Intermediaries and competition in markets with search frictions*

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Abstract

In this paper we study the role of intermediaries in markets where prices are determined through search and negotiation. Our focus is on the market for mortgages, specifically the Canadian market. In this market consumers can accept the posted price, or search for quotes in one of two ways: on their own, or using an intermediary–a mortgage broker. Using a broker implies a lower search cost, but yields a lower expected return. The attractiveness of the broker option depends on the set of lenders contacted by the broker. However, in recent years some of the large Canadian banks have started to exclude brokers. Using an augmented version of the model developed in Allen et al (2014) we study the extent to which this vertical exclusion practice reduces the competitiveness of the market.

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1 Introduction

In this paper we study the role of intermediaries in markets where prices are determined through search and negotiation. Our focus is on the market for mortgages, specifically the Canadian market. When shopping for a mortgage contract consumers can pay the rate posted by financial institutions ("sticker price"), or they can search and negotiate for a better offer. In this environment transaction prices are established based on the relative bargaining leverage of buyers and sellers. For sellers, leverage depends on the spread between the posted price and costs. In the case of buyers, leverage is created by the threat of obtaining competitive offers. The credibility of this threat depends in large part on the level of competition and on the cost of searching for multiple offers. In our setting, search is costly both because of the difficulty of obtaining information about prices, and because of the time cost associated with haggling with multiple sellers.

In Canada, there are two main ways for borrowers to search for quotes. One is to personally visit different lenders in search of a discount. Lenders post high regular prices to obfuscate information on actual prices, including on their website and website aggregators, but are willing to offer discounts that reflects the characteristics of borrower and to retain consumers who obtain competitive quotes from multiple lenders. The other possibility is for borrowers to hire an intermediary – a mortgage broker – who search and negotiate on their behalf. Unlike in the U.S., brokers in Canada are hired by borrowers but compensated by lenders. Also different from the U.S. is that Canadian brokers do not originate-to-distribute but instead act solely as match-makers with fiduciary responsibility to the borrower.

The extent to which hiring a broker is an attractive option depends in large part on the set of lenders contacted by the broker. Recent surveys by Maritz Canada and CAAMP (Maritz (2012) and Dunning (2011)) suggest that mortgage brokers contact on average 4.5 lenders per contract. However, in recent years some of the large Canadian banks have started to employ their own "mobile mortgage specialists" and so are increasingly refusing to deal with external financial intermediaries. This implies that the expected value of the "search on your own" option is higher, since brokers are restricted in their ability to gather a large number of quotes. This vertical exclusion practice reduces the competitiveness of the market. This is especially true in the Canadian context because consumers have a preference for combining multiple financial services with the same institution and many consumers already use the large banks for other services.

The impact of this form of exclusion has not been studied empirically in the context of markets with search frictions. The closest empirical study is Hendel et al. (2009)'s paper on the relative performance of MLS and FSBO. Moreover, there is growing interest from policy-makers since the financial crisis, including in Canada and the U.S., regarding the role of financial intermediaries in credit markets.

To study this question we augment the model developed in Allen, Clark and Houde (2014) to incorporate the consumer decision of whether to search with the help of a broker or on their

own. In the first stage, consumers receive a qualifying offer from their home bank. Conditional on rejecting this offer, they have the option of paying a search cost to contact a broker, or to search on their own. We assume that the cost of searching on one's own is more expensive, but that the expected value of this option is greater. Intuitively, either because of the way they search or the exclusion described above, brokers contact a smaller number of lenders than consumers searching on their own.[1] We model the outcome from each search option as an auction featuring different sets of lenders–the full set of lenders in one's neighborhood when searching on one's own, and a subset if using a broker.

We then use the model to evaluate a counter-factual antitrust policy in which banks are prevented from excluding brokers, and focus our attention on two main outcomes: the mis-allocation of contracts, and the ability of banks to price discriminate.

The paper is organized as follows. Section 2 describes the Canadian banking market, including the presence of mortgage brokers. Section 3 introduces our data sets. Section 4 presents a descriptive analysis of the data. Section 5 presents the model. Section **??** discusses the estimation strategy and Section **??** describes the empirical results. Section **??** presents the counterfactuals. Finally, Section **??** concludes.

2 Brokers and the Canadian Mortgage Market

The Canadian mortgage market is currently dominated by six national banks (Bank of Montreal, Bank of Nova Scotia, Banque Nationale, Canadian Imperial Bank of Commerce, Royal Bank Financial Group, and TD Bank Financial Group), a regional cooperative network (Desjardins in Québec), and a provincially owned deposit-taking institution (Alberta's ATB Financial). Collectively, they control 90% of banking industry assets. For convenience we label these institutions the "Big 8."

The large Canadian banks operate nationally and post prices that are common across the country on a weekly basis in both national and local newspapers, as well as online. There is little dispersion in posted prices, especially at the big banks where the coefficient of variation on posted rates is close to zero. In contrast, there is a significant amount of dispersion in transaction rates.

This dispersion comes about because potential borrowers can search for and negotiate over rates. There are two ways borrowers search. The first is for borrowers to bargain directly with local branch managers.[2] Survey evidence from the Altus Group (FIRM) reveals that on average 59% of Canadian borrowers search. Broken down by ownership we see that 67% of new home buyers gather multiple quotes, compared to just 51% for previous home owners. The search probability also varies significantly across demographic groups. In particular, it is higher in more populated

[1] Alternatively, we could assume that brokers search over a set of banks at least as large as borrowers searching on their own and introduce heterogeneity in costs. This would capture the idea that consumers have a preference over large branch networks and brokers are more likely to contact small multi-product lenders or monolines.

[2] Local branch managers compete against rival banks, but not against other branches of the same bank.

than in less populated areas, and for high income than for low income individuals. Since the survey does not condition on more than one variable at a time, the latter results most likely reflect the relationship between loan size and search. In our empirical analysis below we will match these moments.

The second method for searching is for borrowers to hire a broker to search on their behalf. Brokers were present in the Canadian market going back to the 1970s, but they really only penetrated the market starting in the mid 1990's, establishing a national broker association (CIMBL) in 1994. By 2004 brokers were responsible for negotiating roughly 40% of new contracts. Figure 1 presents the evolution of the share of transactions that were broker-assisted in our sample. The rapid increase between 1999 and 2003 has been attributed to consolidation of brokers into "super broker" groups, and to the Canadian Mortgage Bond Program of 2001. Under this program small lenders got access to cheap funding, but they did not have market access. As a result these lenders teamed up with brokers.

