Exploring the Brazilian high and dispersed loan interest rates: a search cost estimation approach

Julia P. Araujo[1]

ABSTRACT: Rather than an exception, price dispersion seems to be the norm in most markets. One of the possible reasons that breaks *the law of one price* concerns heterogeneities in consumers search costs associated with discovering the lowest priced firm. This article addresses the extent of search costs in explaining the high and disperse loan interest rates observed in the Brazilian credit market. The model and estimation procedure are based on Moraga-González and Wildenbeest (2008). The database consists of weekly bank-level data on annual interest rates of five credit loan products between 2014 and 2016. The article results are in accordance with the existing literature. There is a significant gain in being fully informed in this economy. Consumers seem grouped into three major behavior patterns: (i) some consumers have significantly higher search costs and buy at the first visited firm, paying the monopoly price; (ii) another group do some information-gathering before deciding from which bank they will borrow from, but only looking in a small sample of price quotations, reflecting an intermediate cost of searching; (iii) the remaining consumers have fairly small search costs and are willing to quote prices in all firms, as in a perfect competition scenario.

Keywords: loan interest rates; search cost; price dispersion; structural estimation

RESUMO: Ao invés de mera exceção, a dispersão dos preços parece ser a norma na maioria dos mercados. Uma das possíveis razões que quebram a lei do preço único diz respeito a heterogeneidades nos *search costs* dos consumidores associados à descoberta da empresa com o menor preço. Este artigo busca compreender como *search costs* explicam as altas e dispersas taxas de juros de empréstimos observadas no mercado de crédito brasileiro. O modelo e o procedimento de estimação baseiam-se em Moraga-González e Wildenbeest (2008). A base de dados consiste em dados semanais a nível bancário sobre taxas de juro anuais de cinco produtos de empréstimo entre 2014 e 2016. Os resultados do artigo estão de acordo com a literatura existente. Há um ganho significativo em se estar plenamente informado nesta economia. Os consumidores parecem agrupados em três grandes padrões de comportamento: (i) alguns consumidores possuem *search costs* significativamente maiores e compram na primeira empresa visitada, pagando o preço de monopólio; (Ii) outro grupo recolhe algumas informação antes de decidir de qual banco eles irão tomar um empréstimo, mas apenas olhando em uma pequena amostra de cotações de preços, refletindo *search costs* intermediários; (Iii) os consumidores restantes possuem *search costs* bastante pequenos e estão dispostos a cotar preços em todas as empresas, como em um cenário de concorrência perfeita.

Palavras-chave: taxa de juros de empréstimo; *search cost*; dispersão de preços; estimação estrutural

JEL: D83; E43; C14

Área 6: Macroeconomia

[1] PhD student, Department of Economics, University of São Paulo, Brazil. E-mail: julia.araujo@usp.br.

1 Introduction

Price dispersion of otherwise homogeneous goods is widely observed in many markets. One of the possible reasons that breaks *the law of one price* concerns heterogeneities in consumers search costs associated with discovering the lowest priced firm. When uninformed individuals costly search for a better deal, firms have the incentive to systematically charge prices above their marginal costs, granting them with market power. Therefore, price dispersion often arise as a common equilibrium result.

The Brazilian banking system presents a strong and persistent dispersion of loan interest rates charged across different institutions, see also Nakane and Koyama (2003). For instance, according to data on interest rates available on the Brazilian Central Bank (BCB) homepage website, the annual rate on personal overdraft loans roughly ranges from 10% up to almost 600% (average 2014-2016). Other credit categories also exhibit a significant price dispersion. Although uncountable factors may be behind this significant price dispersion, such as market concentration or product differentiation, this paper propose a search cost approach to evaluate and clarify such feature.

To understand the impacts of search costs in the Brazilian banking market I used a model and estimation procedure based on Moraga-González (2008). The model assumes a continuum of consumers demanding one unit of a homogeneous good supplied by a finite number of firms operating under identical marginal costs. Each individual has a search cost associated with discovering the lowest price after quoting an optimal number of firms. Equilibrium restrictions are set in a structural maximum likelihood estimation problem with nonlinear constraints.

The database consists of weekly data on five loan interest rates categories between years 2014 and 2016. I considered five fixed-rate loan categories to collect data from, being two for personal loans: (i) overdraft; (ii) loans to finance other goods ; and three for corporate loans: (i) overdraft; (ii) vendor; (iii) discount of promissory notes. In this approach, only observed price dispersion is needed to recover the search cost distribution. This is especially useful since price data is widely available, while quantities supplied or demanded are not. Also no parametric assumption needs to be previously made.

The article results are in accordance with the existing literature. There is a significant gain in being a fully informed consumer. As also find in Moraga-González and Wildenbeest (2008), three major behavior groups emerge: (i) some consumers have significantly higher search costs and buy at the first visited firm, paying the monopoly price. All consumer's surplus is extracted; (ii) another group do some information-gathering before deciding from which bank they will borrow from, but only looking in a small sample of price quotations, reflecting an intermediate cost of searching; (iii) the remaining consumers have fairly small search costs and are willing to quote prices in all firms, paying the perfect competition price.

Consumers cannot always correctly identify stores that charge low prices, thus making

differences in observed prices to be expected to persist. Varian (1980) celebrated article recognizes that the *the law of one price* can be no law, since most retail markets exhibits a large degree of price dispersion. In fact, price dispersion seems rather to be norm than an exception in most markets. Although this is an important feature, little has been done to understand it, specially using Brazilian data.

Stigler (1961) presents a pioneer approach regarding the rationale behind price dispersion through search models. Other studies on search costs are Burdett and Judd (1983), Stahl (1989), Baye and Morgan (2001), Janssen and Moraga-González (2004), Hong and Shum (2006) and Wildenbeest (2011). Some models focus on spatial price dispersion [see Varian (1980)]. At a certain instant, firms charge different prices, but their distribution is invariant over time. An alternative approach emphasizes the temporal dimension of price dispersion [see Lach (2002) for its persistence].

