits arbitrarily close to:

$$\Pi_1^D = \frac{\lambda P_G d r^*}{2} + P_B (1 - \lambda) d (r^*) - \frac{\lambda d c}{2} - (1 - \lambda) d (r^*) c$$

By Sticking to $r_1 = r_2 = r^*$, she gets:

$$\Pi_1^S = \frac{\lambda P_G d r^* - P_B (1 - \lambda) d (r^*) - \lambda d c - (1 - \lambda) d (r^*) c}{2}$$

Trivially, $\Pi_1^S \geq \Pi_1^D$ if and only if $P_B \leq c$, which is true by assumption. ■

Proposition 3 *If s is large enough, and/or P_B and λ are low enough, than any high spread situation is robust against discrete cuts in the interest rate.*

Proof. Suppose $r_1 = r_2 = r^*$ and bank make positive profits. Consider bank 1 undercutting bank 2 discreetly, so that she would also attract good borrowers. We consider here the lowest possible price cut, which is just slightly below $r_2 - \frac{s}{d}$. By doing so she gets all borrowers and has profits arbitrarily close to:

$$\Pi_1^D = \lambda P_G \left(r^* - \frac{s}{d} \right) d + P_B (1 - \lambda) d \left(r^* - \frac{s}{d} \right) \left(r^* - \frac{s}{d} \right) - \lambda d c - (1 - \lambda) d \left(r^* - \frac{s}{d} \right) c$$

By Sticking to $r_1 = r_2 = r^*$, she gets:

$$\Pi_1^S = \frac{\lambda P_G d r^* - (1 - \lambda) P_B d (r^*) r^* - \lambda d c - (1 - \lambda) d (r^*) c}{2}$$

Bank1 will not have incentive to undercut if $\Pi_1^S \geq \Pi_1^D$.

$$\Pi_1^D - \Pi_1^S = \lambda \left[\left(\frac{d}{2} - s \right) P_G r^* - \frac{d c}{2} \right] + (1 - \lambda) \left(d \left(r^* - \frac{s}{d} \right) \left(r^* - \frac{s}{d} \right) - \frac{d (r^*) r^*}{2} \right) (P_B - c)$$

Since $P_B \leq c$, the second term at the right-hand side is negative: by undercutting the bank loses by both recruiting bad borrowers and inducing them to borrow more. The first term could negative, and it is the potential rationale for undercutting: gaining on the good borrowers recruited. Obviously then, if s is high enough (too much switch costs for good borrowers), or λ is low enough (too few good borrowers) or P_B low enough (too likely that gbad

borrowers will default), then $\Pi_1^D - \Pi_1^S \leq 0$, and $r_1 = r_2 = r^*$ with positive profits is robust against undercutting. ■

Finally, we derive some equilibrium features. Since the model has multiple equilibria, we concentrated on two things. First, we derive the lowest interest rate equilibrium, and perform some comparative statics on it. Second, we show that, for some parameter values there exists equilibria in which banks make positive profits.

The lowest possible interest rate on loans, in equilibrium, is defined implicitly by:

$$\lambda P_G d r^* - (1 - \lambda) P_B d (r^*) r^* - \lambda d c - (1 - \lambda) d (r^*) c = 0$$

It is interesting to look at how the range of possible equilibria changes with different values of parameters. Suppose the conditions in propositions 2 and 3 are satisfied. Then there is a range of equilibria, possibly with the highest possible interest rate even higher than the monopolist interest rate. When c decreases, it is clear that the lowest possible interest rate decreases. However, both banks charging the previous lowest possible interest rate continues to be equilibrium. On the hand, if c increases, then both banks charging the previous lowest possible interest rate is no longer an equilibrium. In this sense, the equilibrium interest rate presents "downward stickiness": it is more robust to decreases than to increases in the cost of funds c , as in implication 1 above.