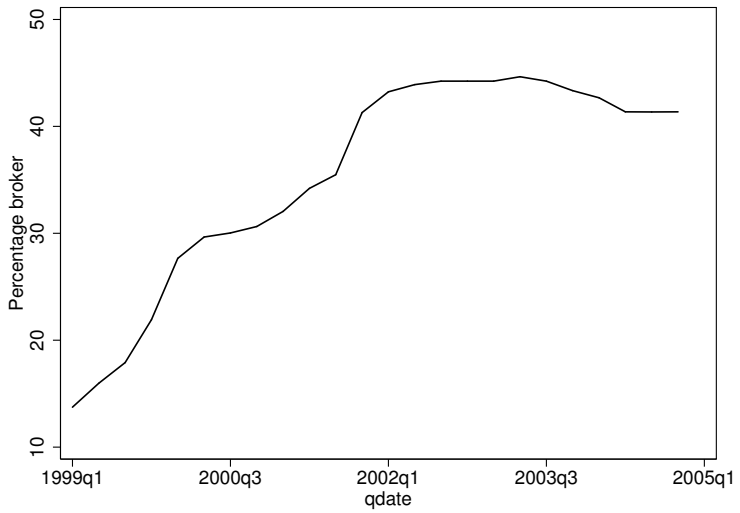


Figure 1: Share of new contracts negotiated with a mortgage brokers

Unlike in the United States (with the exception of California), brokers in Canada have fiduciary duties. Brokers are compensated by lenders, but "hired" by borrowers to gather the best quotes from multiple lenders.[3] Recent surveys by Maritz Canada and CAAMP ((**?**) and (**?**)) suggest that mortgage brokers contact on average 4.5 lenders for each contract.[4] Brokers charge the lender a fee (80-100 bps base commission + compensation based on total volume) and not the con-

[3]In contrast, in the U.S. brokers receive both a cash-fee from the borrower and a yield-spread premium from the lender. The yield-spread premium is an increasing function of both the loan size and the interest rate, therefore brokers in the U.S. do not have an incentive to find borrowers the lowest rate (e.g. (**?**)).

[4]Borrowers could potentially hire several brokers, each gathering an average of 4.5 quotes, however this is something we do not observe.

sumer. A recent trend is for brokers to receive an additional trailer fee if borrower renews with the same lender (long- term contracting). Surveys on broker satisfaction shows borrowers happier with banks and credit unions than brokers; a key reason is that consumers place high value on confidence in the lending institution.

3 Data

The Canadian mortgage market features two types of contracts – conventional, which are uninsured, since they have a low loan-to-value ratio, and high loan-to-value, which require insurance (for the lifetime of the mortgage). Today, 80% of new home-buyers require mortgage insurance. The primary insurer is the Canada Mortgage and Housing Corporation (CMHC), a crown corporation with an explicit guarantee from the federal government. During our sample period a private firm, Genworth Financial, also provided mortgage insurance, and had a 90% government guarantee. CMHC's market share during our sample period averages around 80%. Both insurers use the same guidelines for insuring mortgages, and charge the lenders an insurance premium, ranging from 1.75 to 3.75% of the value of the loan, which is passed on by lenders to borrowers. Appendix A describes the insurance rules, and defines all of the variables included in the data-set.[5]

Our main data-set is a sample of insured contracts from the CMHC, from January 2000 and October 2002. We obtained a 10% random sample of all contracts from CMHC. The data-set contains information on 20 household/mortgage characteristics, including the financial characteristics of the contract (i.e. rate, loan-size, house price, debt-ratio, risk-type), and some demographic characteristics (e.g. income, prior relationship with the bank, residential status, dwelling type). In addition, we observe the location of the purchased house up to the forward sortation area (FSA).[6]

We restrict our sample to contracts with homogenous terms. In particular, from the original sample we select contracts that have the following characteristics: (i) 25 year amortization period, (ii) 5 year fixed-rate term, and (iii) newly issued mortgages (i.e. excluding refinancing and renewal). The final sample includes over 40,000 observations, or most of the initial sample. The largest sample restriction is removing 10% of transactions for which the lender is located more than 5KM away from the centroid of FSA of the new house (see discussion below).

Table 1 describes the main financial and demographic characteristics of the borrowers in our sample broken down by broker and branch transactions, and where we trim the top and bottom 0.5% of observations in terms of income, and loan-size. The resulting sample corresponds to a fairly symmetric distribution of income and loan-size. The average loan-size is about $\$144,000$ in the broker sample and $\$136,000$ in the branch sample, which is more than twice the average

[5] See also Allen et al. (2013) for a detailed discussion of the data.

[6] The FSA is the first half of a postal code. We observe nearly 1,300 FSA in the sample. While the average forward sortation area (FSA) has a radius of 7.6 kilometers, the median is much lower at 2.6 kilometers.

Table 1: Summary statistics on mortgage contracts in the selected sample

	Broker			Branch		
variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Interest rate spread (bps)	14480	122	57.9	26397	143	62.7
Residual spread (bps)	14380	0	47.1	26073	0	50.8
I(Discount=0)	14480	46.1	49.9	26397	30.1	45.9
Monthly payment ($)	14480	979	385	26397	950	398
Total loan ($)	14480	144,126	57,587	26397	135,669	57,585
Income ($	14480	66,013	25,659	26397	69,096	28,704
FICO score	14480	667	71.5	26397	671	72.4
Switcher	14191	76.4	42.5	21651	26.9	44.3
I(Max. LTV)	14480	40.7	49.1	26397	37.7	48.5
I(Previous owner)	14480	14.8	35.5	26397	27.3	44.5
Number of FIs (10 KM)	14480	7.61	1.39	26397	7.44	1.59
HHI (10 KM)	14283	1860	745	25784	1940	932
Relative branch network	14386	1.04	1.01	26093	1.42	1

annual household income. The average monthly payment is $960.

Importantly, only about 27% of households switch banks when searching and negotiating a new mortgage contract on their own, versus over 75% when searching through a broker. This high loyalty rate in the branch transactions is consistent with the fact that most branch transactions are with the large banks, and most consumers combine multiple financial services with the same bank. The large Canadian banks are increasingly offering bundles of services to their clients, helped in part by the deregulation of the industry in the early 1990s. For instance, a representative survey of Canadian finances from Ipsos-Reid shows that 67% of Canadian households have their mortgage at the same financial institution as their main checking account.