The literature of industrial organization models on price dispersion covers a wide set of markets in different countries, such as groceries [Lach (2002) in Israel, Caglayan, Filiztekin, and Rauh (2008) in Turkey and Wildenbeest (2011) in the UK], electronics [Baye, Morgan, and Scholten (2004) for online sales in the US and abroad and Gatti and Kattuman (2003) for several Europeans countries], books [Hong and Shum (2006) in the US and Ancarani and Shankar (2004) in Italy] and airlines [Borenstein and Rose (1991) in the US]. Concerning the financial market, see Hortaçsu and Syverson (2003) for S&P 500 data.

Regarding the Brazilian credit loan market, Nakane (2003) argues of no consistent evidence of monopoly power in the banking structure. The market sets somewhere between perfect competition and oligopolies. Whilst not a monopoly, market concentration positively affects loan rates and interest spreads in the Brazilian banking system, see Alencar et al. (2013). Nakane and Koyama (2003) document the importance of search cost in the observed dispersion of lending rates in Brazil. The authors also identify high dispersion across loan categories and through time.

Following this introduction, the remainder of the article proceeds as follows. The theoretical model is presented on the next section, followed by a succinct description of the estimation procedure and database. Section 5 presents the estimation of search costs by maximum likelihood. At last, Section 6 concludes.

2 Model

The model is broadly based on Hong and Schum (2006), Moraga-González and Wildenbeest (2008) and Sanches, Silva-Junior and Srisuma (2016). All authors propose a similar base model to structurally estimate the presence of search costs in markets of homoge-

neous goods using only observed price distribution data[1].

2.1 Demand side

There is a continuum of imperfectly informed consumers in this economy. Consumer search costs are associated with the onus of discovering a given firm's price. The search strategy adopted will be non-sequential. They buy from the cheapest firm after searching through a random sample of $k \geq 1$ prices. Non-sequential search strategies are fixed sample size based and consumers commit to a number of searches before entering the market. There are homogeneous sampling probabilities over each firm. Define the marginal expected savings from searching k stores rather than $k+1$ as:

$$\Delta_k = E(p_{1k}) - E(p_{1k+1})$$

Where p_{1k} is the lowest price out of k search trips, i.e., $E(p_{1k}) = E[min(p : k \text{ draws})]$. Consumers draw prices from the same continuous cumulative distribution function of prices $F_p(p)$, which is *i.i.d.* and has a density function given by $f_p(p)$. Then:

$$Prob(p_{1k} \leq p \in \Re) = Prob[min(p : k \text{ draws}) \leq p]$$

$$Prob(p_{1k} \leq p \in \Re) = 1 - Prob[min(p : k \text{ draws}) > p]$$

$$Prob(p_{1k} \leq p \in \Re) = 1 - [1 - F_p(p)]^k$$

Therefore:

$$E(p_{1k}) = \int_{\underline{p}}^{\overline{p}} pk[1 - F_p(p)]^{k-1} f_p(p) dp$$

Where $\underline{p}$ and $\overline{p}$ denote the lower and upper bound in the support of $F_p(p)$, respectively. Also $0 < \underline{p} < \overline{p} < \infty$. Integrating by parts:

$$\int_{\underline{p}}^{\overline{p}} pk[1 - F_p(p)]^{k-1} f_p(p) dp = [-(1 - F_p(p))^k p]\Big|_{\underline{p}}^{\overline{p}} + \int_{\underline{p}}^{\overline{p}} [1 - F_p(p)]^k dp$$

Note that $\overline{p}$ can be seen as the consumer valuation of the good, the maximum amount she is willing to pay for it. Because $[1 - F_p(\overline{p})] = 0$ and $[1 - F_p(\underline{p})] = 1$, the first part reduces to only $\underline{p}$:

[1] See Wildenbeest (2011) for search cost with vertically differentiated products. Hortaçsu and Syverson (2003) and Grossman and Shapiro (1984), Brynjolfsson, Dick and Smith (2004) present similar approaches. Also see Blevins and Senney (2014) for a dynamic version of this model.

$$E(p_{1k}) = \underline{p} + \int_{\underline{p}}^{\bar{p}} [1 - F_p(p)]^k dp$$

Therefore $\underline{p}$ is the perfect competition market price and $\int_{\underline{p}}^{\bar{p}} [1 - F_p(p)]^k dp$ is the mark-up charged above it, a non-negative and non-increasing convex function of k. Consumers have to costly search for p_j. The consumer's i demand is inelastic for a single unit of the good. Her utility from sampling through k firms is then set as follows:

$$U_{ik} = -E_{p1k} - kc_i$$

Where c_i is the individual-specific search cost. There is a positive cost of obtaining each additional price quote. This is the so called "*shoe-leather cost*", which accounts for the consumers opportunity cost of searching between firms[2]. This is observed by the consumer, but not by the econometrician, which suppose $c_i \overset{iid}{\sim} G(c)$ with support $]0, \infty[$ and positive density $g(c)$. This heterogeneity in consumer's search costs will generate price dispersion.

The agent seeks to maximize her utility based on an optimal search behavior. Consumers weigh the cost of searching an additional firm against the expected benefit of doing so. An individual searches k times if the expected utility is higher than searching $k-1$ or $k+1$ times. If k solves the consumer's problem, then:

$$U_{ik} \geq U_{ik+1} \text{ and } U_{ik} \geq U_{ik-1}$$

$$-E_{p1k} - kc_i \geq -E_{p1k+1} - (k+1)c_i \text{ and } -E_{p1k} - kc_i \geq -E_{p1k-1} - (k-1)c_i$$

$$c_i \geq E_{p1k} - E_{p1k+1} = \Delta_k \text{ and } c_i \geq E_{p1k-1} - E_{p1k} = \Delta_{k-1}$$

Because $E(p_{1k})$ is a non-increasing and convex function on k, $-E(p_{1k})$ is concave and there is a single maximum value for this maximization problem. The consumer searches k times if her cost lies between $\Delta_k \leq c_i \leq \Delta_{k-1}$. Consumers cannot distinguish firms in terms of expected prices. They randomly search among them, choosing the optimal sample size to do it. Notice that Δ_k can also be interpreted as the search cost of the consumer indifferent between sampling $k+1$ or k prices. The share $q_k \in [0,1]$ of consumers sampling through exactly k firms, or alternatively, the probability that a consumer searches k firms is set as:

$$\text{Prob[consumer } i \text{ searches } k \text{ times]} = q_k = Prob[\Delta_k \leq c_i \leq \Delta_{k-1}] = G(\Delta_{k-1}) - G(\Delta_k)$$

Expanding for each q_k:

[2]The first price quote is obtained at no cost, as is widely considered in the literature.