It is important to notice that neither the verbal exposition nor the model allow for undercutting to actually occur in equilibrium. Indeed it does not allow for any price dispersion. In reality, and in our data, banks undercut each other and there is considerable price dispersion. This may happen for several reasons. Banks may respond at different paces to exogenous changes, such as increases in the cost of funds. Another reason is that banks are multi-product firms. Banks' strategies may differ in the use of different products. For example, a particular banks may a some times use overdraft loans as a loss-leader at some periods.

3 Description of the Industry and Data

The empirical application is the market for overdraft loans in Brazil. Overdraft loans are short-term loans that are made by withdrawing from one's

limit on one's checking account. They work as a line of credit for consumers. These loans are mostly unsecured, i.e., non-collateralized. The average term on these loans is 20 days. When loans mature, borrowers have to repay, at least, the interest rate accrued in the period.

The Brazilian banking industry is dominated by few nationwide universal banks. The 5 largest banks, all of whom operate nationally, held, in December 2003, 56.3% of the industry's assets. The concentration in credit operations is roughly the same: the 5 largest banks hold about 48.6% of the all loans. Evidence gathered by the Central Bank indicate that, although there is considerable market power in the industry, banks do not seem to be colluding.¹ See also Banco Central do Brasil (1999), (2000), (2001), (2002) (2003), Belaisch (2003) and Nakane (2002). Banks specialize different markets segments, especially by customer income level, although there is considerable market overlap. These features indicate that the likely competition regime is oligopolistic competition with differentiated products.

Using different sources, an original data set on overdraft loans in Brazil was built. From the Central Bank, we have confidential monthly bank level data over the period from January 1995 to October 2001 for the 5 largest Brazilian retail banks on the volume of overdraft loans, the volume of problematic overdraft loans, the average (throughout the month) interest rate on overdraft loans, the number of branches, and expenses with advertising. Loans are considered problematic if they are delinquent for more than 15 days and less than 90 days. Delinquent loans are loans that are late as of the due date, which is, on average, 20 days after the loan is made. Late here means the interest rate accrued on the loan has not been repaid. Given the average term on overdraft loans and the nature of the delinquency data, the least possible amount of time between when a loan is made and when it is shown problematic in our data set is 2 months. Unfortunately we do not observe the amount of written-off loans (loans delinquent for more than 90 days), which is a more meaningful measure of problematic loans. However, previous research has shown that the probability of recovery after being more than 15 days late is low (about 20%). See Banco Central do Brasil (1999), (2000), (2001), (2002) and (2003). From banks' accounting data, we collected information on payroll and administrative expenses. From the National Bank Employees Union, we have data on the number of employees. This data forms a panel with five firms over 89 periods. This data is used to estimate the

¹Source: Banco Central do Brasil.

default model.

Again from the Central Bank, we use aggregate data on overdraft interest rates and cost of funds to estimate the sensitivity equation. Our sample goes from January 1997 to June 2004.

4 The Empirical Model

The empirical model accommodates the features of the theory. We estimate two models. The first is a sensitiveness equation, using aggregate data. With this model, we assess how overdraft interest rates respond to the main component of marginal cost, the cost of funds. The second model relates bank level default rate and bank level interest rates.

4.1 The Stickiness Equation

Implication 1 says interest rates on overdraft loans respond asymmetrically to changes in the cost of funds. More precisely, it should present “downward stickiness”, that is, it should respond more to increases than to decreases in the cost of funds.

We estimate the following model of sensitivity, using data from the whole market from January 1997 to June 2004. We split the sample in two sub samples, according to whether there was an increase or a decrease in the contemporaneous cost of funds.

$$\Delta r_t = \beta_1 \Delta cf_t + \beta_2 \mathbf{1}(\Delta cf_t > 0) \times \Delta cf_t + \beta_3 \Delta r_{t-1} + controls + \varepsilon_t \quad (1)$$

The dependent variable, Δr_t , is the change in the effective market level interest rate on overdraft loans; the regressors are Δcf , the contemporaneous change in the cost of funds, and $\mathbf{1}(cf_t > 0)$, a dummy variable indicating whether the change was an increase, interacted with Δcf . ε_t is a shock to the change in the interest rate, which is allowed to have serial correlation in some specifications. Δr_{t-1} is included to allow for some persistence in the series of changes in the interest rate. The model is estimated in the first differences for two reasons. First, we want to recover an asymmetry in how overdraft interest rate responds to changes in cost of funds, so it natural to estimate it in first differences. Second, the levels of interest rate and cost

of funds do not seem to be stationary.² The model is also estimated with changes in the cost of funds and overdraft interest rates measured in percent changes (as opposed to percentage points).