The loan-to-value (LTV) variable shows that many consumers are constrained by the minimum down-payment of 5% imposed by the government guidelines. Around 40% of households invest the minimum. Because of the piece-wise linear structure of the insurance premiums, LTV ratios are highly localized around 90 and 95.

3.1 Broker data

We collected information on broker locations from a directory of brokers gathered annually by the Canadian Association of Accredited Mortgage Professionals. The directory has information on the broker and his/her associated firm. We then measure distances from the households in our main data set to each broker-agent using Mapquest and Google Maps. Unfortunately, the directory is missing for 2000 and 2002. We therefore use broker locations as presented in 2003 to capture the regional dispersion in brokers.[7]

[7]We have also experimented with interpolating location information. However, the time-series variation is minimal.

Table 2: Mortgage Brokers in Canada in 2003: Summary Statistics

variable	N	mean	sd	p25	p50	p75
Number agents (50KM)	40618	93	98.9	19	44	139
Number of firms (50KM)	40618	30.7	31.3	7	22	41
Number of agents/Number of firms (50KM)	40618	2.55	1.11	1.83	2.45	3.31

Table 2 contains information on the number of brokers and associated firms per market (50KM), which we use as exclusion restrictions in the two-stage rate regressions in Table 7. We use a 50KM radius for brokers rather than a 10KM radius for bank branches given that broker offices are slightly more concentrated in cities (see Table 4) but are most often contacted by phone or the internet and willing to travel longer distances to meet with clients. On average a firm has 2.5 agents and there are on average 93 agents in a 50KM radius of a borrower's location. Table 3

Table 3: Mortgage Brokers in Canada: distribution by lender type

	Broker	Bank branch
Big 6	25.2	75.8
Credit Unions	31.6	68.4
Other FIs	77.3	25.2

contains information on the distribution of brokers by lender type. For the Big 6 banks and for credit unions the vast majority of transactions are done at branches. On the other hand, for other financial institutions (small multi-product lenders as well as monolines), most transactions are done through brokers.

Table 4: Mortgage Brokers in Canada: distribution by city size

	Broker	Bank branch
Tercile 1 (small)	32.2	67.8
Tercile 2 (medium)	35.8	62.2
Tercile 3 (large)	38.3	61.7

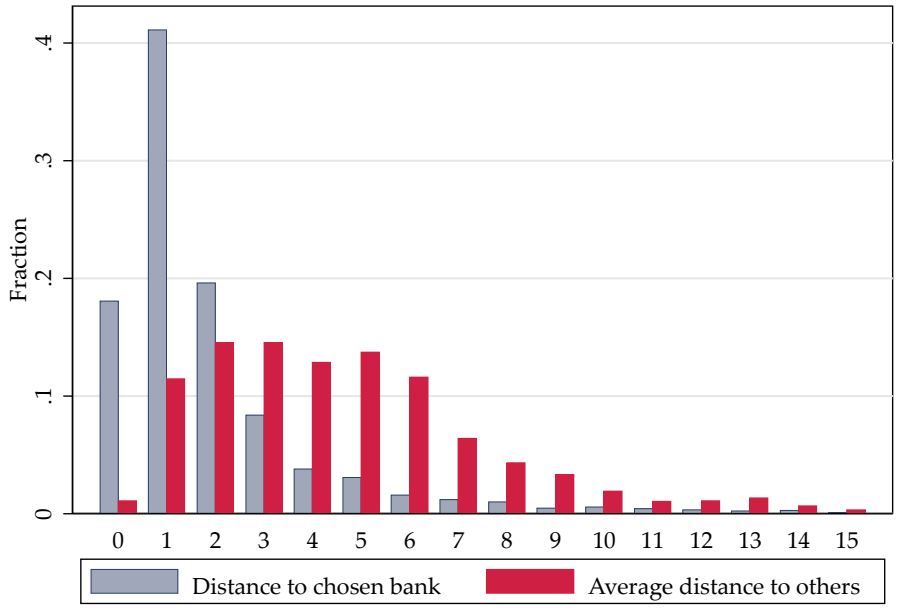
Note that city size is based on population of 15 and over in 2001.

3.2 Local markets and lender information

Our main data-set contains the lender information for ten lenders during our sample period (the big 8 plus Canada Trust and Vancity). For mortgage contracts where we do not have a lender name but only a lender type, these are coded as "Other Bank", "Other credit union", and "Other trusts". The credit-union and trust categories are fragmented, and contain mostly regional financial institutions. We therefore combine both into a single "Other Lender" category.

The "Other Bank" category includes mostly two institutions: Laurentian Bank and HSBC. The former is only present in Québec and Eastern Ontario, while the latter is present mostly in British Colombia and Ontario. We exploit this geographic segmentation and assign the "Other banks" customers to HSBC or Laurentian based on their relative presence in the local market around each home location. After performing this imputation, consumers face at most 13 lending options: the Big 8, Canada Trust, Laurentian Bank, Vancity, HSBC, and Other Lender.

Figure 2: Distribution of minimum distances between banks and consumers for branch transactions



Note: Distances are calculated over bank located within at least 50 Km.

Not all consumers have access to every option, because of the uneven distribution of branches across local markets. We exploit this variation by assuming that consumers shop for their mortgage locally, in a neighborhood around the location of their new house (e.g. municipality). We define this as a consumer's choice set, which is their home bank h plus all other banks in their neighborhood, $\mathcal{N}_i$. To implement this, we match the new house location with the postal code associated with each financial institution's branches (available annually from Micromedia-ProQuest). The information relative to the location of each house is coarser than the location of branches. Therefore, we assume that each house is located in the center of its FSA, and calculate a somewhat large Euclidian distance radius of 10KM around it to define the borrower's maximum choice-set. Formally, a lender is part of consumer i's maximum choice-set if it has a branch located within less than 10KM of the house location. With the help of this, we measure the relative presence of each lender (i.e. number of branches in a choice-set) as the ratio of the number of branches of each

bank, divided by the average number of branches of competing networks.

Figure 2 illustrates the distribution of minimum distances between each house's FSA centroid and the closest branch of each lender for all branch transactions. On average consumers transact with banks that tend to be located close to their house. The average minimum Euclidian distance is nearly 1.5KM for the chosen institution, and 2.4KM for the other lenders. In fact the distributions indicate that 80% of consumers transact with a bank that has a branch within 2KM of their new house, while only 40% of consumers have an average distance to competing lenders less than or equal to 2KM.