$q_1 = 1 - G(\Delta_1)$ - share of consumers searching only one price

$q_2 = G(\Delta_1) - G(\Delta_2)$ - share of consumers searching two prices

$q_3 = G(\Delta_2) - G(\Delta_3)$ - share of consumers searching three prices

...

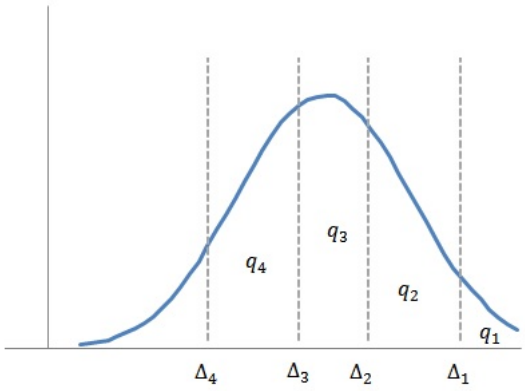


Figure 1: Partition of all consumers into subsets q_k

Figure 1 illustrates the regions limiting each partition of the set of consumers into their optimal sampling behavior. The highlighted areas measure the fraction of agents who obtain one, two, three or four different price quotes before deciding on the purchase. This parametrization will be essential to recover the quantiles associated with the consumers search cost distribution.

The partition of the space regarding the search trips made by every consumer, q_k, assures a strictly positive fraction of all sampling possibilities, i.e., $q_k > 0$ with k being an integer. Given firms optimal behavior, the number of price quotes k a consumer obtain, constrained by her search cost of c per visited firm, must be optimal:

$$k(c) = \arg\min_{k>1} c(k-1) + \int_{\underline{p}}^{\bar{p}} pk[1 - F_p(p)]^{k-1} f_p(p)dp$$

2.2 Supply side

There are N firms indexed by j supplying the same homogeneous good. They all have the same marginal cost denoted by r. [3]. r is common knowledge. Firm's strategy space has only one dimension, namely price. Firms can set higher prices exploiting the fact that some consumers choose where to buy their product at random. All firms are ex-ante identical in terms of expected price. Given q_k, profits therefore are set as:

[3]Is worth notice that, as noted in Hong and Schum (2006), heterogeneity in r cannot, per se, generate price dispersion in equilibrium.

$$\pi(p; F_p(p)) = (p - r) \left\{ \prod_{k=1}^{N} \frac{q_k k}{n} [1 - F_p(p)]^{k-1} \right\}$$

This must hold for all $p \in [\underline{p}; \overline{p}]$[4].

2.3 Equilibrium

The equilibrium is set in mixed strategies played at the price dimension. All sellers choose a price that maximizes their expected profit given consumers' behavior and their beliefs regarding their opponents moves. If consumers search only once (q_1), firms set price at the monopoly level. If consumers search through all N firms, prices are set as in a perfect competition scenario, as in a Bertrand equilibrium. When establishing $\overline{p}$ firms charge exactly how much the consumer evaluates its good.

Firms are indifferent between payoffs generated by choosing any $p \in [\underline{p}; \overline{p}]$. In particular, they are indifferent between p and $\overline{p}$. Therefore, the symmetric Nash mixed strategy equilibrium distribution must satisfy:

$$(p - r) \sum_{k=1}^{N} \frac{q_k k}{N} [1 - F_p(p)]^{k-1} = (\overline{p} - r) \frac{q_1}{N}, \quad \text{for any } p \in [\underline{p}; \overline{p}]$$

From the equation above is possible to recover the search cost distribution $G(c)$ through the equilibrium price distribution $F(p)$ alone. Note that there are $N-1$ restrictions, since $q_k \in [0, 1]$ has $\sum_{i=1}^{k} q_k = 1$, so only $N-1$ fractions need to be estimated. Therefore, there is a system of $N - 1$ equations from which K unknowns parameters will be estimated $(r, \tilde{q}_1, \tilde{q}_2, ..., \tilde{q}_{K-1})$. The obtained values for $\tilde{q}_1, \tilde{q}_2, ..., \tilde{q}_{K-1}$ will be used to solve for $G(\Delta_1)$, $G(\Delta_1)$,...,$G(k-1)$. Also notice that the minimum price $\underline{p}$ and marginal cost r are given by:

$$\underline{p} = \frac{q_1(\overline{p} - r)}{\sum_{k=1}^{N} k q_k} + r \qquad r = \frac{\underline{p} \sum_{k=1}^{N} k q_k - q_1 \overline{p}}{\sum_{k=2}^{N} k q_k}$$

Equilibrium profits are equalized between firms. Supply-demand restriction are sufficient to recover search cost estimates using only observed price dispersion.

[4]The profit function has a straightforward interpretation: $(p - r)$ is the mark-up and $\prod_{k=1}^{n} \frac{q_k k}{N} [1 - F_p(p)]^{k-1}$ refers to the expected quantities sold considering all $k \in [1; N]$ possibilities.

3 Estimation procedure

The structural model presented in the previous section will be estimated using only price data, following the steps of Moraga-González and Wildenbeest (2008). The authors propose a maximum likelihood (ML) estimator to search costs[5]. The focus is on estimating $\{\Delta_k, q_k\}$ for $k \in [1, N]$. There are N firms at this economy in t sampling periods of time. They play a stationary repeated game of finite horizon.