Changes in the cost of funds induce changes in the overdraft loans' interest rate by two channels. First, by changing the marginal cost of providing loans. This is the effect we want to recover. However, since the basic interest rate determines short-term economic activity, it also changes the probability that borrowers will default on their debts. This second effect is accounted for by controlling by including unemployment rates as regressors. While unemployment controls for the effect of changes in cost of funds on the probability of defaulting, it is not determined by overdraft loan interest rates, given that the cost of funds is included, that is unemployment is exogenous. This is equivalent to saying that, above and beyond the information contained in the cost of funds, the interest rate on overdraft loans does not cause unemployment, and the shocks specific to overdraft loans' interest rates (contained in ε_t) do not affect unemployment.³

4.2 The Default Model

The second model is composed by two objects: the pricing equation and the default equation. An observation is a bank at a point in time (a month). Although the default equation in the main interest, the whole system of equations is specified because the two variables are determined jointly. Therefore, an explicit description of the system permits determining what type of variation is legitimate for estimating the default equation.

The Default Equation The theory predicts that the default rate is endogenous. Econometrically, this corresponds to specifying an equation in which the default rate is a function of price aggressiveness. The equation to be estimated is:

²One fails to reject the null hypothesis of unit root on the series of both overdraft loan interest rate and cost of funds.

³Another possible strategy is including leads of delinquent overdraft loans. Unfortunately, this strategy is problematic because, as the theory predicts and the empirical results confirm, future default rates are likely to be endogenous, even after cost of funds is accounted for. Additionally, data on aggregate default rates are not available for the whole sample. The point estimates are qualitatively similar regardless of the measure of default, but are weaker when delinquency is used.

$$D_{nt} = \beta_0 + \beta_1 r_{nt-J} + \beta_2 \mathbf{I}_{nt} + \beta_3 \mathbf{macro}_t + \varepsilon_{1nt} \quad (2)$$

D_{nt} is the default rate for bank n at time t . r_{nt-J} is bank n 's overdraft interest rate J periods before. Given the timing of the default data, the model is estimated for J equals 2, 3 or 4 months. \mathbf{I}_{nt} is a vector of banks' dummies. They control for unobserved bank characteristics that determine both the default rate and aggressiveness in pricing. Heterogeneity in banks' clients characteristics, induced by market segmentation, is an example. Finally \mathbf{macro}_t is a vector of macroeconomic variables that determine default rates, such as unemployment and income. We impose structure on the error term ε_{1nt} . Shocks to bank specific default rates are allowed to have different variances between banks and are also serially correlated within banks but not between banks. The dynamic nature of the default equation follows from the nature of the data as it will become clear at the next section.

Implication 2 predicts $\beta_1 < 0$, that is, increase in aggressiveness has a detrimental effect on loan quality.

The Pricing Equation The bank specific interest rate is a function of the expected default probability on its loans, $E[D_{nt+J} | t]$, of the cost of providing loans, c_{nt} , and of the characteristics of the bank, B_{nt} , such as the type of service the bank provides. One example of the latter is the quality of service the bank provides, for which clients are willing to pay a premium.

$$r_{nt} = \gamma_0 + \Gamma_1 E[D_{nt+J} | t] + \gamma_3 c_{nt} + \Gamma_4 B_{nt} + \varepsilon_{2nt} \quad (3)$$