This feature reflects the fact that consumers tend to choose lenders with large networks of branches. Table 1 reports the average network size of the chosen institution relative to the average size of others present in the same neighborhood (i.e. relative network size). On average consumers shopping on their own transact with lenders that are around 40% larger than their competitors in terms of branches, while consumers using a broker wind up with banks with average networks. Table 1 also presents measures on the level of concentration in a consumers choice-set. On average each consumer faces about 7 lenders within 10KM. Most of these banks have a relatively small presence, indicated by the large Herfindahl-Hirschman index, calculated using the distribution of branches within 10KM of each contract.

4 Descriptive analysis

4.1 Rate dispersion

Table 5 describes the distribution of publicly available posted rates across lenders. The first column shows the fraction of weeks for which lenders post the maximum rate, which is posted by one of the national lenders. All of the national and regional lenders, plus some of the trusts post this rate the vast majority of the time. In contrast, low-cost lenders often deviate from this price. Moreover, from columns 2-4 we can see the extent of these deviations. When the national and regional lenders, and the trusts deviate it is typically to set a rate that is slightly below or slightly above the maximum national lender posted rate. In contrast, when the low-cost lenders deviate it is to post a much lower rate than the one offered by the larger lenders. In the modeling section we define the low-cost lenders as no-haggle lenders. The offered posted price is lower than other lenders but they do not bargain over prices. First Line and ING are both "no haggle" lenders. Since 2002 some of the large banks have always experimented with no haggle, specifically TD Bank and BMO, but this did not last long.

Figure 3a plots the density of borrower-specific discounts off the rate posted by the contracting financial institution. Approximately 30% of borrowers shopping on their own and 50% of borrowers using brokers pay the posted rate.[8] The remainder receive a discount. Conditional on

[8]This is based on the posted price being defined as the posted rate within 90 days from the closing date minus the

Table 5: Posted rate distribution

	Posted-rate dispersion: $\bar{r}_t^{\max} - \bar{r}_{jt}$			
	Fraction	Non-zero differences		
	$\bar{r}_t^{\max} - \bar{r}_{jt} = 0$	$P25$	$P50$	$P75$
National Lenders				
BMO	0.92	0.10	0.15	0.20
CIBC	0.95	0.15	0.15	0.25
Scotia Bank	0.84	0.05	0.15	0.22
RBC	0.86	0.05	0.12	0.18
TD	0.97	0.15	0.18	0.25
Regional Lenders				
ATB	0.89	0.10	0.15	0.20
Desjardins	0.88	-0.15	0.10	0.20
HSBC	0.82	-0.03	0.15	0.20
NBC	0.95	-0.20	-0.15	0.15
Laurentian	0.87	-0.15	0.10	0.20
Trust companies				
Canada Trust	0.98	0.25	0.25	0.25
London Life	0.84	-0.15	0.12	0.18
Royal Trust	0.58	-0.30	0.05	0.30
National Trust	0.70	-0.25	0.05	0.15
Low-cost lenders				
First Line	0.01	0.66	0.73	0.85
ING	0.00	1.00	1.05	1.20
Montreal Trust	0.10	0.10	0.60	1.10

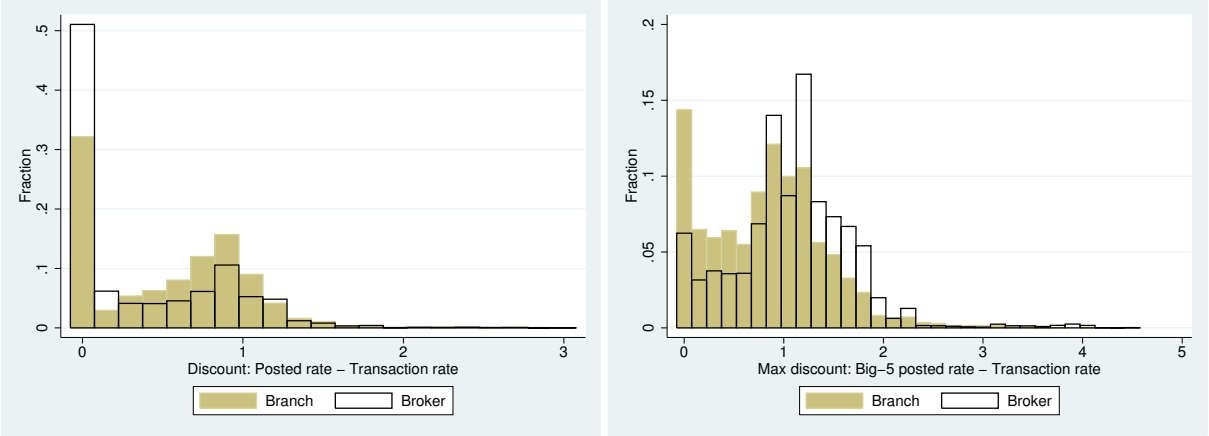
Montreal Trust and National Trust are owned by Scotia Bank, Royal Trust is owned by RBC, and First-Line is owned by CIBC. Canada-Trust was acquired by TD in 2000, stopped operating as a separate lender. The variable $\bar{r}_t^{\max}$ denotes the maximum posted-rate offered by one of the national lender in week t. Sample period: 01/01/2000 to 31/20/2002. All rates in this table are publicly available.

receiving a positive discount, the median discount is 75 bps, while the 25th and 75th percentile discounts are 55 and 95 bps for branch transactions and 35 and 95 basis points for broker transactions, respectively. Brokers are much less likely to offer a discount off the posted rate. However, brokers tend to seek out low-posted rate lenders.

Panel 3b shows the discount relative to the posted rate at the Big 5. In contrast to the distribution of discounts in panel 3a, here we see that relatively few consumers using brokers pay a rate equal to the posted rate at the Big 5. If they are paying the posted rate it is because the posted rate at the financial institution offering them the contract is lower than at the Big 5.