The cutoff points Δ_k will be recovered based on the estimated price distribution parameters.

$$\Delta_k = \int_{\underline{p}}^{\overline{p}} p[(k+1)F_p(p) - 1](1 - F_p(p))^{k-1} f_p(p)dp \ , \quad k = 1, 2, ...N - 1$$

Which integrating by parts yields: $\Delta_k = \int_{\underline{p}}^{\overline{p}} F_p(p)(1 - F_p(p))^k dp \ , \quad k = 1, 2, ...N - 1.$

The inverse function $F_p(p)^{-1}$ exists since $F(p)$ is monotonically increasing in prices. Therefore using a change of variable:

$$p(z) = \frac{q_1(\overline{p} - r)}{\sum_{k=1}^{N} k q_k (1 - z)^{k-1} dz} \ , \quad k = 1, 2, ...N - 1$$

Which is equivalent to:

$$\Delta_k = \int_0^1 p(z)[(k+1)z - 1](1 - z)^{k-1} dz \ , \quad k = 1, 2, ...N - 1$$

Tests of the significance of each parameter are straightforward based on standard asymptotic theory, see Moraga-González and Wildenbeest (2008). Consider the sequence of prices $p_1, p_2, \ldots, p_N$ ordered as $p_1 \leq p_2 \leq \ldots \leq p_N$ without loss of generality. In this ascending order, the minimum observed price p_1 can be consistently used to estimate $\underline{p}$ in the same matter as p_N to $\overline{p}$. They super-consistently converge to the true values of the edges of the price distribution support.

$$\widehat{\underline{p}} = p_1 \leq p_2 \leq ... \leq p_{N-1} \leq p_N = \widehat{\overline{p}}$$

The problem then reduces to the following maximum likelihood estimation problem:

$$\max_{\{q_k\}} \sum_{l=2}^{N-1} log f_p(p_l; q_1; , q_2, ..., q_N)$$

[5]See also Hong and Shum (2006) for a empirical likelihood estimation (MEL) and Sanches, Silva-Junior and Srisuma (2016) for a minimum distance (MD) estimation approach.

Where by the implicit function theorem:

$$f_p(p) = \frac{\sum_{k=1}^{N} k q_k (1 - F_p(p))^{k-1}}{(p - r) \sum_{k=1}^{N} k(k-1) q_k (1 - F_p(p))^{k-2}}$$

And $F_p(p_l)$ solves the profit indifference condition of all firms in a symmetric Nash mixed strategy equilibrium:

$$(p - r) \sum_{k=1}^{N} \frac{q_k k}{N} [1 - F_p(p)]^{k-1} = (\overline{p} - r) \frac{q_1}{N}, \quad \text{for all } l - 2, 3, ..., N - 1$$

4 Data

The Brazilian credit market is somewhat unique in comparison with other countries. Numerous articles aim to address what may determine the high level of loan interest rates observed, see, for instance, Koyama and Tonooka (2003), Costa and Nakane (2004) and Bignotto and Rodrigues (2006). Not only the Brazilian interest rates are high, but the dispersion is quite large, see Nakane and Koyama (2003).

Figure 2 presents the relationship between GDP per capita (current US$) and credit lending rates (% per year) in 2015. Brazil presents itself as an outlier, with much higher rates compared to its peers and other countries. In the 2015 ranking Brazil figured in third place of higher lending rates.

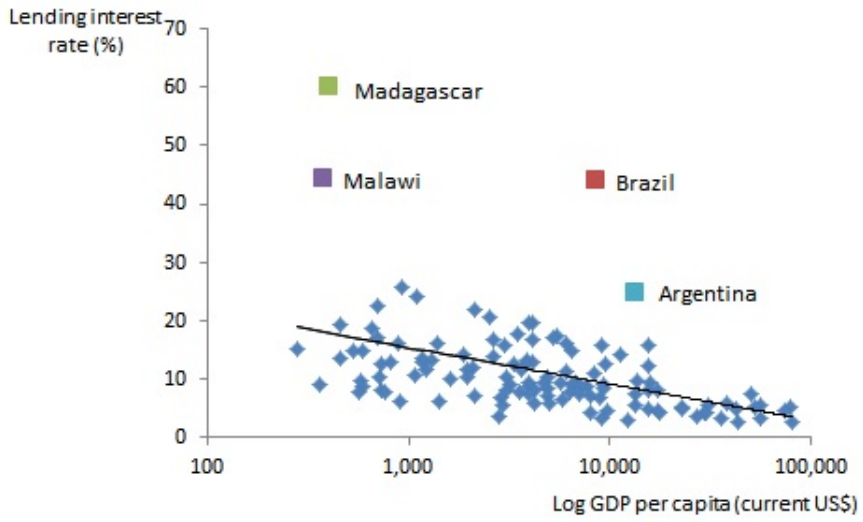


Figure 2: GDP and lending rates

A BCB legislation from October 1999 established rules whereby financial institutions must provide information about their credit operations - such as volumes of new loans, fees and interest rates - to the Central Bank in an attempt to increase transparency and competition in the market. Despite the 1999 legislation, loan rates dispersion and high levels persist until the present day.

This paper database consists of bank-level average annual interest rates on five different types of credit categories. All data was extracted from the BCB website homepage[6]. Banks self-report this information. I collected weekly based data from 2014 to 2016. For each credit product, every week has to be individually extracted. I considered five fixed-rate loan products to collect data from, being two for personal loans: (i) overdraft; (ii) loans to finance other goods ; and three for corporate: (i) overdraft; (ii) vendor[7]; (iii) discount of promissory notes. Each product is a separate market in its own way. Figure 3 presents the histogram for each product.

Table 1 summarizes the database. The temporal dimension comprehends 156 weeks. The cross-section length changes according to each different loan category in an unbalanced panel. Loan interest rates observations reported as at zero on annual basis were dropped. Other outliers were also dropped. The sample is subject to other non-captured errors, although its size, with thousands of observation points, should help minimize any bias implied by incorrectly reported data.

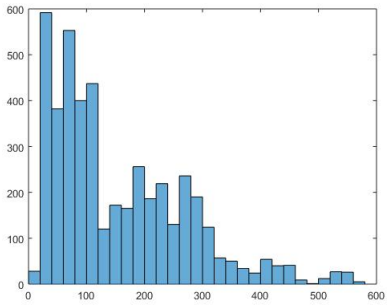
	Personal		**Corporate**		
Loan categories	Overdraft	Other goods	Overdraft	Vendor	Promissory notes
Total no. of banks	36.0	37.0	20.0	17.0	52.0
Mean no. of banks	28.4	28.5	16.7	12.8	41.9
Max no. of banks	31.0	36.0	19.0	16.0	46.0
Min no. of banks	24.0	22.0	14.0	10.0	36.0
Total no. of observations.	4,570	4,444	2,751	1,996	6,532
Max price(%)	565.7	189.3	369.8	46.1	91.9
Min price (%)	11.5	13.9	36.0	8.0	9.4
Mean price (%)	155.8	72.3	172.7	22.2	38.1
Median price(%)	112.1	66.9	149.2	20.0	36.5
Std. deviation(%)	116.3	33.7	93.6	8.5	13.2
Coef. variation (%)	74.7	46.6	54.2	38.1	34.7

Table 1: Summary statistics

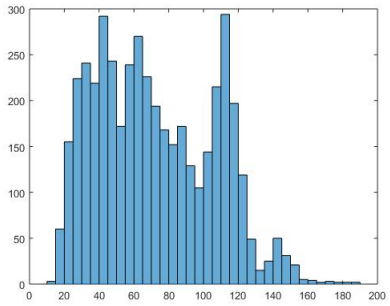
An agent looking for a loan faces many options regarding financial institutions counterparts. For instance, there are 28.4 banks to search in average for personal overdraft loans.