The system composed by (2) and (3) simultaneously determine the default rate and the bank specific interest rates. Since bad borrowers are more interest rate sensitive than good ones, when a bank prices aggressively, she will induce her current bad borrowers to borrow more than her current good borrowers. Furthermore, she recruits relatively more bad borrowers than good ones. Anticipating this effect of pricing on their future default rates, banks adjust their interest rates accordingly, making the default rate D_{nt+J} endogenous. Through the default equation, increases in interest rate cause decreases in the default rates (implication2). Through the pricing equation, increases in the default rate cause increases in the interest rate. Therefore, failing to account for the endogeneity of r_{nt-J} in estimating the default equation (2) produces downward bias on the estimates of β_1 . This is precisely what implication 3 says.

5 Results and Discussion

All tables are in the appendix.

Table 1 shows some descriptive statistics on both the aggregate and the bank level data. An observation is a point in time (month) in rows 1 to 3. In rows 4 and 5 an observation is a bank at a point in time (month).

The main motivation for this paper arises from this table. The interest rates and the spread on overdraft loans among the five largest retail banks are extremely high: 9.33 and 7.17 percentage points. Even after controlling for the default rate, the spread is still 6.54 percentage points⁴. Unfortunately we do not have data to directly estimate how much of this spread is due to operational, fiscal and other costs. Estimates from the Central Bank indicate that, after decomposing the spread into these components, the spread is still around 2.97 percentage points per month. That is precisely why the problem at hand is interesting.

5.1 The Stickiness Equation

Tables 2 and 3 in appendix show the main results of the estimation of equation (1). In table 2, the model is estimated in percentage point changes. In table 3, in percent changes.

Results tables 2 and 3 show implication 1 has support in the data. The coefficients on the interaction effect confirm the interest rate on overdraft loans reacts more to increases than to decreases in the cost of funds. This result is fairly robust to different specifications.

Start with the results in table 2, column (4). In this specification, the error term in (1) is modeled as an AR(1). One quarter of a percentage point increase in cost of funds is associated with roughly a 0.37 percentage point increase in interest rate in overdraft loans.⁵ A decrease of the same magnitude, on the other hand, is associated with only a 0.21 percentage point decrease. The difference is significant at the 5% level.

The theory, narrowly interpreted, predicts that a decrease in cost of funds should not have an effect on overdraft interest rates. Here we estimate that the response is asymmetric, but not a zero response for decreases in cost

⁴This figure comes from multiplying 7.17 (the spread) by $(1 - 0.0834) = 0.09166$.

⁵A quarter of percentage point is roughly a quarter of the standard deviation in cost of fund. See table 1 above. The number 0.37 percentage points comes from multiplying the sum of the coefficients on $1(\Delta cf_t > 0) \times \Delta cf_t$ ($0.83 + 0.67$) by 0.25.

of funds. Clearly, there are other forces at work in determining overdraft interest rates. There is, for example, some evidence that, from time to time, banks use overdraft loans as loss-leaders, in which case the theory does not apply and interest rates should respond to decreases of cost of funds. See Banco Central do Brasil (1999, 2000, 2001, 2002, 2003). More importantly, the results show that, on average, overdraft interest rates do respond more to increases than to decreases in cost of funds.

The other columns of table present different models to assess the robustness of the estimates described above. When the structure is not imposed on the error term (no autocorrelation, columns (1) to (3)) the results are not as strong. However, the point estimates on the interaction term is always positive. The Durbin-Watson statistics on columns (1) to (3) indicate that, when the error term is not modeled as an AR(1) process, substantial serial correlation arise on the error term, indicating the structure imposed on the error is reasonable. The fact that significant serial correlation still arises when the r_{t-1} is included (column (2)) indicates r_{t-1} correlates with the error term. For this reason, the results in column (3) as the most interpretable ones.

The difference between columns (5) and (6) indicate that controlling for default rates does have an effect on estimates. In fact, after accounting for the effect of cost of funds on default rates, the asymmetry of responses of interest rates to cost of funds is even stronger.