Figure 4 illustrates the dispersion by plotting the distribution of retail interest rates in the sample, for broker and non-broker transactions, respectively. We measure spreads using the swap-

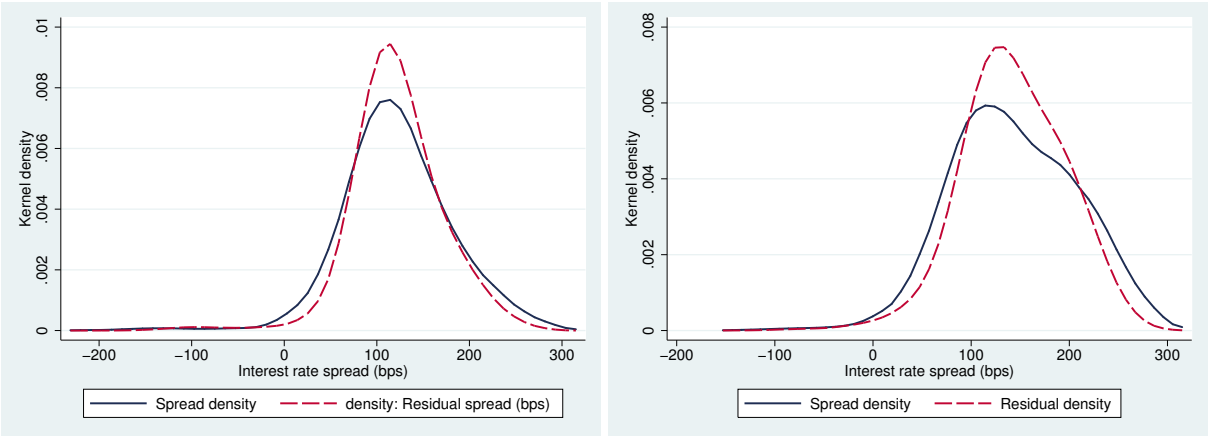
negotiated rate. The majority of lenders offer 90-day rate guarantees, which is why we use this definition. Some lenders have occasionally offered 120-day rate guarantees.



(a) Discounts (b) Maximum discounts

Figure 3: Discounts between 2000-2002

adjusted 5-year bond-rate as a proxy for marginal cost. The transaction rate is on average 144 basis points above the 5-year bond rate for branch transactions and 122 basis points for broker transactions; both densities exhibits substantial dispersion. Importantly, a large share of the dispersion is left unexplained when we control for a rich set of covariates: financial characteristics, week fixed effects, lender/province fixed-effects, lender/year fixed-effects, and location fixed-effects. These covariates explain 35% of the total variance of observed spreads. The figure also plots the residual dispersion in spreads. The standard-deviation of retail spreads is equal to 58 basis points in the broker sub-sample and 63 basis points for the branch sub-sample, while the residual spread has a standard-deviation of 47 basis points in the broker sub-sample and 51 basis points for the branch sub-sample.



(a) With Brokers (b) Without Brokers

Figure 4: Dispersion of interest rate spreads between 2000-2002

4.2 Broker analysis

4.2.1 Broker use

In aggregate 35.4% of borrowers used a broker between the start of 2000 and 2002. In Table 6 we characterize the probability of using a broker. We model the probability of using a broker using a Probit model. We include the same control variables used to explain margins below, and also control for the presence of brokers near the purchased house. We use three measures of broker presence: the number of broker-agents, the number of broker-firms, and the ratio of broker agents to brokerage firms (hereafter denoted by the broker share) all in 2003. Both variables are measured within a 50KM radius of a borrower's FSA; the same choice-set definition we use for lenders. Between 1999 and 2002, brokers progressively entered nearly every market in our data-set, and increasingly organized their services into regional firms. The two variables therefore capture regional differences in the diffusion of brokers, and the increase in the concentration of the broker market. Since we also control for week and province fixed-effects, the two variables do not exploit variation due to aggregate trends or systematic regional differences in rates and adoption.

4.2.2 Broker rates

Table 7 shows the effect on rates. Columns (1) to (3) present results from the OLS regression without controlling for selection. Columns (2) and (3) control for FSA fixed effects and market structure (as measure in 1999), respectively. Column (4) controls for the inverse-mills ratio estimated from Table 6. The coefficient on the inverse mills ratio is positive and significant, suggesting that not only is there selection on observables, but there is also selection on unobservables. Comparing the results in columns (1)-(3) and (4) we can see that not correcting for selection leads to a downward bias in the broker coefficient. The sign of the bias suggests that households who would otherwise negotiate relatively smaller discounts on their own for unobserved reasons are more likely to hire a broker. This bias is sizeable: we estimate that brokers are able to negotiate rates that are on average 50 basis-points lower than individual borrowers, compared to about 15 basis-points in columns (1) to (3).

Table 6: Probability of using a broker

LABELS	(1) broker
Loan size (/100,000)	0.0718
	(0.0461)
Income (/100,000)	-0.729***
	(0.126)
Loan/income	0.228***
	(0.0325)
Maximum LTV	0.0759***
	(0.0159)
Total debt ratio (%)	-0.0227***
	(0.00329)
renter	0.462***
	(0.0195)
parents	0.318***
	(0.0328)
Other debts	0.321***
	(0.0495)
FICO score (/1000)	-0.699***
	(0.105)
Bond rate	0.155***
	(0.0211)
Number of brokers (2003)	-0.000446
	(0.000404)
Number of broker-firms (2003)	0.00225**
	(0.00113)
Brokers/Firm (2003)	0.0883***
	(0.0134)
Constant	-1.694***
	(0.274)
Observations	39,653
1999 market structure	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Mortgage Brokers in Canada: Rates