[6]Baye, Morgan, and Scholten (2004) argue that the internet, although its importance on declining consumers search costs, will not ultimately lead to the law of one price. The overwhelming empirical evidence still accounts for the presence of search costs even in online search, where the cost of an additional "mouse click" seems almost insignificant.

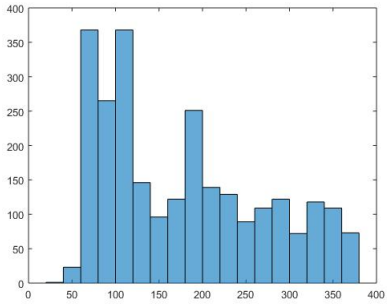
[7]Vendor financing is a product that allows producers to receive in advance for their sales, not following the sell contract maturity, number of installments and other specifications.



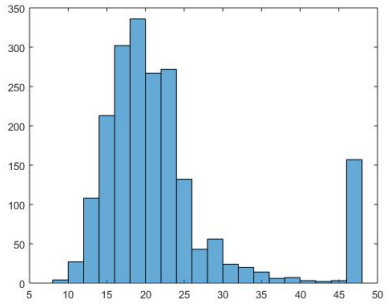
(a) Personal - overdraft



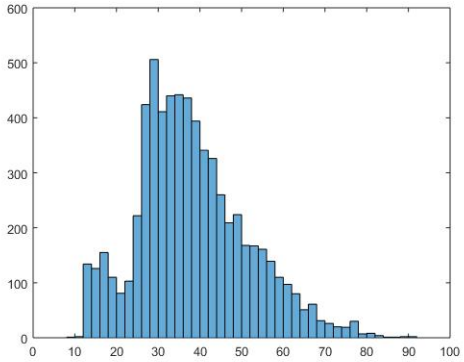
(b) Personal - finance other goods



(c) Corporate - overdraft



(d) Corporate - vendor



(e) Corporate - discount of promissory notes

Figure 3: Histogram

For corporate vendor, there are 12.8 options in average. In the five categories considered here, discount of promissory notes presents the highest number of firms to quote, 41.9 in average. The maximum and minimum number of banks to search loan rates at every period also change according to different categories of credit. Note that although the number of firms to quote prices is relatively high, at least 10 in vendor, there is a significant dispersion in charged loan interest rates.

Depending on the considered product, the loan interest rate may exhibit a quite high dispersion. The coefficient of variation - defined as the ratio of the standard deviation to

the series mean $\left[CV = \frac{\sigma}{\mu}\right]$ - is 54.2% for corporate overdraft and 34.7% for discount of promissory notes, for instance. In personal overdraft, the interest rate ranges from 11.5% to 565.7%, with mean 155.8% and median at 112.1%. This credit category exhibits the highest coefficient of variation, 74.7%.

Finally it is important to note that not all lending rates are observed at all periods of time. Moraga-González and Wildenbeest (2008) conduce Monte Carlo studies and show that this does not introduce a significant bias to the estimation. This is important here since banks self-report their lending rates, but there is no legal mechanism that completely enforce them to, thus turning absent financial institutions data very likely to be present.

5 Estimation results

The estimation follows directly the procedure presented in Moraga-González and Wildenbeest (2008). Table 2 presents the results regarding $[\underline{p}, \overline{p}, q_1, q_2, \ldots q_N, r]$. Estimated standard errors are shown in parenthesis. Recall that $\overline{p}$ is equivalent to the monopoly price, set when consumers buy from the one and only first visited firm and is equal to their valuation v.

The estimation of sampling quotes probabilities suggest important similarities. Note that although different in many dimensions, there is evidence of some source of common pattern in all loan categories. Agents quote prices in one, two or maximum three banks, or otherwise visit all institutions to search for the lowest price. Consumers acquiring any of these credit products likely have a similar search cost distribution. The exception is in personal overdraft, where a fraction of consumers also visit five banks[8].

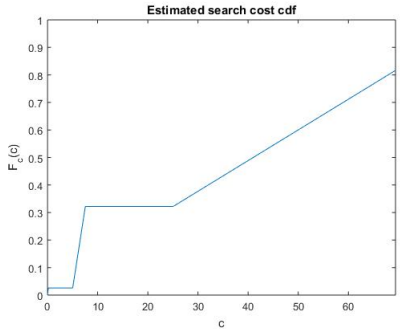
It is interesting to note that this homogeneous behavior seems consistent considering either personal or corporate loans, albeit all inherent differences observed in each type of loan. The estimates of the share of consumers who search only once, q_1, is significant in all estimations, indicating the presence of high search costs. This type of consumer may be loyal to a particular bank, choosing the financial institution where they already have their main checking account in, not looking for a possible better deal. This share is as high as 40% in overdraft loans for companies and is only 18% for the same household product. The share q_N is significant in all categories as well. Some consumers have low search costs and quote every bank's price. See Figure 4 for the estimated search cost distributions.