Finally, table 3 shows the results when the units of measurement is percent changes. The results hold across the board. Across models, a 1% increase in cost of funds has a 0.28% higher effect than a 1% decrease in cost of funds. Incidentally, for the OLS models, the effect of a decrease in cost of funds is statistically zero, and economically small.

Graphs 1 and 2 show clearly that r and cf move up and down during the sample period. This means the asymmetry in the interest response is not driven by very few downward movement in cf relative to increases. Furthermore, the variation that allows us to estimate the whole response of interest rates to cost of funds is not restricted to very few movements in the cost of funds.

5.2 The Default Equation

Tables 4 and 5 present the results of the estimation of the default equation, by Ordinary Least Squares (OLS) and Instrumental Variables (IV), respectively. Here all observations are a bank at a point in time (month).

Tables 4 and 5 provide convincing evidence for implications 2 and 3. Start at table 4. The point estimates in columns (1), (2) and (3) indicate aggressiveness in pricing at a certain period has a negative effect on a bank's quality of loans. A decrease in the interest rate is tantamount to an increase in price aggressiveness. A percentage point decrease in the bank level interest rate (roughly 60% of the standard deviation of deviation from the mean) produces a 0.18 percentage point increase in a bank's default rate four months ahead (column (3)). Same is true for two and three months ahead (columns (1) and (2)). Given a median default rate of 1.70 percentage points, and a standard deviation of 1.63 for the deviation from the mean, this effect is practically significant. For the third and the fourth lags, the coefficient on deviation is estimated quite precisely: both are significant at the 5% level.

In table 5 contains the results from the IV estimation. We use two set of instruments. From the pricing equation (3), we have some instruments that provide exogenous variation to estimate the coefficients of the default equation (2) are: employment to branch ratio, labor expenses to assets and administrative costs to assets. These instruments contain mainly cost variation that, through the supply of loans, shift the bank specific interest rate. The identifying assumption is that borrowers do not take into consideration the number of employees, or the level of administrative costs, when choosing how much to borrow and, more importantly, when deciding whether or not to default on their debts. The second set of instruments comes from the dynamic nature of the data. Default rates are the proportion of loans delinquent for more than 15 days. Given this and the term on these loans (20 days), the contemporaneous overdraft interest rate and its first lag can be safely excluded from the default equation. Since there is persistence on the series of deviation from the mean rate, contemporaneous deviation from the mean and its first lag correlate with past lags. Therefore we use r_{nt} and r_{nt-1} as instruments for r_{nt-2} , r_{nt-3} and r_{nt-4} .

There are three important results in table 5. First, and foremost, the difference in the estimated coefficients from table 4 to table 5 goes precisely to the direction predicted by implication 3. For all three lags, the point

estimates increase significantly, and are now all significant at least at the 10% level. For example, the point estimate on the third lag r_{nt-3} goes from -0.17 percentage points to -0.28 percentage point, and the coefficient is significantly different from 0 at the 5% percent level. The coefficients on the fourth and second lags are generally similar, -0.24 and -0.30 , up from -0.17 and -0.18 , respectively. Second, the point estimates on price aggressiveness still increase for longer lags. Third, and opposite to the OLS estimates, with the IV procedure, the longer the lag the less precisely estimated the coefficients on price aggressiveness are. This is not surprising because the correlation with the instruments r_{nt} and r_{nt-1} is stronger for shorter lags.