VARIABLES	(1) rate	(2) rate	(3) rate	(4) rate	(5) No broker	(6) Broker
broker	-0.160***	-0.155***	-0.160***	-0.502***		
	(0.00776)	(0.00801)	(0.00779)	(0.0516)		
Relative branch network (10KM)	0.0246***	0.0202***	0.0239***	0.0137**	0.0330***	-0.00916
	(0.00565)	(0.00575)	(0.00558)	(0.00564)	(0.00686)	(0.00955)
Nb of fringe lenders (10KM)= 1.0000	-0.0517*	-0.0588	-0.0767**	-0.0868***	-0.140***	0.0224
	(0.0267)	(0.0543)	(0.0332)	(0.0328)	(0.0283)	(0.0531)
Nb of fringe lenders (10KM)= 2.0000	-0.0795***	-0.0573	-0.116***	-0.131***	-0.190***	0.0223
	(0.0254)	(0.0610)	(0.0363)	(0.0356)	(0.0336)	(0.0629)
Nb of fringe lenders (10KM)= 3.0000	-0.0920***	-0.118*	-0.117***	-0.129***	-0.180***	0.00828
	(0.0256)	(0.0629)	(0.0378)	(0.0372)	(0.0361)	(0.0638)
Nb of fringe lenders (10KM)= 4.0000	-0.0904***	-0.156**	-0.128***	-0.129***	-0.200***	0.00211
	(0.0271)	(0.0685)	(0.0436)	(0.0432)	(0.0459)	(0.0755)
Nb of fringe lenders (10KM)= 5.0000	-0.141***	-0.278***	-0.178***	-0.154***	-0.249***	-0.0494
	(0.0327)	(0.0688)	(0.0481)	(0.0482)	(0.0519)	(0.0801)
Inverse Mills				0.202***	0.221***	-0.326***
				(0.0303)	(0.0557)	(0.0667)
Constant	3.803***	3.545***	3.794***	3.793***	3.828***	4.161***
	(0.111)	(0.108)	(0.113)	(0.113)	(0.136)	(0.215)
Observations	39,653	39,653	39,653	39,653	25,418	14,235
R-squared	0.707	0.716	0.707	0.708	0.690	0.737
FSA FE	No	Yes	No	No	No	No
1999 market structure	No	No	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2.3 Broker exclusion

In Table 8 we present results from a regression in which for each of the predominant banks (which we denote A,B,C, etc.) we estimate the probability that the observed contract is generated by a broker. The regressors are the usual ones at the household level. The key variable of interest is the log share of branches of each bank in a 10KM radius. If branch presence affected equally the probability of giving quotes to brokers or consumers, the coefficient should be zero. We find that it is negative for almost all of the banks, and very significant in the pooled sample of the predominant banks. In other words, big banks are more likely to offer loans to brokers in market where they do not have a large branch presence. That is, they exclude brokers in order to avoid cannibalizing their line of business.

Table 8: Exclusion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LABELS	A	B	C	D	E	F	G	Full sample
Log branch share (A)	-0.229							
	(0.163)							
Log branch share (B)		-0.341***						
		(0.0854)						
Log branch share (C)			0.115					
			(0.168)					
Log branch share (D)				-0.257***				
				(0.0895)				
Log branch share (E)					-0.100			
					(0.128)			
Log branch share (F)						-0.133**		
						(0.0655)		
Log branch share (G)							-0.144*	
							(0.0785)	
Log branch share								-0.364***
								(0.0244)
Constant	-0.484	-0.513	2.790*	-2.730***	-3.239***	-0.702	-2.287***	-2.781***
	(0.988)	(0.807)	(1.513)	(0.744)	(0.774)	(0.479)	(0.490)	(0.229)
Observations	2,626	3,905	1,988	3,204	4,920	7,437	6,060	30,216

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 Model

The game takes place over two stages. Initially, borrowers are randomly matched with lender j with probability m_j, and both parties observe the cost of transacting with this lender, denoted by c_0. The initial lender then makes an offer p^0 that maximize its expected profit, and the consumer decides to accept this offer, or reject it and search for additional offers. If the borrower elects to search, the initial offer can be recalled and so it serves as a reserve price.

Consumers face two search options: (i) conduct a limited search by hiring a broker at cost $\lambda\kappa_i$, and (ii) conduct an extended search at cost κ_i. The search cost κ_i is privately observed by the consumer. We denote the search options by $k_i \in \{a, b, s\}$, where a, b, and s represent $accept$, $broker$ and $search$ respectively, and the number of quotes by n_k. We assume that consumers performing an extended search get quotes from all of the $\mathcal{N}_i$ lenders in their neighbourhood, while those using a broker get just two such that $n_b = 2$.

We use $c_{(l)}$ to denote the l^{th} lowest cost option in $\mathcal{N}_i$. The distribution of costs for firm j is given by $G_j(x) = \Pr(c_j < x)$, and we use $G_{(l)}(x) = \Pr(c_{(l)} < x)$ to denote the CDF of the l^{th} order statistic of the cost distribution.

An important feature of the market is the presence of no-haggling lenders offering low posted rates. Let $\bar{p}_L$ denote the monthly payment associated with this posted rate and assume that borrowers engaging in search, either on their own or with a broker, will always get a quote from this lender if they qualify. With probability $G(\bar{p}_L)$ the consumer qualifies for a loan from this lender, and so the low posted rate becomes the reserve price (instead of p^0), with the important exception that a no-haggling lender cannot undercut other banks. We assume further that the initial quote is higher than the lowest posted-price (i.e. $\bar{p}_L \leq p^0$ and $c_0 < p^0$).

5.1 Competition stage

In the second stage of the game, if consumers choose to perform an extended search, the transaction is the outcome of an english auction between $n_k + 1$ lenders (i.e. the choice-set includes the initial lender, and n_k other lenders, one of which is the no-haggling lender). Let $c_{(1)}$ and $c_{(2)}$ denote the lowest and second lowest cost among lenders in the choice-set (excluding the initial lender). Since the reserve price $r \in \{p^0, \bar{p}_L\}$ can be recalled, the outcome of this game is given by:

$$p^* = \begin{cases} r & \text{If } r < c_{(1)} \\ c_{(1)} & \text{If } r > c_{(1)} > c_{i0} \\ \min\{c_{i0}, c_{(2)}\} & \text{If } c_{(1)} < c_{i0} \end{cases} \tag{1}$$

Then $E(p^*|r, n_k)$ denotes the expected transaction price:

$$\begin{aligned} E(p^*|r,n_k) &= r(1-G_{(1)}(r|n_k)) + \int_{\min\{c_0,r\}}^{r} c_{(1)} dG_{(1)}(c_{(1)}|n_k) \\ &\quad + \min\{c_0,r\}\left[G_{(1)}(\min\{c_0,r\}|n_k) - G_{(2)}(\min\{c_0,r\}|n_k)\right] + \int_{-\infty}^{\min\{c_0,r\}} c_{(2)} dG_{(2)}(c_{(2)}|n_k) \end{aligned}$$

Recall from above that the consumer qualifies for a loan from the no-haggle lender with probability $G(\bar{p}_L)$, therefore we can rewrite this as:

$$E(p^*|p^0,\bar{p}_L,n_k) = G(\bar{p}_L)\left[E(p^*|\bar{p}_L,n_k)\right] + (1-G(\bar{p}_L))\left[E(p^*|p^0,n_k)\right]$$

For notational simplicity, henceforth we will express the expected transaction price conditioning only on p^0 and not $\bar{p}_L$, since this is how we will express the likelihood.