Table 2 also reports the results of a Kolmogorov-Smirnov goodness-of-fit test (KS-test). The test basically investigates if the real observed prices are possibly drawn from the estimated price distribution function obtained from the theoretical model and its restrictions. By comparing the empirical cumulative distribution (cdf) of prices with the one

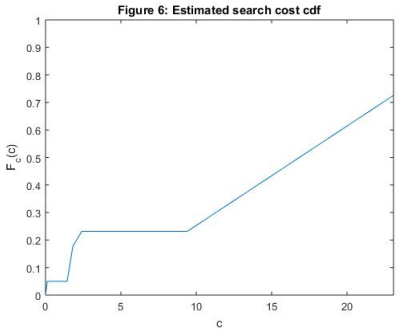
[8]Note that other shares, as q_6 and q_7 in personal loans to finance other goods, are not significant. This confirms that consumers apparently have high or low search costs

	Personal		**Corporate**		
Loan categories	Overdraft	Other goods	Overdraft	Vendor	Promissory notes
$\underline{p}$ (%)	11.46	13.92	36.00	8.04	9.44
$\overline{p}$ (%)	565.70	189.31	369.82	46.05	91.93
Total no. of banks	36	37	20	17	52
Total no. of obs.	4,570	4,444	2,751	1,996	6,532
q_1	0.18 (0.02)	0.27 (0.02)	0.40 (0.04)	0.30 (0.005)	0.28 (0.005)
q_2	0.49 (0.05)	0.49 (0.03)	0.23 (0.06)	0.54 (0.01)	0.52 (0.005)
q_3	0.00	0.00	0.33 (0.09)	0.00	0.00
q_4	0.00	0.00	0.00	0.00	0.00
q_5	0.30 (0.05)	0.00	0.00	0.00	0.00
q_6	0.00	0.05 (0.11)	0.00	0.00	0.00
q_7	0.00	0.13 (0.11)	0.00	0.00	0.00
.	.	.	.	.	.
.	.	.	.	.	.
q_{10}	.	.	.	.	0.01 (0.01)
.	.	.	.	.	.
q_{25}	.	.	.	.	0.02 (0.29)
q_{26}	.	.	.	.	0.10 (0.29)
.	.	.	.	.	.
q_N	0.03 (0.01)	0.05 (0.02)	0.04 (0.01)	0.17 (0.01)	0.08 (0.01)
r	18.49 (3.61)	2.06 (1.20)	25.24 (8.39)	5.20 (0.02)	6.54 (0.11)
LL	27089.66	21865.26	14871.66	5815.33	26299.54
KS	3.59	6.71	3.92	4.57	7.72

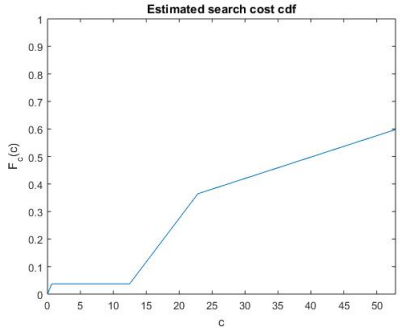
Table 2: Estimation results



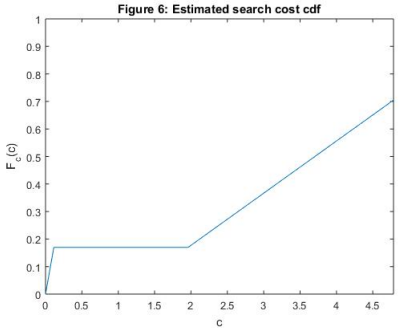
(a) Personal - overdraft



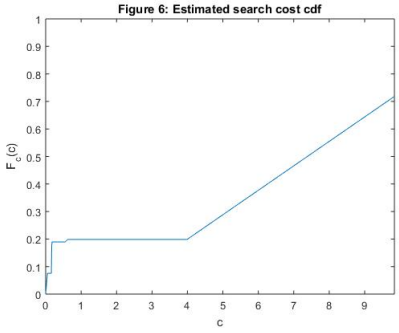
(b) Personal - finance other goods



(c) Corporate - overdraft



(d) Corporate - vendor

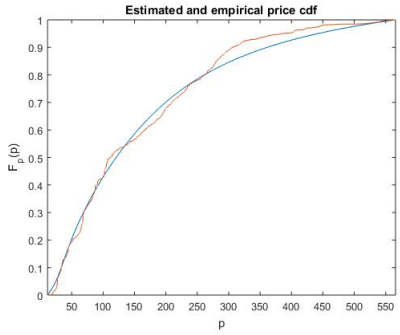


(e) Corporate - discount of promissory notes

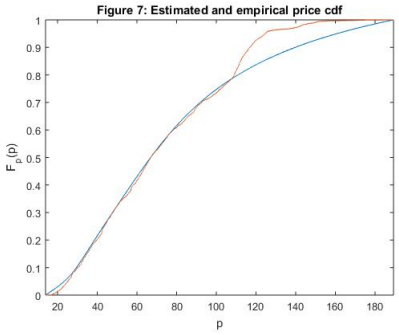
Figure 4: Estimated search cost distributions

structurally estimated through the model it is possible to reject the null hypothesis, there is some divergence between the simulated model and the data. Other aspects are behind the high observed price dispersion, with search costs being one of them. See Figure 5 for the estimated and empirical price distributions. The blue line is distribution obtained within the model, while the red is the empirical.

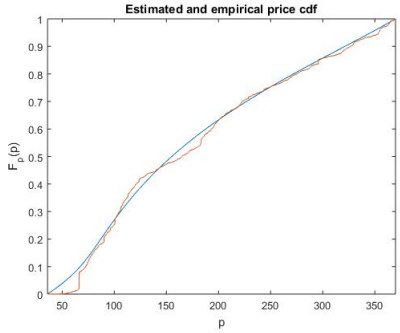
Starting with a maximum N firms operating in each credit category, it is also possible to estimate $the\Delta_i$ cut-off points of the search cost distribution. These values are presented Appendix A. Estimated standard errors are then again shown in parentheses. All Δ_i are significant. Combining Δ_i and q_k is possible to infer that for the relation of search costs



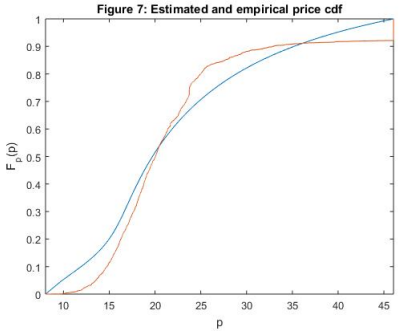
(a) Personal - overdraft



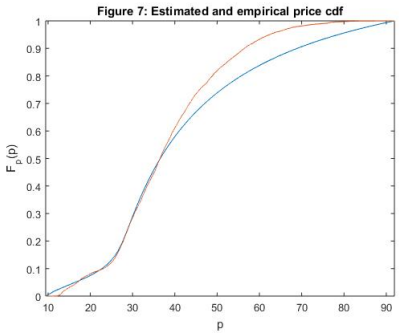
(b) Personal - finance other goods



(c) Corporate - overdraft



(d) Corporate - vendor



(e) Corporate - discount of promissory notes

Figure 5: Estimated and empirical price distributions

and shares of quoting firms. For instance, in personal overdraft loans, 18% of consumers have a search cost of 69.4% $[\Delta_1; q_1]$ and for 3% of them the search cost is at most in 0.16%.