Note that the first lag of the default is included all specifications. It is very significant statistically and its value is around 0.90 in all specification. Therefore, there is significant persistence in the default series and the theory itself predicts aggressiveness correlates with default. Excluding it would make the lags of interest rate pick up something that is only persistence in series of default rate. Furthermore, after including the lag of default, the error term in the default equation does no longer shows serial correlation (see the Durbin-Watson statistics at the bottom of tables 4 and 5). Therefore, we do not have to worry about consistency of the standard errors of the coefficients in this respect. Furthermore, the fact that error term does not appear to be serially correlated after including the first lag of of the default rate indicates that one does not have to be concerned about biases caused, with panel data, by the introduction of lags of the dependent variable as regressors.⁶

An important point is worth noting. Our specifications in tables 4 and 5 include a set of bank dummies and macroeconomic variables such as unemployment. This restricts significantly the amount of variation used to estimate the coefficients, since both pure cross-section and pure time series variation are thrown out. The variation left to estimate the coefficients is how the difference (between banks) in bank specific interest rates (r_{nt}) changes over time, and how the difference -also between banks - in marginal cost changes over time. Regarding the marginal cost instruments, there is some evidence that banks' marginal costs changed differently over time. The state-owned bank in the sample has, relatively to other banks, moved towards a larger scale, less costumer tailored type of service, taking even more advantage of economies of scale. On the other hand, the fifth and fourth largest

⁶This is equivalent to saying that the process for the error term is strictly exogenous. See Woldridge (2002) and Arellano & Bond (1991).

banks moved towards more personalized services. With respect to the lead instruments, pricing policies also appeared to have changed, with the state-owned bank becoming relatively more aggressive over the period. See Banco Central do Brasil (1999, 2000, 2001, 2002, 2003). The first stage R^2 from the IV regression is about 13% when only the marginal cost instruments are included, and it shoots up to 86% when the leads are included as instruments. This shows the instruments are correlated with the interest rates, and their variation, as explained above, is likely to be exogenous.

6 Conclusion

The adverse selection hypothesis is empirically relevant on the Brazilian market for overdraft loans. A decrease in the interest rate (relative to the market interest rate) of a particular bank by 1 percentage point is associated to with -0.28 percentage points increase in the default rate. The difference between the OLS and IV results confirm the endogeneity of the default rate, as the theory predicts, and the OLS results produce a bias exactly to the direction predicted by the theory. Furthermore, overdraft interest rates exhibit significant “downward bias”. These three results show that the three implications of the theory have support on the data. Therefore, this particular type of adverse selection is empirically relevant in explaining the pricing of overdraft loans in Brazil.

Far from being a complete explanation, these results do help to understand the extremely high spreads on Brazilian overdraft loans. The market outcome is collusive but the mechanism that produces it stems from private incentives, not cartelization. We estimate here the private incentives. Furthermore, they provide empirical support to an interesting theory relating informational problems with the strength of competition. Finally, and more importantly, they suggest a non trivial dynamics of competition in credit markets, which has implications for the competition authority. One should be cautious in interpreting high spreads as evidence of anti-competitive behavior. Reluctance in competing aggressively stems from the information structure, and not from the market structure or the conduct of market participants. This is not simply a semantic question, because the policy implications are different, even if the two stories produce the same collusive outcome.

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Descriptive Statistics

	Mean	Standard Deviation	Between Banks Standard Deviation	Median	N° of Observations
Interest Rates (% points monthly)	9.33	2.43	-	8.93	90
Cost of Funds (% points monthly)	2.16	0.93	-	1.77	90
ΔCost of Funds (% points monthly)	-0.08 1.61 if $\Delta cf > 0$ -1.09 if $\Delta cf < 0$	2.55 3.07 if $\Delta cf > 0$ 1.44 if $\Delta cf < 0$	-	-0.19 0.45 if $\Delta cf > 0$ -0.40 if $\Delta cf < 0$	89 33 if $\Delta cf > 0$ 56 if $\Delta cf < 0$
Deviation from the Market Rate (% points)	0	1.63	1.25	0.09	300
Default Rate (% points)	8.34	14.07	11.76	1.71	300

Table 1: Source: Banco Central do Brasil. For rows 1 to 3, time-series aggregate data. For rows 4 and 5, panel data for the 5 largest Brazilian Retail Banks.