We assume that $\mathcal{N}_i \geq 2$, and therefore the expected value of using a broker is lower than the expected value of performing an extended search. Therefore, the value of the three options, (i) accept p^0, (ii) search on own, and (iii) search with a broker, are ranked, and the optimal search strategy is characterized by two cutoffs:

$$\text{Choice}_i = \begin{cases} \text{Accept } p^0 & \text{If } \kappa_i \geq \bar{\kappa}_b\left(p^0\right) \\ \text{Broker} & \text{If } \bar{\kappa}_b\left(p^0\right) > \kappa_i \geq \bar{\kappa}_s\left(p^0\right) \\ \text{Search} & \text{If } \kappa_i < \bar{\kappa}_s\left(p^0\right) \end{cases} \tag{2}$$

where $\bar{\kappa}_b\left(p^0\right) = \frac{p^0 - E(p^*|p^0,2)}{\lambda}$ is the search cost of a consumer indifferent between accepting p^0 and hiring a broker, and $\bar{\kappa}_s\left(p^0\right) = \frac{E(p^*|p^0,2) - E(p^*|p^0,n)}{(1-\lambda)}$ is the search cost of a consumer indifferent between hiring a broker and searching on his own. This threshold rule leads to the following choice-probability function:

$$s_k(p^0) = \begin{cases} 1 - H\left(\bar{\kappa}\left(p^0\right)\right) & \text{If } k = \text{Accept}, \\ H\left(\bar{\kappa}_b\left(p^0\right)\right) - H\left(\bar{\kappa}_s\left(p^0\right)\right) & \text{If } k = \text{Broker}, \\ H\left(\bar{\kappa}_s\left(p^0\right)\right) & \text{If } k = \text{Search}. \end{cases} \tag{3}$$

5.2 Initial offer

The expected profit of the initial lender is given by:

$$\begin{aligned}
E\left(\pi|p^0\right) &= (p^0-c_0)s_a(p^0) \\
&\quad + \sum_{k\in\{b,s\}} s_k(p^0)\Bigg[G(\bar{p}_L)\left((\max\{c_0,\bar{p}_L\}-c_{i0})(1-G_{(1)}(\bar{p}_L|n_k)) + \int_{\min\{c_0,\bar{p}_L\}}^{\bar{p}_L}(c_{(1)}-c_{i0})dG_{(1)}(c_{(1)}|n_k)\right) \\
&\quad +(1-G(\bar{p}_L))\left((p^0-c_{i0})(1-G_{(1)}(p^0|n_k)) + \int_{c_{i0}}^{p^0}(c_{(1)}-c_{i0})dG_{(1)}(c_{(1)}|n_k)\right)\Bigg]
\end{aligned}$$

The optimal initial quote is given by the following first-order condition:

$$\begin{aligned}
&s_a(p^0) + (p^0-c_{i0})s_a'(p^0) \\
&+ \sum_{k\in\{b,s\}} s_k'(p^0)\Bigg[G(\bar{p}_L)\left((\max\{c_0,\bar{p}_L\}-c_{i0})(1-G_{(1)}(\bar{p}_L|n_k)) + \int_{\min\{c_0,\bar{p}_L\}}^{\bar{p}_L}(c_{(1)}-c_{i0})dG_{(1)}(c_{(1)}|n_k)\right) \\
&+(1-G(\bar{p}_L))\left((p^0-c_{i0})(1-G_{(1)}(p^0|n_k)) + \int_{c_{i0}}^{p^0}(c_{(1)}-c_{i0})dG_{(1)}(c_{(1)}|n_k)\right)\Bigg] \\
&+ \sum_{k\in\{b,s\}} s_k(p^0)(1-G(\bar{p}_L))\left[1-G_{(1)}(p^0|n_k)\right] = 0
\end{aligned}$$

The marginal effect of p^0 on the search probabilities are given by:

$$\begin{aligned}
\frac{\partial s_a}{\partial p^0} &= -h(\bar{\kappa}_b)\frac{1-(1-G(\bar{p}_L))(1-G_{(1)}(p^0|n=2))}{\lambda} \\
\frac{\partial s_b}{\partial p^0} &= h(\bar{\kappa}_b)\frac{1-(1-G(\bar{p}_L))(1-G_{(1)}(p^0|n=2))}{\lambda} - h(\bar{\kappa}_s)\frac{(1-G(\bar{p}_L))(G_{(1)}(p^0|n>2)-G_{(1)}(p^0|n=2))}{1-\lambda} \\
\frac{\partial s_s}{\partial p^0} &= h(\bar{\kappa}_s)\frac{(1-G(\bar{p}_L))(G_{(1)}(p^0|n>2)-G_{(1)}(p^0|n=2))}{1-\lambda}
\end{aligned}$$

where $h(\bar{\kappa}_k)$ is the density of the search cost distribution, and the derivative of each threshold is given by:

$$\begin{aligned}
\frac{\partial \bar{\kappa}_b}{\partial p^0} &= \frac{1}{\lambda}\left[1-\frac{\partial E(p^*|p^0,n=2)}{\partial p^0}\right] = \frac{1-(1-G(\bar{p}_L))(1-G_{(1)}(p^0|n=2))}{\lambda} \\
\frac{\partial \bar{\kappa}_s}{\partial p^0} &= \frac{1}{1-\lambda}\left[\frac{\partial E(p^*|p^0,n=2)}{\partial p^0} - \frac{\partial E(p^*|p^0,n>2)}{\partial p^0}\right] = \frac{(1-G(\bar{p}_L))(G_{(1)}(p^0|n>2)-G_{(1)}(p^0|n=2))}{1-\lambda}
\end{aligned}$$

References

Allen, J., R. Clark, and J. F. Houde (2013). Price dispersion in mortgage markets. Forthcoming *Journal of Industrial Economics*.

A Data description

Our data-set consists of a 10% random sample of insured contracts from CMHC. It covers the period from 1992 to 2004. We restrict our analysis to the 2000-2002 period for two reasons. First, between 1992 and 1999, the market transited from one with a larger fraction of posted-price transactions and loans originated by trust companies, to a decentralized market dominated by large multi-product lenders. Our model is a better description of the latter period. Second, between November 2002 and September 2003, TD-Canada Trust experimented with a new pricing scheme based on a "no-haggle" principle. Understanding the consequences of this experiment is beyond the scope of this paper, and would violate our confidentiality agreement.