Finally is worth noticing that credit products may not be as homogeneous as we might think. Banks provide a certain type of loan, but they can differ in value added to this service. Some examples may be the quality of their customer attendance, spatial location of stores, firm reputation, among others. In this case a model with differentiated products would seem more appropriate. Wildenbeest (2011), for instance, propose a structure of search with vertically differentiated products.

6 Final remarks

Price dispersion is consistently observed in many markets. A group of reasons may justify such empirical fact. This article addresses consumers search costs associated with quoting prices. Uninformed consumers costly look for the lowest priced firm, which translate into market power and heterogeneous prices for the same homogeneous good. Based on a model and estimation procedure presented in Moraga-González and Wildenbeest (2008), this article analyses the extent of search costs in the Brazilian credit market. Loan interest rates in Brazil are not only high but they also exhibit a significant dispersion across financial institutions.

The database consists of weekly data on five loan interest rates categories. Banks self-report this information and data is public available on the BCB homepage website. I considered five fixed-rate loan categories to collect data from, being two for personal loans: (i) overdraft; (ii) loans to finance other goods ; and three for corporate: (i) overdraft; (ii) vendor; (iii) discount of promissory notes. The model was estimated by maximum likelihood. The temporal dimension comprehends 156 weeks, between years 2014 and 2016. The cross-section length changes according to each different loan category in an unbalanced panel.

The distribution of search costs across buyers exhibits a common pattern. As also found by the authors, consumers seem to be grouped in three major behavior patterns. Some consumers only search for one price. They have quite high search costs and end up paying the monopoly price. The second group quote prices in a few banks before deciding from which one they will borrow from. Finally, a third group visit all firms, thus assuring to pay the lowest possible price, as in a perfect competition scenario. Finally, based on a Kolmogorov-Smirnov goodness-of-fit test is possible to reject the null hypothesis that the observed price distribution is similar to the simulated one, which indicates that other market imperfections and macroeconomic idiosyncrasies are also behind some of the price dispersion observed in this industry.

The paper aim to help shedding light on the importance of search costs behind Brazilian high and dispersed loan interest rates. There is evidence that uninformed consumers are behind some of the industry participants' monopoly power. Being a fully informed consumer in this economy results in welfare improvements. Understanding the behavior of bank interest rates is relevant at a monetary policy level and in welfare analysis. Search costs should be taking into account by both public policies measures and recommendations, assuring the relevance of the topic.

7 References

ALENCAR, Leonardo S. et al. Revisiting Bank Pricing Policies in Brazil: evidence from loan and deposit markets. Ensayos Económicos— 67, p. 36, 2013.

ANCARANI, Fabio; SHANKAR, Venkatesh. Price levels and price dispersion within and across multiple retailer types: Further evidence and extension. Journal of the Academy of Marketing Science, v. 32, n. 2, p. 176-187, 2004.

ANDERSON, Simon P.; RENAULT, Regis. Pricing, product diversity, and search costs: A Bertrand-Chamberlin-Diamond model. The RAND Journal of Economics, p. 719-735, 1999.

ARMSTRONG, Mark; VICKERS, John. Competitive price discrimination. rand Journal of economics, p. 579-605, 2001.

BAYE, Michael R. et al. Information, search, and price dispersion. Handbook on economics and information systems, v. 1, p. 323-375, 2006.

BAYE, Michael R.; MORGAN, John. Information gatekeepers on the internet and the competitiveness of homogeneous product markets. American Economic Review, p. 454-474, 2001.

BLEVINS, Jason R.; SENNEY, Garrett T. Dynamic Selection and Distributional Bounds on Search Costs in Dynamic Unit-Demand Models. Ohio State Department of Economics Working Paper, p. 14-02, 2014.

BURDETT, Kenneth; JUDD, Kenneth L. Equilibrium price dispersion. Econometrica: Journal of the Econometric Society, p. 955-969, 1983.

BORENSTEIN, Severin; ROSE, Nancy L. Competition and price dispersion in the US airline industry. National Bureau of Economic Research, 1991.

BRYNJOLFSSON, Erik; DICK, Astrid Andrea; SMITH, Michael D. Search and product differentiation at an Internet shopbot. 2004.

CAGLAYAN, Mustafa; FILIZTEKIN, Alpay; RAUH, Michael T. Inflation, price dispersion, and market structure. European Economic Review, v. 52, n. 7, p. 1187-1208, 2008.

GATTI, John R. J.; KATTUMAN, Paul. Online price dispersion within and between seven European countries. University of Cambridge, Department of Applied Economics, 2003.

HONG, Han; SHUM, Matthew. Using price distributions to estimate search costs. The RAND Journal of Economics, v. 37, n. 2, p. 257-275, 2006.

HORTAÇSU, Ali; SYVERSON, Chad. Product differentiation, search costs, and competition in the mutual fund industry: a case study of the SP 500 Index Funds. National Bureau of Economic Research, 2003.

JANSSEN, Maarten CW; MORAGA-GONZÁLEZ, José Luis. Strategic pricing, consumer search and the number of firms. The Review of Economic Studies, v. 71, n. 4, p. 1089-1118, 2004.

LACH, Saul. Existence and persistence of price dispersion: an empirical analysis. Re

MORAGA-GONZÁLEZ, José Luis; WILDENBEEST, Matthijs R. Maximum likelihood estimation of search costs. European Economic Review, v. 52, n. 5, p. 820-848, 2008.