Dependent Variable: Change in Market Level Overdraft Loans' Interest Rate Δr_t

	(1) OLS	(2) OLS	(3) OLS	(4) AR(1)	(5) AR(1)	(6) AR(1)
Δcf_t	0.98 (0.19)***	0.90 (0.21)***	1.05 (0.18)***	0.83 (0.20)***	0.96 (0.20)***	0.98 (0.16)***
$1(\Delta cf_t > 0) \times \Delta cf_t$	0.69 (0.43)*†	0.58 (0.44)*†	0.62 (0.46)*†	0.67 (0.35)**†	0.59 (0.37)*†	0.53 (0.34)*†
Δr_{t-1}	-	-0.28 (0.09)***	-	-	-0.05 (0.08)	-
Unemployment Controls?	Yes	Yes	No	Yes	Yes	No
N° Observations	84	84	89	83	83	88
Seasonal Dummies?	Yes	Yes	Yes	Yes	Yes	Yes
Durbin-Watson	2.96	2.63	2.88	2.20	2.13	2.07

Table 2: Source: Banco Central do Brasil. Aggregate time-series data used. Sample: January 1997 – June 2004. All variables in percentage points. Columns (4) to (6) are estimated by Feasible Generalized Least Squares (FLGS) with AR(1) error term. Standard error in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. † = one-sided test

Dependent Variable: Change in Market Level Overdraft Loans Interest Rate Δr_t

	(1) OLS	(2) OLS	(3) AR(1)
$\Delta cf_t / cf_{t-1}$	0.14 (0.19)	0.12 (0.16)	0.17 (0.09)*
$1(\Delta cf_t > 0) \times \Delta cf_t / cf_{t-1}$	0.30 (0.22)*†	0.33 (0.19)**	0.24 (0.11)**
Δr_{t-1}	-	-0.29 (0.11)**	-
Unemployment Controls?	Yes	Yes	Yes
N° Observations	84	84	83
Seasonal Dummies?	Yes	Yes	Yes
Durbin-Watson	2.80	2.34	2.10

Table 3: Source: Banco Central do Brasil. Aggregate time-series data used. Sample: January 1997 – June 2004. Percent changes in cost of funds and overdraft interest rates. Columns (3) is estimated by Feasible Generalized Least Squares (FLGS) with AR(1) error term. Standard error in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. † = one-sided test

Dependent Variable: Bank Level Default Rate D_{nt}

	(1) OLS	(2) OLS	(3) OLS
Constant	0.24 (1.21)	0.15 (1.24)	-.39 (1.21)
D_{nt-1}	0.93 (0.05)***	0.92 (0.06)***	0.92 (0.06)***
r_{nt-2}	-0.16 (0.11)	-	-
r_{nt-3}	-	-0.17 (0.08)**	-
r_{nt-4}	-	-	-0.18 (0.07)***
N° Observations	295	290	285
Activity Controls?	Yes	Yes	Yes
Firm Dummies?	Yes	Yes	Yes
Durbin-Watson	2.00	2.04	2.04

Table 4: Source: Banco Central do Brasil. Panel data on five largest Brazilian Retail Banks used. All variables in percentage points. Robust Standard Error in parentheses. Cross-section independence assumed. . * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level.

Dependent Variable: Bank Level Default Rate D_{nt}

	(1) IV	(2) IV	(3) IV
Constant	0.45 (1.07)	0.15 (1.24)	-0.00 (1.90)
D_{nt-1}	0.92 (0.07)***	0.91 (0.07)***	0.92 (0.08)***
r_{nt-2}	-0.24 (0.11)**	-	-
r_{nt-3}	-	-0.28 (0.13)**	-
r_{nt-4}	-	-	-0.30 (0.18)*
N° Observations	295	290	285
Activity Controls?	Yes	Yes	Yes
Firm Dummies?	Yes	Yes	Yes
Durbin-Watson	2.00	2.03	2.00

Table 5: Source: Banco Central do Brasil. Panel data on five largest Brazilian Retail Banks used. All variables in percentage points. Robust Standard Error in parentheses. Instruments: employees/branch ratio, leads of deviation from mean rate. Cross-section independence assumed. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level.