We also have access to data from Genworth Financial, but use these only to test for robustness, since we are missing some key information for these contracts. We obtained the full set of contracts originated by the 12 largest lenders and further sampled from these contracts to match Genworth's annual market share.

Both insurers use the same guidelines for insuring mortgages. First, borrowers with less than 25% equity must purchase insurance.[9] Second, borrowers with monthly gross debt service (GDS) payments that are more than 32% of gross income or a total debt service (TDS) ratio of more than 40% will almost certainly be rejected. Crucial to the guidelines is that the TDS and GDS calculations are based on the posted rate and not the discounted price. Otherwise, given that mortgages are insured, lenders might provide larger discounts to borrowers above a TDS of 40 in order to lower their TDS below the cut-off. The mortgage insurers charge the lenders an insurance premium, ranging from 1.75 to 3.75% of the value of the loan – lenders pass this premium onto borrowers. Insurance qualifications (and premiums) are common across lenders and based on the posted rate. Borrowers qualifying at one bank, therefore, know that they can qualify at other institutions, given that the lender is protected in case of default.

[9] This is, in fact, not a guideline, but a legal requirement for regulated lenders. After our sample period, the requirement was adjusted and today borrowers with less than 20% equity must purchase insurance.

Table 9: Definition of Household / Mortgage Characteristics

Name	Description
FI	Type of lender
Source	Identifies how lender generated the loan (branch, online, broker, etc)
Income	Total amount of the borrower(s) salary, wages, and income from other sources
TDS	Total debt service ratio
GDS	Gross debt service
Duration	Length of the relationship between the borrower and FI
R-status	Borrowers residential status upon insurance application
FSA	Forward sortation area of the mortgaged property
Market value	Selling price or estimated market price if refinancing
Applicant type	Quartile of the borrowers risk of default
Dwelling type	10 options that define the physical structure
Close	Closing date of purchase or date of refinance
Loan amount	Dollar amount of the loan excluding the loan insurance premium
Premium	Loan insurance premium
Purpose	Purpose of the loan (purchase, port, refinance, etc.)
LTV	Loan amount divided by lending value
Price	Interest rate of the mortgage
Term	Represents the term over which the interest rate applies to the loan
Amortization	Represents the period the loan will be paid off
Interest type	Fixed or adjustable rate
$CREDIT$	Summarized application credit score (minimum borrower credit score).

Some variables were only included by one of the mortgage insurers.

B Robustness

Table 10: Summary statistics on mortgage contracts in the joint CMHC and Genworth sample

variable	N	mean	sd	p25	p50	p75
loan	35,457	140,015	56,606	94,257	131,846	177,548
income	35,457	69,535	27,630	49,946	65,292	83,232
payment	35,457	974	387	665	920	1223
spread	35,457	1.26	.63	.82	1.22	1.69
I(no discount)	35,457	22.6	41.8	0	0	0
switch	22,815	26.7	24.2	0	1	1
credit score	35,457	668	72.1	650	700	750
I(LTV=95)	35,457	36.9	48.2	0	0	1
previous owner	35,457	24.3	42.9	0	0	0

Table **??** provides summary statistics for the main data-set, which is based only on contracts insured by CMHC. For robustness we also include estimate the model using contracts insured by Genworth Financial, even though there are more missing observations. This table provides summary statistics of the full sample.

Table 11: MLE estimation results for alternative specifications[10]

	(1)	(2)	(3)
Parameters	No Heterogeneity	W/ Genworth	$\omega = 100$
Common shock (σ_ε)	0.288	0.290	0.247
	(0.002)	(0.002)	(0.002)
Idiosyncratic shock (σ_u)	0.124	0.156	0.155
	(0.002)	(0.002)	(0.003)
Avg. search cost:			
$\bar{\kappa}_0$	-1.080	-1.660	-1.275
	(0.013)	(0.028)	(0.016)
$\bar{\kappa}_{\text{inc}}$		0.576	0.143
		(0.039)	(0.018)
$\bar{\kappa}_{\text{owner}}$		0.326	0.820
		(0.043)	(0.013)
Loyalty premium:			
λ_0	-1.780	-1.973	-1.822
	(0.011)	(0.008)	(0.005)
λ_{inc}		0.692	0.670
		(0.004)	(0.002)
λ_{owner}		0.020	0.260

		(0.003)	(0.002)
Measurement error:	0.936	0.941	0.886
	(0.004)	(0.005)	(0.004)
Cost function:			
Intercept	3.510	3.871	3.430
	(0.063)	(0.247)	(0.043)
Bond rate	0.610	0.580	0.629
	(0.009)	(0.039)	(0.006)
Loan size	0.035	0.083	0.077
	(0.012)	(0.015)	(0.015)
Income	-0.024	-0.214	-0.098
	(0.025)	(0.030)	(0.028)
Loan/Income	-0.078	-0.109	-0.077
	(0.009)	(0.012)	(0.010)
Other debt	-0.054	-0.046	-0.043
	(0.006)	(0.007)	(0.005)
FICO score	-0.501	-0.518	-0.463
	(0.029)	(0.033)	(0.029)
Max. LTV	0.060	0.060	0.053
	(0.004)	(0.005)	(0.004)
Previous owner	0.017	-0.008	-0.093
	(0.005)	(0.006)	(0.005)
Number of parameters	43	47	47
LLF/10,000	-4.062	-4.279	-5.037
Likelihood-ratio test: $2 \times (\mathcal{L}_{\text{base}} - \mathcal{L}_0)$	943.371	5274.540	20437.486
Sample size	29,000	35,457	29,000

[10] Average search cost function: $\log(\bar{\kappa}_i) = \kappa_0 + \kappa_{\text{inc}}\text{Income}_i + \kappa_{\text{owner}}\text{Previous owner}_i$. Home bank premium function: $\log(\lambda_i) = \lambda_0 + \lambda_{\text{inc}}\text{Income}_i + \lambda_{\text{owner}}\text{Previous owner}_i$. Cost function: $C_i = L_i \times (Z_i\beta + \varepsilon_i - u_i)$. Units: \$/100. All specifications include year, market and bank fixed-effects. The likelihood ration test is calculated relative to the baseline specification presented in Table **??**.