NAKANE, Márcio I. Concorrência e spread bancário: uma revisão da evidência para o Brasil. Banco Central do Brasil, Juros e Spread Bancário no Brasil: Avaliação de 4 Anos do Projeto, p. 58-67, 2003.

NAKANE, Márcio I.; KOYAMA, Sérgio M. Search costs and the dispersion of loan interest rates in Brazil. Cemla Papers and Proceedings, 2003.

SANCHES, Fabio A. Miessi; JUNIOR, Daniel Silva; SRISUMA, Sorawoot. Minimum Distance Estimation of Search Costs using Price Distribution. University of São Paulo (FEA-USP), 2015.

STAHL, Dale O. Oligopolistic pricing with sequential consumer search. The American Economic Review, p. 700-712, 1989.

STIGLER, George J. The economics of information. The journal of political economy, p. 213-225, 1961.

VARIAN, Hal R. A model of sales. The American Economic Review, v. 70, n. 4, p. 651-659, 1980.

WILDENBEEST, Matthijs R. An empirical model of search with vertically differentiated products. The RAND Journal of Economics, v. 42, n. 4, p. 729-757, 2011.

APPENDIX A

	Personal		Corporate		
Loan categories	Overdraft	Other goods	Overdraft	Vendor	Promissory notes
Δ_1	69.40 (3.53)	23.08 (1.60)	52.85 (0.14)	4.78 (0.01)	9.84 (3.63)
Δ_2	25.07 (2.74)	9.41 (0.57)	22.83 (1.62)	1.96 (0.01)	3.99 (1.46)
Δ_3	12.60 (1.82)	5.21 (0.53)	12.47 (1.53)	1.12 (0.01)	2.29 (0.47)
Δ_4	7.54 (1.25)	3.38 (0.52)	7.87 (1.26)	0.76 (0.01)	1.58 (0.04)
Δ_5	5.02 (0.90)	2.41 (0.48)	5.45 (1.03)	0.57 (0.01)	1.21 (0.30)
Δ_6	3.59 (0.68)	1.82 (0.43)	4.04 (0.86)	0.45 (0.01)	0.98 (0.44)
Δ_7	2.70 (0.53)	1.43 (0.39)	3.14 (0.72)	0.37 (0.003)	0.82 (0.51)
Δ_8	2.11 (0.42)	1.17 (0.35)	2.53 (0.62)	0.31 (0.002)	0.71 (0.54)
Δ_9	1.70 (0.35)	0.97 (0.31)	2.09 (0.54)	0.26 (0.005)	0.62 (0.55)
Δ_{10}	1.40 (0.29)	0.83 (0.28)	1.77 (0.47)	0.23 (0.001)	0.55 (0.54)
Δ_{11}	1.18 (0.25)	0.71 (0.25)	1.52 (0.42)	0.20 (0.004)	0.50 (0.52)
Δ_{12}	1.01 (0.21)	0.62 (0.23)	1.32 (0.38)	0.18 (0.001)	0.45 (0.50)
Δ_{13}	0.88 (0.19)	0.55 (0.21)	1.16 (0.34)	0.16 (0.002)	0.41 (0.48)
Δ_{14}	0.77 (0.16)	0.49 (0.19)	1.04 (0.31)	0.14 (0.004)	0.37 (0.45)
Δ_{15}	0.68 (0.15)	0.44 (0.17)	0.93 (0.28)	0.13 (0.003)	0.34 (0.43)
Δ_{16}	0.61 (0.13)	0.40 (0.16)	0.84 (0.26)	0.11 (0.002)	0.32 (0.41)
Δ_{17}	0.55 (0.12)	0.37 (0.15)	0.76 (0.24)		0.29 (0.38)
Δ_{18}	0.50 (0.11)	0.33 (0.14)	0.70 (0.22)		0.27 (0.36)
Δ_{19}	0.46 (0.10)	0.31 (0.13)	0.64 (0.20)		0.25 (0.34)
Δ_{20}	0.42 (0.09)	0.28 (0.12)			0.24 (0.32)
Δ_{21}	0.39 (0.08)	0.26 (0.11)			0.22 (0.30)
Δ_{22}	0.36 (0.08)	0.25 (0.10)			0.21 (0.28)
Δ_{23}	0.33 (0.07)	0.23 (0.10)			0.19 (0.27)
Δ_{24}	0.31 (0.07)	0.21 (0.09)			0.18 (0.25)
Δ_{25}	0.29 (0.06)	0.20 (0.09)			0.17 (0.24)
Δ_{26}	0.27 (0.06)	0.19 (0.08)			0.16 (0.22)
Δ_{27}	0.25 (0.06)	0.18 (0.08)			0.15 (0.21)
Δ_{28}	0.24 (0.05)	0.17 (0.07)			0.14 (0.20)
Δ_{29}	0.23 (0.05)	0.16 (0.07)			0.14 (0.19)
Δ_{30}	0.21 (0.05)	0.15 (0.07)			0.13 (0.18)
Δ_{31}	0.20 (0.04)	0.14 (0.06)			0.12 (0.17)
Δ_{32}	0.19 (0.04)	0.14 (0.06)			0.12 (0.16)
Δ_{33}	0.18 (0.04)	0.13 (0.06)			0.11 (0.15)
Δ_{34}	0.17 (0.04)	0.12 (0.05)			0.10 (0.14)
Δ_{35}	0.16 (0.04)	0.12 (0.05)			0.10 (0.14)
Δ_{36}		0.11 (0.05)			0.09 (0.13)
Δ_{37}					0.09 (0.12)
Δ_{38}					0.09 (0.12)
Δ_{39}					0.08 (0.11)
Δ_{40}					0.08 (0.11)
Δ_{41}					0.08 (0.10)
Δ_{42}					0.07 (0.10)
Δ_{43}					0.07 (0.09)
Δ_{44}					0.07 (0.09)
Δ_{45}					0.06 (0.08)
Δ_{46}					0.06 (0.08)
Δ_{47}					0.06 (0.08)
Δ_{48}					0.06 (0.07)
Δ_{49}					0.05 (0.07)
Δ_{50}					0.05 (0.07)
Δ_{51}					0.05 (0.06)

Table 3: Estimated critical search cost values